14th International Green Energy Conference (IGEC-XIV)

July 4-8, 2022

Virtual Conference

Program

(updated on July 2, 2022)

International Association for Green Energy

UNIVERSITY OF WATERLOO

University of Glasgow

Acknowledgement

We would like to thank our sponsors!

14th International Green Energy Conference (IGEC-XIV)

Agenda

Monday, July 4, 2022

Preliminary Plan	(All Eastern Time, UTC−04:00)						
8:00 am - 8:50 am	**Opening Session** **Zoom ID: 464 008 2022**						
8:50 am - 8:55 am	**Break**						
Session S1: Energy harvesting & storage 1 Session Chairs: Xiaoya Li Zoom ID: 464 009 2022		**Session S2 Renewable and clean energy 1** Session Chairs: Abolaji Rasaki, Kaushik Saha Zoom ID: 464 010 2022		**Session S3 Energy systems modelling and optimization 1** Session Chairs: Chuang Wen, Hongbing Ding Zoom ID: 464 011 2022		**Session S4 Hydrogen and fuel cells 1** Session Chairs: Samaneh Shahgaldi Zoom ID: 464 012 2022	
8:55 am - 9:30 am	Keynote: Dr. Huizhi Wang Imperial College London	8:55 am - 9:15 am	14 Peter Akhator peter.akhator@uniben.edu	8:55 am - 9:15 am	64 Santu Dolui esz208173@ces.iitd.ac.in	8:55 am - 9:15 am	29 Rui Jiao YU yuruijiao@emails.bjut.edu.cn
9:30 am - 9:50 am	108 DANG Qun qun.dang@bit.edu.cn	9:15 am - 9:35 am	16 Mohammad Azim Rasuli rasuli.azim@gmail.com	9:15 am - 9:35 am	66 Na Zhang zhangna881127@163.com	9:15 am - 9:35 am	150 Yongqian Chen 1062759248@qq.com
9:50 am - 10:10 am	79 Yan Peiliang yanpeiliang@buaa.edu.cn	9:35 am – 9:55 am	18 Fatih Yilmaz fatiyilmaz7@gmail.com	9:35 am – 9:55 am	69 Narges Hassani-Mokarram n.hassani-mokarram.1@research.gla.ac.uk	9:35 am – 9:55 am	55 Enrui Zhang 18742519739@163.com
10:10 am - 10:15 am	Break	9:55 am - 10:15 am	Break	9:55 am - 10:15 am	Break	9:55 am - 10:15 am	Break
10:15 am - 10:35 am	54 Ravi Kumar rdz218261@iitd.ac.in	10:15 am - 10:35 am	24 V. B Murali Krishna muralikrishna.cuk@gmail.com	10:15 am - 10:35 am	103 Rida Javed ridajaved617@yahoo.com	10:15 am - 10:35 am	65 Saptarshi Gupta g.saptarshi@iitg.ac.in
10:35 am - 10:55 am	74 Chao He chao.he@stu.xjtu.edu.cn	10:35 am - 10:55 am	61 Mustafa Vargün mustafavargun@gmail.com	10:35 am - 10:55 am	60 Nyan Shu Qi sn35@hw.ac.uk	10:35 am - 10:55 am	76 Shipei Deng dengshipei@stu.xjtu.edu.cn
10:55 am - 11:00 am	Break						
11:00 am - 11:50 am	**Time and Beauty** Professor Adrian Bejan (Duke University) Session Chair: Xianguo Li Zoom ID: 464 007 2022						
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events							

Tuesday, July 5, 2022

Preliminary Plan	(All Eastern Time, UTC−04:00)								
8:00 am - 8:50 am	**Hydrogen on the Way to Competitiveness – A Hydrogen Cost and Decarbonization Perspective** Dr. Tobias Christopher Brunner (Hynergy GmbH & Cryomotive GmbH) Session Chair: Jianbo Zhang **Zoom ID: 464 008 2022**								
8:50 am - 8:55 am	**Break**								
8:55 am - 9:45 am	**Geothermal Heat Pumps for Space and Industrial Heating Applications** Neil J Hewitt, Ulster University Session Chair: Zhibin Yu **Zoom ID: 464 008 2022**								
9:45 am - 9:50 am	Break								
Session S5: Energy harvesting & storage 2 Session Chairs: Shang Zhai Zoom ID: 464 009 2022		**Session S6 Renewable and clean energy 2** Session Chairs: Hongxia Li, Aikifa Raza Zoom ID: 464 010 2022		**Session S7: Energy conversion and management 1** Session Chairs: XiaoYu Wu Zoom ID: 464 011 2022		**Session S8 Hydrogen and fuel cells 2** Session Chairs: Jian Zhao Zoom ID: 464 012 2022		**Session SS1 Advances in Energy Recovery** Session Chairs: Guopeng Yu, Youcai Liang Zoom ID: 464 007 2022	
9:50 am - 10:10 am	80 Kun Liu Kun-Liu@stu.xjtu.edu.cn	9:50 am - 10:10 am	26 Banjo Stephen Adewunmi sabanjo@uwaterlo.ca	9:50 am - 10:10 am	13 Arpit Ghate arpitghate2017@gmail.com	9:50 am - 10:25 am	Keynote: Kui Jiao Tianjin University	9:50 am - 10:10 am	Guopeng YU yugp3@mail.sysu.edu.cn
10:10 am - 10:30 am	106 LEI Shangwen 3220200258@bit.edu.cn	10:10 am - 10:30 am	49 Oguzhan Kazaz o.kazaz.1@research.gla.ac.uk	10:10 am - 10:30 am	22 Himanshu Srivastava hsrivastava747@gmail.com			10:10 am - 10:30 am	Xuan Wang wangxuanwx@tju.edu.cn
10:30 am – 10:50 am	75 Rui Wang ruiwang@xjtu.edu.cn	10:30 am – 10:50 am	27 V. B Murali Krishna muralikrishna.cuk@gmail.com	10:30 am – 10:50 am	72 M.Ziya Sogut mzsogut@gmail.com	10:25 am - 10:45 am	35 Muhammad Muddasar mmuddasarese19.ces@student.nust.edu.pk	10:30 am – 10:50 am	Lingfeng Shi slf@ustc.edu.cn
10:50 am - 11:10 am	119 Zihan Zhang zzh991218@outlook.com	10:50 am - 11:10 am	45 Ujjiban Kakati rdz208714@rdat.iitd.ac.in	10:50 am - 11:10 am	84 Zengjia Guo guozengjia.guo@connect.polyu.hk	10:45 am – 11:05 am	39 Yabiao Pei ybpei@tju.edu.cn	10:50 am - 11:10 am	Long Jiang Jianglong@zju.edu.cn

11:10 am - 11:20 am	Break	11:10 am - 11:20 am	Break	11:10 am - 11:20 am	Break	11:05 am - 11:20 am	Break	11:10 am - 11:20 am	Break
11:20 am - 11:40 am	107 Keke SHAO 3120215288 @bit.edu.cn	11:20 am - 11:40 am	56 Auni Nur Sabrina Binti Kamaru Azman auninursabrinaa@gmail.com	11:20 am - 11:40 am	129 Yan Zhu 1911392006@st.gxu.edu.cn	11:20 am - 11:40 am	143 Jiao Han 2443954767@qq.com	11:20 am - 11:40 am	Youcai Liang liangyoucai@scut.edu.cn
11:40 am - 12:00 pm	59 Shaopeng Guo guoshaopeng @163.com	11:40 am - 12:00 pm	50 Oguzhan Kazaz o.kazaz.1@research.gla.ac.uk	11:40 am - 12:00 pm	41 Jing Li gzfylj@163.com	11:40 am - 12:00 pm	87 Zi Rui GUO guozr@emails.bjut.edu.cn	11:40 am - 12:00 pm	Wei Wu weiwu53@cityu.edu.hk
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events									

Wednesday, July 6, 2022

Preliminary Plan	(All Eastern Time, UTC−04:00)								
Session S9: Advanced materials for energy systems 1 Session Chairs: Hongxia Li, Aikifa Raza Zoom ID: 464 009 2022		**Session S10: Advanced energy systems 1** Session Chairs: Xi Chen Zoom ID: 464 010 2022		**Session S11: Energy systems modelling and optimization 2** Session Chairs: Xiangkun (Elvis) Cao, Qi Dang Zoom ID: 464 011 2022		**Session S12: Hydrogen and fuel cells 3** Session Chairs: Xia Li, Rui Wang Zoom ID: 464 012 2022		**Session SS2: Frosting and Icing** Session Chairs: Mengjie Song, Minglu Qu Zoom ID: 464 008 2022	
8:00 am - 8:20 am	31 Aima Shibata 219d8462@st.kumamoto-u.ac.jp	8:00 am - 8:35am	Keynote: Meng Ni The Hong Kong Polytechnic University	8:00 am - 8:20 am	71 M.Ziya Sogut mzsogut@gmail.com	8:00 am - 8:35am	Keynote: Nada Zamel Fraunhofer Institute for Solar Energy Systems	8:00 am - 8:20 am	Xuan Zhang xuan.zhang@bit.edu.cn
8:20 am – 8:40 am	36 Na Xie xiena@tju.edu.cn	8:35 am – 8:55am	37 Kotaro Fujimoto 208t2231@st.kumamoto-u.ac.jp	8:20 am – 8:40 am	86 LI Zheng ZLDreamania1996@outlook.com	8:35 am – 8:55am	40 Shuoyao Yin yinshuoyao@tju.edu.cn	8:20 am – 8:40 am	Xu Quanyong xuquanyong@tsinghua.edu.cn
8:40 am - 9:00 am	85 Ting He heting@shu.edu.cn	8:55 am - 9:15 am	94 Tonghui Xu Xuth@shu.edu.cn	8:40 am - 9:00 am	98 Adithya Legala alegala@uwaterloo.ca	8:55 am - 9:15 am	51 lijuan huang m15901188726@163.com	8:40 am - 9:00 am	Zhihua Wang wangzh065@xjtu.edu.cn
9:00 am - 9:20 am	Break	9:15 am - 9:20 am	Break	9:00 am - 9:20 am	Break	9:15 am - 9:20 am	Break	9:00 am - 9:20 am	Break
9:20 am -	38 Haotian Liu	9:20 am -	95 Xiao Yan	9:20 am -	118 Haotian Zhou	9:20 am -	47 Qiao Yang	9:20 am -	ZHANG Long

9:40 am	liuht98@tju.edu.cn	9:40 am	yanxiaox@shu.edu.cn	9:40 am	z18364119182@163.com	9:40 am	qyang@cqu.edu.cn	9:40 am	long.zhang@bit.edu.cn
9:40 am - 10:00 am	109 Xuan Zhou zx201601071015@163.com	9:40 am - 10:00 am	137 Chukwuemeka Nwauche chukwuemeka.nwauche@ontariotechu.net	9:40 am - 10:00 am	132 Abdelmajid SAOUD abdelmajidsaoud17@gmail.com	9:40 am - 10:00 am	100 Daixin Ye daixinye@shu.edu.cn	9:40 am - 10:00 am	Baoyu Ni nibaoyu@hrbeu.edu.cn
10:00 am – 10:20 am	46 Shilong Li lishilong@tju.edu.cn	10:00 am – 10:20 am	138 Ashik Rahman mdashikur.rahman@ontariotechu.net	10:00 am – 10:20 am	144 Saif Alshammari s.alsammari.1@research.gla.ac.uk	10:00 am – 10:20 am	78 Yuewen Zhang zhangyuewen@tju.edu.cn	10:00 am – 10:20 am	SONG Mengjie mengjie.song@bit.edu.cn
10:20 am – 10: 40 am	81 Siyuan Zhao siyuan.zhao@connect.polyu.hk	10:20 am – 10: 40 am	147 Warda Ben Atia warda.benatia@enig.u-gabes.tn	10:20 am – 10: 40 am	117 Monika Mikhail monika.mikhail@uwaterloo.ca	10:20 am – 10: 40 am	97 Pascal Ruzzante pascal.ruzzante@uwaterloo.ca		
10:40 am – 10:45 am	Break	10:40 am – 10:45 am	Break	10:40 am – 10:45 am	Break	10:40 am – 10:45 am	Break		
10:45 am - 11:05 am	44 Muhammad Muddasar muhammad.muddasar@ul.ie	10:45 am - 11:05 am		10:45 am - 11:05 am	116 Mustafa Vargün mustafavargun@gmail.com	10:45 am - 11:05 am	136 Yi Yang yangyi@ms.giec.ac.cn		
11:05 am - 11:25 am	25 Erqian Gao e4gao@uwaterloo.ca	11:05 am - 11:25 am	57 Jeffrey Johnston jjohnston496@qub.ac.uk	11:05 am - 11:25 am	133 Nan Zhang 2584460z@student.gla.ac.uk	11:05 am - 11:25 am	19 Fatih Yilmaz fatiyilmaz7@gmail.com		
11:25 am – 11:45 am	124 Babak O' Shahreza omranpou@uqtr.ca	11:25 am – 11:45 am	127 Ashkan Makhsoos Ashkan.Makhsoos@uqtr.ca	11:25 am – 11:45 am	92 L. Harish Kumar harishsanjeetha@gmail.com	11:25 am – 11:45 am	128 Sanaullah Qamar sanaullahqamar002@hotmail.com		
11:45 am - 11:50 am	**Break**								
11:50 am - 12:40 pm	**Plenary** Dr. Jun Liu (Pacific Northwest National Laboratory) Session Chair: Xianguo Li Zoom ID: 464 008 2022								
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events									

Thursday, July 7, 2022

Preliminary Plan	(All Eastern Time, UTC−04:00)
8:00 am - 8:50 am	**How to dye the building green - install more equipment or reduce equipment energy consumption?** Zhang Lin, City University of Hong Kong **Session Chair: Hikmet Karakoc** **Zoom ID: 464 008 2022**
8:50 am - 8:55 am	**Break**
8:55 am - 9:45 am	**Next-generation Hybrid Solar Technologies and Systems: Challenges and Opportunities** Christos N. Markides, Imperial College London Session Chair: Zhibin Yu **Zoom ID: 464 008 2022**
9:45 am - 9:50 am	Break

Session S13: Advanced materials for energy systems 2 Session Chairs: Zhengmao Lu, Shu-Hao Chang Zoom ID: 464 009 2022		**Session S14: Renewable and clean energy 3** Session Chairs: Shang Zhai, Hang Meng Zoom ID: 464 010 2022		**Session S15: Environmental and economic analysis** Session Chairs: Shiqi (Shawn) Ou Zoom ID: 464 011 2022		**Session S16: Hydrogen and fuel cells 4** Session Chairs: XiaoYu Wu, Xiangkun (Elvis) Cao Zoom ID: 464 012 2022	
9:50 am - 10:10 am	151 Runfei Yue d_flash3@tju.edu.cn	9:50 am - 10:10 am	62 SANJEEV KUMAR SANJEEV.KUMAR@DSEU.AC.IN	9:50 am - 10:10 am	30 Murat AYAR konesera@gmail.com	9:50 am - 10:10 am	126 Zheng Nan 22127070@zju.edu.cn
10:10 am - 10:30 am	90 Caixia Li 21720251@shu.edu.cn	10:10 am - 10:30 am	93 Tao Chen windsimu@163.com	10:10 am - 10:30 am	115 Ankit Singh a_singh@hre.iitr.ac.in	10:10 am - 10:30 am	83 Na Zhou zhouna3116195001@stu.xjtu.edu.cn
10:30 am – 10:50 am	91 Jingkun Bi bjk@shu.edu.cn	10:30 am – 10:50 am	121 Ahmad Rusydan Zaabah azfarizal.mukhtar@gmail.com	10:30 am – 10:50 am	73 M.Ziya Sogut mzsogut@gmail.com	10:30 am – 10:50 am	89 Mengyao Li Crystal_11@tju.edu.cn
10:50 am - 11:10 am	131 Souha HARABI souhaharrabi20@g	10:50 am - 11:10 am	152 Morgen Mukamwi m.mukamwi@strath.a	10:50 am - 11:10 am	88 M.Ziya Sogut mzsogut@gmail.com	10:50 am - 11:10 am	139 Li Guan 283160467@qq.com

	mail.com		c.uk				
11:10 am - 11:20 am	Break	11:10 am - 11:20 am	Break	11:10 am - 11:20 am	Break	11:10 am - 11:20 am	Break
11:20 am - 11:40 am	104 Hongling Pan panhongling0823@163.com	11:20 am - 11:40 am	153 Halil Cagatay Basaran cagataybasaran@marun.edu.tr	11:20 am - 11:40 am	67 Ebraheem Alanazy 2724748a@student.gla.ac.uk	11:20 am - 11:40 am	122 Yu Han hanyu0219@zju.edu.cn
11:40 am - 12:00 pm	17 NGUYEN Minh Hoang minh-hoang.nguyen@uha.fr	11:40 am - 12:00 pm	70 Michael Giovanniello magio1@mit.edu	11:40 am - 12:00 pm	141 Narges Hassani Mokarram n.mokarram.1@research.gla.ac.uk	11:40 am - 12:00 pm	125 Xingchen Wang 2367818947@qq.com
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events							

Friday, July 8, 2022

Preliminary Plan	(All Eastern Time, UTC−04:00)								
Session S17: Renewable and clean energy 4 Session Chairs: Yuesen Wang Zoom ID: 464 009 2022		**Session S18: Advanced energy systems 2** Session Chairs: Xiaoya Li, Kaushik Saha Zoom ID: 464 010 2022		**Session S19: Energy systems modelling and optimization 3** Session Chairs: Qi Dang Zoom ID: 464 011 2022		**Session S20: Energy conversion and management 2** Session Chairs: Jun Li, Hua Tian Zoom ID: 464 012 2022		**Session SS3: Electrolysis process and Membrane transport** Session Chairs: Ronghui Qi, Chuanshuai Dong Zoom ID: 464 008 2022	
8:00 am - 8:35am	Keynote: Bin Li Tianjin University	8:00 am - 8:35am	Keynote: Kaushik Saha Indian Institute of Technology Delhi	8:00 am - 8:20 am	58 Prabhakar Sharma psharmahal@gmail.com	8:00 am - 8:35am	Keynote: Hua Tian Tianjin University	8:00 am - 8:20 am	Su Jinzhan j.su@mail.xjtu.edu.cn
8:35 am – 8:55am	23 Hebatallah Teamah teamahh@algonquincollege.com	8:35 am – 8:55am	43 Weijie Ye yewj9@mail2.sysu.edu.cn	8:20 am – 8:40 am	21 Hebatallah Teamah teamahh@algonquincollege.com	8:35 am – 8:55am	33 Yubai Li liyubai2021@126.com	8:20 am – 8:40 am	Zhenye Kang zkang@hainanu.edu.cn
8:55 am - 9:15 am	52 Farjana Akhter Munni farjana.munni428@gmail.com	8:55 am - 9:15 am	32 Muhammad Muddasar mmuddasarese19.ces@student.nust.edu.pk	8:40 am - 9:00 am	28 Xiaoqing Yang yang@missouriwestern.edu	8:55 am - 9:15 am	110 Zhengyong JIANG 3220210247@bit.edu.cn	8:40 am - 9:00 am	Jinwen Shi jinwen_shi@mail.xjtu.edu.cn
9:15 am -	Break	9:15 am -	Break	9:00	Break	9:15 am -	Break	9:00	Break

9:20 am		9:20 am		am - 9:20 am		9:20 am		am - 9:20 am	
9:20 am - 9:40 am	53 Fan Xiaoxuxu fanxiaoxu@sderi.cn	9:20 am - 9:40 am	99 Ya Tang tangya0709@shu.edu.cn	9:20 am - 9:40 am	63 Youwen Zhang 707482954@qq.com	9:20 am - 9:40 am	146 Akhil Garg akhil.nitrkl2010@gmail.com	9:20 am - 9:40 am	Lin Yang yanglin@cqu.edu.cn
9:40 am - 10:00 am	68 Yunadong Liu liuy@ornl.gov	9:40 am - 10:00 am	101 Daixin Ye daixinye@shu.edu.cn	9:40 am - 10:00 am	77 E Qing eqinghust@163.com	9:40 am - 10:00 am	135 Dongxu Chen 18b910049@stu.hit.edu.cn	9:40 am - 10:00 am	Nengneng Xu nengnengxu@dhu.edu.cn
10:00 am – 10:20 am	123 Hai Wang wanghai_sky@126.com	10:00 am – 10:20 am	102 Yu Sun 18221993032@163.com	10:00 am – 10:20 am	48 Majbah Uddin uddinm@ornl.gov	10:00 am – 10:20 am	15 Birol I. Kilkis birolkilkis@hotmail.com	10:00 am – 10:20 am	Qi Ronghui qirh@scut.edu.cn
10:20 am – 10: 40 am	42 Lee Chin Yee ChinYee.Lee@petronas.com			10:20 am – 10: 40 am	145 Daniel Rohacs rohacs.daniel@kjk.bme.hu	10:20 am – 10: 40 am	82 Hong Xu xuhong7@mail.sysu.edu.cn	10:20 am – 10: 40 am	Chuanshuai Dong dongcs@scut.edu.cn
10:40 am – 10:50 am	Break								
10:50 am - 11:40 am	**Energy Storage** Claudio Canizares, University of Waterloo Session Chair: XiaoYu Wu Zoom ID: 464 007 2022								
11:40 am - 12:30 pm	**Closing ceremony and awards** Session Chair: Xianguo Li Zoom ID: 464 007 2022								

Abstracts of Plenary Sessions

Biographies of Plenary Speakers

Award Speech

2021 IAGE Lifetime Achievement Award Recipient

Adrian Bejan

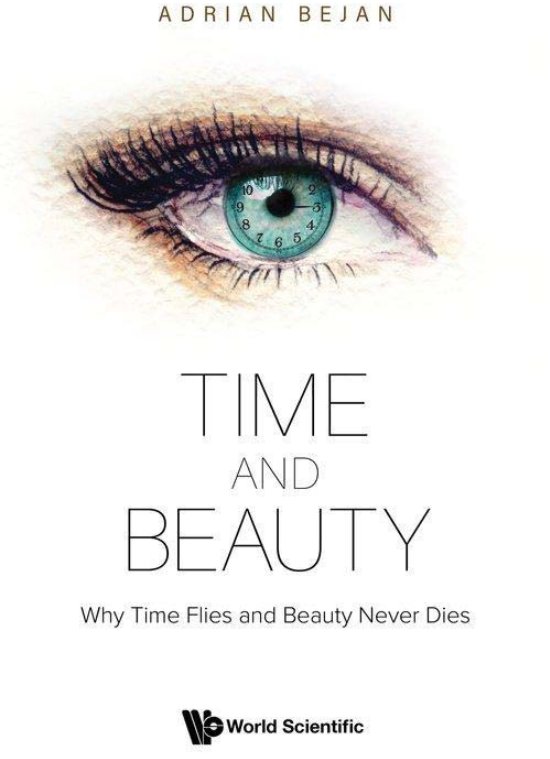
J.A. Jones Distinguished Professor
Duke University
abejan@duke.edu

The IAGE Lifetime Achievement Award recognizes an individual who has made extraordinary contribution to the advancement of green energy over his/her lifetime. The Lifetime Achievement Award is the highest honor bestowed upon an individual by IAGE.

Speech Title: TIME AND BEAUTY

Time and beauty are two of our most visceral perceptions. Yet, their nature is seldom questioned. In this lecture I will show why we feel that time flies faster as we get older. Perceived time, also called 'mind time', is different from clock time. In this context, time is another word for 'perceived change'. Next, we will discover that beauty is appealing because beautifully shaped images are scanned faster by two eyes. To observe our immediate surroundings and to understand them faster is highly advantageous to survival; therefore, in accord with the constructal law of flow design evolution in nature, there is an underlying evolutionary advantage to our efficient discernment for ideal ratios, shapes, and beauty at large. In the process, key questions to our cognition are answered from physics. Why does the mind 'try' to make sense of a new mental image? Why is there a natural tendency to organize a new input and mentally position it among past perceptions? What is the role of art and ethics in science? Through physics, the general answer is this: to empower the individual with speed and clarity of thought, understanding, decision-making and more effective movement, i.e., life.

The lecture is based on the book "TIME AND BEAUTY: Why time flies and beauty never dies".



Short Bio

Adrian Bejan was awarded the 2018 Benjamin Franklin Medal:

"For his pioneering interdisciplinary contributions in thermodynamics and convection heat transfer...and for constructal theory, which predicts natural design and its evolution in engineering, scientific, and social systems."

He received all his degrees from the Massachusetts Institute of Technology: B.S. (1971, Honors Course), M.S. (1972, Honors Course) and Ph.D. (1975). He is the J.A. Jones Distinguished Professor at Duke University.

Professor Bejan is the author of 30 books and 700 peer-refereed journal articles. His h index is 106, with total 83,000 citations on Google Scholar. He received the major international awards for thermal sciences. He was awarded 18 honorary doctorates from universities in 11 countries.

He is a member of the Academy of Europe and the national academies of Mexico, Turkey, Romania, and Moldova. He is Honorary Member of the American Society of Mechanical Engineers (ASME).

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Tobias Christopher Brunner
Affiliation	Managing Director, Hynergy GmbH, Germany and Cryomotive GmbH, Germany, and former Vice President, Hydrogen Business Great Wall Motor China

Invited Plenary Lecture

Presentation Title	**Hydrogen on the Way to Competitiveness – A Hydrogen Cost and Decarbonization Perspective**
Abstract (Approximately 200 words)	The Hydrogen Council, the world's largest CEO-backed organization has published Hydrogen Insights 2021, an industry-led study on the cost development of hydrogen technologies in multiple sectors including mobility, energy, industry and heating. The study revealed that the competitiveness of hydrogen technologies is closer than many expected and that investment to overcome the gap is moderate compared with investments in today's energy and fuel systems. Until 2030 nine mobility applications reach competitive cost to conventional and alternative low-emission technologies. The cost of hydrogen production by electrolysis will drop significantly with scaling-up to electrolyzer capacity as do fuel cell systems for mobility applications once a volume production is reached. Fuel cell vehicles may become competitive to battery electric vehicles in several long-range applications, with both technologies complementing each other over the portfolio of mobility applications. As a key conclusion the study also revealed that hydrogen can get a key role in the transition of energy and mobility towards a zero-emission world: hydrogen will be a powerful and indispensable carrier for renewable energy and may be the foundation for an international renewable energy and fuel trading system starting as early as 2030.
Biographical Sketch (Approximately 200 words)	Dr. Brunner is a Managing Director and Co-owner of Hynergy GmbH, a Hydrogen Energy and Mobility Engineering company in Germany as well as of Cryomotive GmbH, a Startup company to develop cryogenic hydrogen storage and refueling technology for long-haul commercial vehicles. From 2016 to 2020 he also served Great Wall Motors as their VP Fuel Cell R&D. In 2019 Dr. Brunner was appointed Strategic Council of FTXT Future Energy, the new Hydrogen Fuel Cell Company of the Great Wall Group. Since 2021 Dr. Brunner is focusing his activities on Germany and Europe and is co-founding further hydrogen energy companies. Before co-founding Hynergy GmbH in 2015, Dr. Brunner has been serving BMW Group in various roles for more than 10 years, most recently as head of BMW's Technology Project Hydrogen Fuel Cell. Under Dr. Brunner's supervision several fuel cell electric vehicle prototypes and test fleets as well as novel cryogenic storage and refueling technologies have been developed and demonstrated.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Claudio Canizares
Affiliation	University of Waterloo

Invited Plenary Lecture

Presentation Title	**Energy Storage**
Abstract (Approximately 200 words)	As the penetration of variable renewable generation increases in power systems, issues such as grid stiffness, larger frequency deviations, and grid stability are becoming more relevant. In this context, Energy Storage Systems (ESSs) are proving to be effective in facilitating the integration of renewable resources, and thus are being widely deployed in both microgrids and large power grids. This talk will review several energy storage technologies, particularly Compress Air Energy Storage (CAES), flywheels, batteries, and thermal energy systems, and their modeling and applications for power systems. An overview will be provided of the work being carried out by Prof. Canizares' group at the University of Waterloo on all these energy storage systems, focusing on novel models and applications in microgrids and distribution and transmission grids for system stability and control, in particular for frequency regulation.
Biographical Sketch (Approximately 200 words)	Dr. Claudio Cañizares is a University Professor and the Hydro One Endowed Chair at the Electrical and Computer Engineering (E&CE) Department, and the Executive Director of the Waterloo Institute for Sustainable Energy (WISE) at the University of Waterloo, where he has held various academic and administrative positions since 1993 and has received multiple recognitions, especially the 2021-2022 Awards of Excellence in Graduate Supervision at both the University and Faculty of Engineering levels. He obtained the Electrical Engineer degree from the Escuela Politécnica Nacional (EPN) in Quito-Ecuador in 1984, where he held different academic and administrative positions between 1983 and 1993, and his MSc (1988) and PhD (1991) degrees in Electrical Engineering are from the University of Wisconsin-Madison. His research activities focus on the study of stability, control, optimization, modeling, simulation, and computational issues in bulk power systems, microgrids, and energy systems in the context of competitive energy markets and smart grids. In these areas, he has led or been an integral part of many grants and contracts from government agencies and private companies worth millions of dollars, and has collaborated with multiple industry and university researchers in Canada and abroad,

	supervising/co-supervising over 170 research fellows and graduate students. He has authored/co-authored more than 350 publications with over 24,000 citations and a 70+ H-index, including journal and conference papers, technical reports, book chapters, disclosures and patents, and has been invited to deliver keynote speeches, seminars, tutorials, and presentations at many institutions and conferences worldwide. He is the Editor-In-Chief of the Institute of Electrical & Electronic Engineering (IEEE) Transactions on Smart Grid, the 2022-2023 IEEE Division VII Director of the IEEE and Power & Energy Society (PES) Boards, and a Fellow of the IEEE, a Fellow of the Royal Society of Canada, where he was the Director of the Applied Science and Engineering Division of the Academy of Science from 2017 to 2020, and a Fellow of the Canadian Academy of Engineering. He is also the recipient of the 2017 IEEE PES Outstanding Power Engineering Educator Award, the 2016 IEEE Canada Electric Power Medal, and of multiple IEEE PES Technical Council and Committee awards and recognitions, holding leadership positions in several IEEE-PES Committees, Working Groups, and Task Forces.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Neil J Hewitt
Affiliation	Belfast School of Architecture and the Built Environment, Centre for Sustainable Technologies, Ulster University

Invited Plenary Lecture

Presentation Title	**Geothermal Heat Pumps for Space and Industrial Heating Applications**
Abstract (Approximately 200 words)	Geothermal energy has resurfaced for Net-Zero Heating ambitions. While areas are blessed with high temperatures, the techno-economics for drilling in lower temperature heat sources is around 800m depth. Therefore, for these lower temperatures, but useful heat resources, the roles of heat pumps in meeting the needs for a range of space and industrial heating roles will be examined in terms of global best practice in both research and deployment. Some indications of risk, economics and planning/licencing aspects will also be given for both heat extraction at depths and the role of thermal storage in managing variable, non-dispatchable renewable electricity.
Biographical Sketch (Approximately 200 words)	Professor Neil J Hewitt is Ulster University's Chair in Energy and is Head of School, Belfast School of Architecture and Built Environment as well Director of the Centre for Sustainable Technologies. He is a World Renewable Energy Network Lifetime Pioneer and has attracted over £22M in external funding including EPSRC, EU and international sources. With over 140 publications ranging from large scale power generation to heat pumps and demand side management, he has graduated 17 PhD students.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Zhang Lin
Affiliation	City University of Hong Kong

Invited Plenary Lecture

Presentation Title	**How to dye the building green - install more equipment or reduce equipment energy consumption?**
Abstract (Approximately 200 words)	There are two approaches to low-net-energy buildings: one is adding renewable energy installations to the buildings; the other is applying more energy (including the embedded energy)-efficient equipment. Life cycle analysis is necessary to determine actual economic and environmental costs for the former, whereas qualitative analysis may be sufficient for the latter. To demonstrate this, ventilation in buildings is used as an example. Building ventilation system largely determines the indoor environmental quality and building energy use. However, there are still few studies concerning the life cycle assessment of various alternative ventilation systems incorporating the combined effect of life cycle cost and carbon emission in the supply-and-installation phase, and energy performances in the operation phase. The supply-and-installation phase of the system materials and components significantly contributes to the total energy consumption and environmental loads of buildings. This talk covers a systematic approach to estimate their environmental impact, which was counted in terms of energy demand and CO_2 emission in the two phases. This approach has been applied to an actual typical classroom served by mixing ventilation, displacement ventilation and stratum ventilation. The results show that SV has the least environmental impact and life cycle cost. This approach may be generally applied to a sustainability analysis of ventilation methods in various scales of air-conditioned spaces.
Biographical Sketch (Approximately 200 words)	Zhang Lin graduated from Tsinghua University in air conditioning engineering in 1983, and completed his Ph.D. in Process and Environmental Technology at Massey University in New Zealand in 1994. He has been engaged in engineering consultancy for seven years. He is currently a chair professor and head in the Division of Building Science and Technology at the City University of Hong Kong. His major research interests include advanced room air distribution (ventilation), associated thermal comfort, indoor air quality (IAQ), energy efficiency, and outdoor thermal comfort and tolerance. As the PI/co-PI, he has been in charge of twelve highly competitive research projects (RGC-TRS, RGC-CRF, NSFC and RGC-GRF). He has published more than 280 articles, including more than 170 SCI articles. His Google Scholar H-index is 55, and the number of citations is > 10,000.

International Association for Green Energy

UNIVERSITY OF WATERLOO

University of Glasgow

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Christos N. Markides
Affiliation	Chemical Engineering, Imperial College London

Invited Plenary Lecture

Presentation Title	**Next-generation Hybrid Solar Technologies and Systems: Challenges and Opportunities**
Abstract (Approximately 200 words)	"Making solar energy economical" is widely recognized as a global engineering grand challenge with the potential to enable the transition to a clean and sustainable energy future. By far the highest global growth and new investment in renewable technologies is being experienced by the solar sector. In fact, solar systems are projected to deliver the majority of the world's electricity by 2050. Although most solar technologies today are designed for either electrical power generation (e.g., photovoltaic or PV, and concentrated solar power or CSP) or hot water provision (e.g., solar thermal/hot water systems), solar systems can be used to deliver multiple useful energy vectors, including heating, cooling, clean water, or any combination of the above. In this talk, we will present the underpinning principles of conventional solar technologies, including PV, CSP and solar-thermal, and extend the discussion to more recent options (both collectors and systems), such as hybrid PV-X solar technologies, covering advances from the material to the system level, and discussing their potential, along with the challenges and opportunities of their further development.
Biographical Sketch (Approximately 200 words)	Christos Markides is Professor of Clean Energy Technologies and Head of the Clean Energy Processes (CEP) Laboratory at Imperial College London. He is also, amongst other, Editor-in-Chief of Applied Thermal Engineering. He specializes in applied thermodynamics, fluid flow and heat/mass transfer processes as applied to high-performance devices, technologies and systems for thermal-energy recovery, utilization, conversion or storage. His research interests include heating, cooling and power, and in particular, solar energy and heat recovery and conversion in diverse applications. He has published >250 journal papers and >300 conference papers on these topics.

Abstracts of Keynote Sessions

Biographies of Keynote Speakers

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Kui Jiao
Affiliation	Tianjin University

Invited Keynote Lecture

Presentation Title	**Toward engineering application: powerful and efficient tool for PEM fuel cell 3D simulation**
Abstract (Approximately 200 words)	Modeling and simulation help shed light on unclear transport mechanism in PEM fuel cell and provide valuable instructions for engineering application. 3D model has advantage on reproducing cell geometry and giving a holistic view of cell operating state. However, it also faces rigorous challenge on simulation efficiency and stability. Here, we first present some simulation work accomplished by 3D model in limited computational domain. Then, a "3D+1D" modeling method will be introduced aiming for efficient large-scale simulation, which has become a burgeoning need of the industry. After comparing the two models, it is found that the "3D+1D" model achieves a decent trade-off between efficiency and accuracy. To further improve the model's adaptability, water transition mechanism among different water state (vapor, liquid and dissolved) in catalyst layer is investigated in detail. A self-adaptative mechanism is proposed based on an application practice in cooperation with a commercial-level laboratory. The "3D+1D" model is comprehensively validated with experimental data regarding cell performance, ohmic resistance, current density distribution and temperature distribution under different operating conditions. It is expected to fulfil the engineering requirement on large-scale simulation regarding commercial-level single cell or even a small stack, as a powerful and efficient tool.
Biographical Sketch (Approximately 200 words)	Kui Jiao is a professor in the State Key Laboratory of Engines at the Tianjin University, China. He received his Ph.D. degree of mechanical engineering in 2011 from the University of Waterloo, Canada. His research interest includes fuel cell, battery, thermoelectric generator, turbocharger compressor, etc. He has published several books and 200+ papers in international journals such as Nature, and led 30+ national and industrial projects, provided modeling and design services in development of fuel cell engines for many major automotive fuel cell manufactures such as FAW, SAIC Motor, Bosch and Weichai Power. He severed as the Chair for several international conferences such as International Conference on Energy and AI, and the founding Editor of Energy and AI and Associate Editor of International Journal of Green Energy. He is the Vice President of the Fuel Cell Engine Division, Chinese Society of Internal Combustion Engine (CSICE), a Fellow of the Royal Society of Chemistry (FRSC), and a Fellow of the Institution of Engineering and Technology (FIET).

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Bin Li
Affiliation	Tianjin University

Invited Keynote Lecture

Presentation Title	**Key Techniques of Transmission System for Offshore Wind Power**
Abstract (Approximately 200 words)	The development and utilization of offshore wind energy resources is the critical path for energy structure reformation. With saturation development of the near offshore wind energy resources, large-scale deep-sea offshore wind farms have been becoming significant trends in recent years. The voltage source converter based high-voltage DC transmission system has unique technical advantages such as long transmission distance, small transmission losses, and better performance in power control compared with the conventional AC transmission methods. Therefore, it is confirmed as one of the best feasible solutions to explore offshore wind power in deep-sea areas. However, the converter topologies, primary equipment composition, and fault ride-through requirements are extremely different in comparison with the onshore transmission network. To address the issues above, this presentation investigates the precise characteristics of the whole fault process in power transmission system. Moreover, the influence of control strategies on fault characteristics is analyzed quantitatively. Typical protection principles for the transmission lines are analyzed in detail. Furthermore, the risks and challenges of protections in the offshore transmission system are discussed. Then, the single-ended distance protection principles respectively based on the traveling-wave natural frequency and time-domain line-model iteration, which are not dependent on the line boundary elements, are introduced.
Biographical Sketch (Approximately 200 words)	Bin Li, professor, doctoral supervisor. Supported by the National Natural Science Foundation for Distinguished Young Scholars of China, selected into the National Millions of Talents Project of China, and Elsevier China Highly Cited Scholar. He obtained the second prize of National Technology Invention Award of China (2020, ranked 2nd), Tianjin Technological Invention Special Award (2021, ranked 1st), et al. He has been authorized 46 Chinese invention patents and 2 American invention patents. As the first author, he has published 1 monograph in Chinese and 1 monograph in English, participated in the writing of 3 monographs. He has published more than 180 papers as the first author, of which 75 are indexed by SCI and more than 100 are indexed by EI. Currently, he is the Executive Vice Dean of the Graduate School of Tianjin University, the Director of the International Science and Technology Cooperation Base for Distributed Energy and Microgrids of the Ministry of Science and Technology of China, the Director of the Tianjin Key Laboratory of Power System Simulation and Control, and the Deputy Director of Key Laboratory of Smart Grid of Ministry of Education of China.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Meng Ni
Affiliation	The Hong Kong Polytechnic University

Invited Keynote Lecture

Presentation Title	**Solid oxide fuel cell for clean power generation**
Abstract (Approximately 200 words)	Solid oxide fuel cells (SOFCs) are promising electrochemical devices for clean power generation, especially for combined heat and power cogeneration. Reducing the operating temperature of SOFC from 800-1000°C to about 400-600°C improves the durability and reduces the cost of SOFC on the one hand, but decreases the actual cell performance on the other hand. As the cathode usually causes the highest overpotential loss in SOFC, efforts have been made in developing nanostructured SOFC cathodes by infiltration or developing new cathode materials. In this talk, research activities conducted at HK PolyU will be presented, including modeling and testing of nanostructured SOFC cathode, development of a series of perovskite oxides, and the thermal expansion offset approach for composite cathode. The future development of SOFC will also be discussed.
Biographical Sketch (Approximately 200 words)	Prof. Meng Ni received his Ph.D. in Mechanical Engineering from University of Hong Kong (HKU) in 2007. Then Prof. NI stayed in HKU as a Post-doctoral researcher for 2 years, before joining the Hong Kong Polytechnic University as an Assistant Professor in July 2009. Prof. Ni was promoted to Associate Professor and then Full Professor. After serving as an Associate Head for BRE for 5 years, he started to serve as an Associate Dean of FCE in July 2021. Prof. Ni worked as a Humboldt Fellow at the Forschungszentrum Jülich, Germany in 2017. Prof. Meng Ni's research interests include fuel cells and rechargeable metal-air batteries. In particular, Prof. Ni has developed a series of multi-physics models for fuel cells to optimize the fuel cell electrode microstructure and fuel cell stack configuration. He also developed perovskite oxides for use as fuel cell cathodes. He served as an Associate Editor for Science Bulletin in 2015-2017. Currently, he is a Senior Editor for Sustainable Energy Technologies and Assessments (Elsevier) and an Associate Editor for International Journal of Green Energy (Taylor & Francis) and International Journal of Energy Research (Wiley).

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	KAUSHIK SAHA
Affiliation	Department of Energy Science and Engineering, Indian Institute of Technology Delhi

Invited Keynote Lecture

Presentation Title	**Analysis of Fuel Sprays for Internal Combustion Engines**
Abstract (Approximately 200 words)	Research on Engines and Unconventional Fuels is more important than ever, considering the impending IC Engine ban looming over the horizon. Contrary to popular belief, recent LCA studies are showing that 'Future is eclectic' rather than 'Future is electric'. Keeping this in mind we need better engine designs and better fuel utilization. Hence, both numerical and experimental analyses of fuel sprays are highly warranted for the operating conditions seen in modern injection systems and engine designs. The presentation will cover the numerical efforts on fuel spray modeling using IIT Delhi HPC Facility and the experimental spray diagnostics being used for gasoline direct injection (GDI) applications. Using CONVERGE CFD code we use different spray modeling approaches, such as ROI-based blob injection, one-way coupled spray simulation, and coupled nozzle flow & ELSA spray simulations. Without reliable experimental data, it is not possible to build trust in model predictions. The Engine Combustion Network (ECN), provided an excellent platform for extensive model validations. Additionally, a constant volume spray chamber is also prepared to mimic different GDI spray operating conditions and different experimental diagnostic tools being used to characterize these sprays, such as LED-based spray illumination, Nd:YAG laser-based spray imaging, etc.
Biographical Sketch (Approximately 200 words)	Kaushik Saha is currently an Assistant Professor at Centre for Energy Studies, Indian Institute of Technology of Delhi in India. Dr. Kaushik Saha received his PhD in 2014 from Mechanical and Mechatronics Engineering Department at University of Waterloo, Canada. During his PhD, Dr. Saha worked on cavitation in diesel injectors, blended fuel droplet evaporation, NOx reduction systems. Dr. Saha finished his M.S. in 2009 at Mechanical Engineering Department, University of Connecticut, where he worked on numerical simulation of material processing using microwave excited plasmas. After his PhD, Dr. Saha worked as Postdoctoral Appointee at Energy Systems Division, Argonne National Laboratory, USA. At Argonne, Dr. Saha worked on gasoline direct injection (GDI) sprays, coupling of internal nozzle flow with spray atomization, diesel engine combustion and cavitation erosion. In December 2017, Dr. Saha joined Bennett University in Greater Noida, India as Assistant Professor. In June 2018 Dr. Saha joined Centre for Energy Studies (currently known as Department of Energy Science and Engineering, IIT Delhi). He is currently working on experimental and numerical studies of GDI sprays, combustion of alternative fuels. Dr. Saha received SERB (Govt. of India) Early Career Research Award in 2019.

International Association for Green Energy

UNIVERSITY OF WATERLOO

University of Glasgow

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Hua Tian
Affiliation	State Key Lab of Engine, Tianjin University, China

Invited Keynote Lecture

Presentation Title	**CO_2 Ice Rink Technology and Its Applications**
Abstract (Approximately 200 words)	To keep an ice rink frozen, traditional refrigeration systems utilizing a liquid refrigerant, e.g., ammonia or organic fluids, are often used to absorb heat from the source and maintain a low temperature environment. However, traditional refrigerants are often with high global warming potential (GWP). As a natural refrigerant, carbon dioxide (CO_2) is safe, economic, and environmentally sustainable which can be used in heat pump and refrigeration systems especially in trans-critical cycles. To overcome the deficiencies of traditional CO_2 trans-critical cycle with large pressure difference and high adiabatic index, a novel CO_2 trans-critical cycle system is developed, which involves two-stage compression, direct evaporation, and heat reclaim integration. The prototype was first exploited and applied in Beijing 2022 Winter Olympics. The test results suggested that in comparison with traditional R507a ice rink techniques, which was also used in Olympic venue, the developed CO_2 ice rink system utilizing both cooling and heating energy can achieve three times higher energy efficiency. The produced ice was more uniform, and the temperature difference was maintained less than 0.3 °C in comparison with 1.3 °C for traditional ice. A further estimation demonstrated approximately 99% CO_2 emission reduction and 12.5 billion tons of CO_2 storage can be achieved by replacing synthetic refrigerants with CO_2 in China.
Biographical Sketch (Approximately 200 words)	Prof. Hua Tian is the deputy director of state key laboratory of engines, Tianjin University, and the chief scientist of National Key R&D program. His main research interests include CO_2 power technology and CO_2 refrigeration technology. He has published more than 130 SCI papers, 23 authorized invention patents, and 4 monographs in Chinese and English. He has won the Second Prize of National Natural Science Award, the First Prize of Tianjin Natural Science Award, the Fok Yingdong Young Teacher Award of the Ministry of Education, the Wu Zhonghua Outstanding Young Scholar Award of Chinese Society of Engineering Thermophysics, Highly Cited Chinese Researchers of Elsevier 2021, etc.

International Association for Green Energy

UNIVERSITY OF WATERLOO

University of Glasgow

CONFERENCE WEBSITE

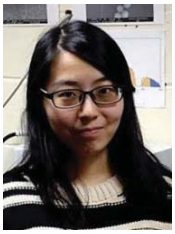
https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Huizhi Wang
Affiliation	Imperial College London



Invited Keynote Lecture

Presentation Title	**Next-generation lithium-ion batteries and beyond**
Abstract (Approximately 200 words)	Lithium-ion batteries (LIBs) are currently the dominant energy storage technology for consumer electronics, and they are expanding their applications to automobiles and stationary storage. The rapid expansion in LIB applications requires continuous improvements in energy density, power density, lifespan and safety, which has spurred research into novel LIB chemistries and even "beyond lithium" chemistries. One next-generation LIB solution that has been attracting considerable attention is to replace graphite anodes with silicon-based electrodes. In contrast to the intercalation carbonaceous materials, silicon is an alloying electrode material and thus can provide a theoretical capacity ten times higher than that of graphite. Silicon has unique electrochemical behaviors with a huge voltage hysteresis between the charge and discharge voltage curves. In this talk, we will first present a mechanistic study to reveal the origin of the path-dependent voltage hysteresis of silicon at different lithiation depth. We will next discuss the role of silicon in a silicon/graphite composite electrode using a multi-material electrochemical model. A dimensionless factor will be introduced to indicate the active regions of silicon and graphite materials and we will demonstrate how it can be used to design cycling protocols for mitigating degradation of silicon/graphite electrodes. Some of our recent efforts in going beyond lithium will also be covered in this talk.
Biographical Sketch (Approximately 200 words)	Dr Huizhi Wang is a Senior Lecturer (Associate Professor) in the Department of Mechanical Engineering at Imperial College London, United Kingdom. She received her Ph.D. degree in Mechanical Engineering from the University of Hong Kong. Prior to joining Imperial College London, she was an Assistant Professor in the School of Engineering and Physical Sciences at Heriot-Watt University, Edinburgh. Her research centers on electrochemical engineering with activities including design, manufacturing, characterization, and modeling of electrochemical energy devices such as fuel cells, batteries and electrolysers. She has (co)authored over 100 articles in peer reviewed journals and several book chapters and patents.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2022

14th International Green Energy Conference

(IGEC-XIV)

July 4-8, 2022 | Virtual

Name	Nada Zamel
Affiliation	Senior Scientist, Fraunhofer Institute for Solar Energy Systems

Invited Keynote Lecture

Presentation Title	**Understanding degradation in PEM fuel cells**
Abstract (Approximately 200 words)	Increasing the long-term stability of polymer electrolyte membrane fuel cells in general and under dynamic operation in particular is crucial for its commercialization. This stability is affected by not only operation parameters but also the components and their materials. In this talk, we discuss our initiatives at Fraunhofer ISE in order to fully understand how materials and operation parameters affect the overall degradation processes taking place in the membrane electrode assembly. We specifically highlight the importance of the use of both experimental and numerical methods to further this understanding.
Biographical Sketch (Approximately 200 words)	Dr. Nada Zamel is a Senior Scientist at the Department Fuel Cell Systems at Fraunhofer Institute for Solar Energy Systems, ISE. She received her doctoral degree in Mechanical Engineering in 2011 from the University of Waterloo, Canada. Her research interests are focused on various topics pertaining to material development and cell characterization of PEM fuel cells. Specifically, she has been involved in projects on life cycle analysis, effect of air and hydrogen contamination on PEM fuel cells, effects of various stressors on the lifetime of PEM fuel cells and the production of catalyst coated membranes. She has contributed to the field over 40 peer reviewed articles in high impact journals and several reports and book chapters. She is also an active reviewer and has been involved in the organization of various international conferences and workshops. She is currently serving on the editorial board of Energy and AI and as an Associate Editor in International Journal of Green Energy.

Special Sessions

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-201~206 (invited)

Special Session: Advances in Energy Recovery

Session Description:

The last decade has witnessed significant advances in energy recovery technology for supplying part of the world's energy needs and thus reduce the rate of consumption of fossil fuels and other non-renewable resources. As one of the green energy solutions, energy recovery can reduce greenhouse gas emissions generated with traditional energy sources. This special session is aimed at evaluating the existing energy recovery systems and methods, and is devoted to the latest development and R&D achievements for the energy recovery technology, ranging from components to systems, and from modeling, simulations and analyses to experimental investigations.

Session Organizers:

Guopeng Yu (SunYat-Sen University)

Youcai Liang (South China University of Technology)

Session Contents:

Topic 1: Evaluation system for thermal-cycle based energy recovery system
Topic 2: Modeling and control for heat transfer process based on deep reinforcement learning
Topic 3: CO2-based thermodynamic cycle for engine waste heat recovery
Topic 4: Combined CO2 Power-Ejector based refrigeration system driven by waste heat of engine
Topic 5: Sorption thermal battery governed by reaction wave model
Topic 6: Absorption thermal batteries for high-efficiency and high-density energy storage

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-201 (invited)

Topic 1: Evaluation system for thermal-cycle based energy recovery system

Guopeng Yu
Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-Sen University, China
yugp3@mail.sysu.edu.cn

Abstract

For effective utilization of sustainable resources, evaluation systems based on innovative optimization algorithms and decision-making methods are of great significance. This talk presents a systematic and generic design method, which integrates the modelling, optimizing, scheme comparing and decision-making process. This method is developed by emphasizing on mobile systems in which the working condition is complex and ever-changing, it actually provides a general-adapted approach to get the final optimal solution, which can be widely employed in industrial energy recovery, co-generation systems, geothermal energy/biomass energy utilization, etc. In this topic, multi-objective optimization models are constructed for typical thermal-cycle-based energy recovery systems, and thirteen decision criteria including environmental, thermodynamic, and techno-economic perspectives are evaluated for the performance analysis. Four decision-making methods including Shannon Entropy, modified LINMAP (combined with Relative entropy), modified TOPSIS (integrated with Shannon entropy and Relative entropy), and TLFDM (Three-level fuzzy decision method) are employed to determine Pareto-optimal solutions, which are finally evaluated by Taylor method to identify the optimization target.

Keywords: Evaluation system; Multi-objective optimization; Decision-making method

Dr Guopeng Yu is now working as associate professor in Sino-French Institute of Nuclear Engineering and Technology (IFCEN) of Sun Yat-Sen University. She received her Ph.D degree in 2017 from Tianjin University, and was appointed as associate researcher from 2017 to 2021 in James Watt School of Engineering in University of Glasgow before joining Sun Yat-Sen University. The main research interests of Dr Yu are heat management of advanced thermal system, heat and mass transfer of innovative and high-performance energy technologies, efficient and cost-effective utilization of renewable energy and waste heat. As the main author, she has published more than 20 SCI papers, including 3 ESI top1% highly-cited papers. She has received provincial government awards for Outstanding PhD Degree Dissertation. She is in the editorial board of SCI journal *Frontiers in Energy Research*, *International Journal of Green Energy*, and EI journal *Transactions of CSICE*.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-202 (invited)

Topic 2: Modeling and control for heat transfer process based on deep reinforcement learning

Xuan Wang
State Key Laboratory of Engines, Tianjin University, No. 92, Weijin Road, Nankai District, Tianjin, 300072, China wangxuanwx@tju.edu.cn

Abstract

Heat exchangers have been widely used in various thermodynamic systems, and precise tracking control of important parameters of the heat transfer process, such as temperature and pressure, is vital for ensuring safety and highly efficient operation of the entire system. Owing to the high degree of nonlinearity of the heat-transfer process, not only the dynamic model of heat exchanger is difficult to accurately established, but also the important parameters are difficult to control, especially under highly fluctuating operating conditions. In view of the strong perception and decision-making capabilities of deep reinforcement learning (DRL), this study proposes a DRL-based modeling method and DRL-based control method for heat transfer process.

This study proposes to use the most basic mechanism as the model skeleton to establish the stability of the model and reduce the computation of the model, while deriving some physically meaningful characterization parameters to ensure the accuracy of the model, and using DRL to obtain the exact values of these parameters.

Besides, we use the DRL agent to learn the control strategy of the temperature in heat transfer process. The results of our research indicate that the DRL agent can satisfactorily perform the control task under the trained and untrained transient heat source. A case study shows that the DRL control can track the reference temperature with an average error of only 0.19 K, whereas that of the traditional PID control is 2.16 K.

Keywords: Modeling; Control; Thermodynamic system; Deep reinforcement learning

Dr. **Xuan Wang** received his Ph.D. degree in Power Machinery and Engineering from the Tianjin University in 2019. In 2017-2018, he worked at Lawrence Berkeley Laboratory, the United States as a visiting scholar. Currently he is an associate Professor at Tianjin University, China. His research focuses on the aspects of design, modeling and control of thermodynamic system, including (1) energy management of hybrid electric vehicle system; (2) waste heat recovery of internal combustion engine; (3) modeling and control for CO_2 Brayton Cycle; (4) thermal energy management of battery. He has received several relative funds from National Natural Science Foundation of China, Ministry of Science and Technology of the People's Republic of China, China Postdoctoral Foundation etc. He has published over 50 SCI journal papers and more than 10 patents.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-203 (invited)

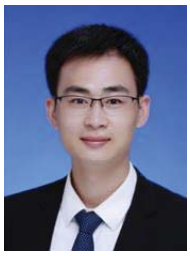
Topic 3: CO2-based thermodynamic cycle for engine waste heat recovery

Lingfeng Shi
Department of Thermal Science and Energy Engineering, University of Science and Technology of China, Hefei 230027, China
slf@ustc.edu.cn

Abstract

The bottoming thermodynamic cycle is of great significance to recover waste heat from the ICE and improve the overall efficiency of it. Therein, CO_2 transcritical power cycle is regarded as a promising energy conservation means for its effectiveness in concurrently recovering both waste heat from the jacket water and exhaust gas. In this report, the development process of CO_2 power cycle used in ICE waste heat recovery are deeply discussed, including different aspects namely the specific thermodynamic characteristics of the ideal working fluid, design & optimization of the bottoming cycle, development on expander and micro heat exchanger, and finally the safe operation & control of the prototype system. Additionally, a multi-mode operation scheme of CO_2–based combined cooling and power cycle is further proposed to satisfy the special cooling and power requirements in practical scenarios of refrigerated vehicles and shipboards.

Keywords: carbon dioxide, thermodynamics cycle, waste heat recovery



Dr. **Lingfeng Shi** received his Ph.D. degree in Power Machinery and Engineering from the Tianjin University in 2019. After graduation, he has acquired support from the Postdoctoral Innovative Talent Support Program and worked as a postdoctoral researcher at Department of Thermal Science and Energy Engineering in the University of Science and Technology of China. Currently, he is serving as an Associate Research Fellow in the University of Science and Technology of China, and is elected as the member of Youth Innovation Promotion Association of Chinese Academy of Sciences (2022). He has published over 44 peer-reviewed international journal publications in energy field. His research focuses on four different aspects of CO_2-based thermodynamics cycles, including (1) design of advanced power/refrigeration cycle, (2) composition tuning in CO_2-based binary mixtures, (3) key component development in waste heat recovery, (4) dynamic simulation and intelligent controls.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-204 (invited)

Topic 4: Combined CO2 Power-Ejector based refrigeration system driven by waste heat of engine

Yan Zhu, Youcai Liang*, Kai Ye
School of Electric Power, South China University of Technology, Guangzhou 510640, China
liangyoucai@scut.edu.cn

Abstract
With the increasing demand of residents for fresh food, refrigerated trucks have become an indispensable part of cold chain transportation. For a typical diesel engine, nearly 60% of the energy is lost to the atmosphere via exhaust gas and jacket coolant, leading to a low fuel utilization rate. Considering the demand multi-variety and small-batch transportation in the current cold chain logistics, a heat driven ejector-based refrigeration combined cycle with two evaporators was proposed to meet the dual temperature requirement of both refrigerator compartment and freezer compartment. The comprehensive performance evaluation on the construction of both single ejector and dual ejectors are conducted. The results shows that both proposed systems can satisfy the basic cooling capacity requirements of refrigerator compartment and freezer compartment. To obtain the maximum refrigeration capacity, the exergy efficiency, cost per exergy unit of product, and dynamic payback period of the system with two ejectors are 17.70%, 94.60 $/GJ, and 6.12 years, respectively. The exergy efficiency is 8.32% higher than that of the system with single ejector, while the cost per exergy unit of product and dynamic payback period are reduced by 2.8% and 0.218 years, respectively.
Keywords: Waste heat recovery; supercritical CO2 cycle; Compression/ejection refrigeration cycle;

Short bio:

Dr. **Youcai Liang** received his Ph.D. degree in Power Machinery and Engineering from State Key Laboratory of Engine (Tianjin University) in 2015, and started his academic career as a lecturer in Tianjin University of Commerce, and then worked as a postdoctoral researcher in University of Glasgow from 2016 to 2019. He joined in South China University of Technology in 2020 and he is currently a Professor in School of Electric Engineering. He has published over 50 peer-reviewed journal papers with more than 1100 citations. He has received 7 research funds from National Natural Science Foundation of China, Guangdong Basic and Applied Basic Research Foundation etc., and made contributions in the areas of design and optimization of thermodynamic cycle, including Advanced Power system, Heat Pump/Refrigeration system, Distributed energy system etc.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-205 (invited)

Topic 5: Sorption thermal battery governed by reaction wave model

Long Jiang*,1, Yuchen Lin[1], Yubin Fan, Xuejun Zhang

Key Laboratory of Refrigeration and Cryogenic Technology of Zhejiang Province, Institute of Refrigeration and Cryogenics, Zhejiang University, Hangzhou, 310027, China

Email. Jianglong@zju.edu.cn

Abstract

Adsorption thermal battery has attracted burgeoning attention which is considered as a promising method to reduce energy consumption for space heating. Adsorption "reaction wave" model could be used to remain the stable output. However, internal mechanism between reactor and material is still not clear. The presentation will introduce a new definition of "reaction wave" model which could bring more insights of adsorption thermal battery from heat and mass transfer perspective. Also response surface methodology is adopted to evaluate key parameters e.g. humidity, flow rate, temperature of inlet air o stable output temperature and duration. Results indicates that wave length of reaction is negatively correlated with heat and mass transfer efficiency. Velocity of reaction wave increases with the increase of flow rate. To achieve stable output over long period, shorter wave lengths and slower wave velocity are needed. The expected stable output time can be calculated according to "Reaction wave" model. However, the lower limit of air flow should meet the minimum output power requirement of adsorption thermal battery. Therefore, the proposed "Reaction wave" model is expected to guide sorbent selection and reactor design for adsorption thermal battery.

Short bio:

Professor Long Jiang is a professor (research track) in the department of energy engineering, Zhejiang University. Before that, he worked as a lecturer and assistant professor (research) in University of Aberdeen and Durham University. He is a member of International Institute of Refrigeration and editorial board member of energy and environmental materials, energy and built environment and advanced powder materials. His research interest lies in sorption related thermal conversion technologies e.g. sorption thermal energy storage, sorption refrigeration and power. He has published 102 research articles across energy storage, sorption trigeneration and CCUS with more than 1500 citations. Besides, Prof. Jiang work as a PI of project on thermochemical desorption for power generation, refrigeration and thermal storage based on low-grade waste heat utilization, and Co-I on projects on regional energy system optimization from NSFC.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-206 (invited)

Topic 6: Absorption thermal batteries for high-efficiency and high-density energy storage

Wei Wu

School of Energy and Environment, City University of Hong Kong, Hong Kong, China

weiwu53@cityu.edu.hk

Abstract

Thermal energy storage is important for renewable energy utilization towards carbon neutrality. Absorption thermal battery (ATB) is a promising solution due to its excellent energy storage performance and flexibility. There are different ATB cycles to cover a wide range of design options, including single-effect cycle, compression-assisted cycle, double-stage cycle, double-effect cycle, and double-effect compression-assisted cycle. To reveal the advantages and shortcomings of different ATB cycles, comparative investigations are conducted from a multi-criteria perspective, including energy storage efficiency, energy storage density, exergy efficiency, charging temperature, and initial cost. The effects of charging/discharging/cooling temperatures on the storage performance are analyzed in three scenarios, i.e., short-term cold storage, short-term heat storage, and long-term heat storage. The double-effect, compression-assisted, and single-effect cycles respectively achieve the maximum energy storage efficiency (1.53), energy storage density (365.4 kW/m^3), and exergy efficiency (0.61). The compression-assisted and double-stage cycles require the lowest charging temperatures (<70 °C). This work aims to facilitate the rational development of ATB cycles for high-efficiency and high-density thermal energy storage during low-carbon energy transition.

Short bio:

Dr. Wei Wu obtained his Ph.D. degree from Tsinghua University in 2016. He was a visiting scholar at the University of Maryland in 2013. Since 2016, he served as a guest researcher at the National Institute of Standards and Technology. He joined the City University of Hong Kong as an assistant professor in 2018. Dr. Wu's research is focused on sustainable energy technologies, including absorption heating/cooling, thermochemical energy storage, thermal management, renewable/waste energy utilization, advanced heat pump, alternative refrigerants, and net-zero energy buildings. He has obtained/filed 18 patents, published a book by Springer Nature, and published around 90 SCI journal papers. He received the IIR Willis H. Carrier Young Researcher Award, the NIST Distinguished Associate Award, and the Excellent Young Scholar Award of Energy and Built Environment. He serves as an editorial board member or guest editor of 6 SCI journals. He is among the Top 2% Scientists Worldwide by Stanford University. He is an expert of IEA-HPT and IEA-SHC Annex.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-211~216 (invited)

Special Session: Frosting and icing

Session Description:
Frosting and icing are widely seen in nature and industrial fields. In the real applications, they always play negative effects. For example, frosting on the surface of outdoor coil degrades the operation efficiency of air source heat pump, frosting on surface of evaporator extends the time and wastes more energy during liquid natural gas vaporization, icing on the wings' surface changes the aerodynamic profile of aircraft and may result in air crush, and ice accumulated on wind turbine blade surface reduces the power generation efficiency. Moreover, frosting and icing problems are reported in the fields of electricity cables, coal transportation, food or ice storage, etc. Droplet condensation and freezing are at the early stages of frosting and icing, and thus influence their final formation. Therefore, in this session, it is fundamental and meaningful to summarize and evaluate the existing experimental and numerical studies about frosting and icing at different stages and application backgrounds.

Session Organizers:

Mengjie SONG (Beijing Institute of Technology)

Minglu QU (University of Shanghai for Science and Technology)

Session Contents:
Topic 1: Experiments and simulations on the impact and freezing characteristics of supercooled water droplets on cold substrates
Topic 2: Droplet Collection Efficiency Distribution Laws in high speed air flows
Topic 3: Investigation on an air source heat pump system with coupled liquid-storage gas-liquid separator regarding heating and defrosting performance
Topic 4: A systematic study on the condensation frosting characteristics of a horizontal cold plate under forced convection
Topic 5: Ice breaking by a high-speed water jet impact
Topic 6: Recent challenges on the fundamental study around frosting and icing

Session Organizers:

Dr. SONG Mengjie, Professor of Department of Energy and Power Engineering, Teli Young Scholar, Director of Frost Lab, School of Mechanical Engineering, Beijing Institute of Technology (BIT), China. He is also the Editor-in-Chief of Recent Patents on Mechanical Engineering (EI, Scopus), Associate Editor of Frontiers in Energy Research (SCI, IF=2.746), DECRA Research Fellow in Sustainable Buildings Research Centre (SBRC), University of Wollongong, Australia, and Guest Professor of Tomas Bata University in Zlín, Czech Republic. Before starting the research work in BIT, he worked in the University of Tokyo as JSPS Research Fellow. Prof. SONG focuses on the mechanism study of heat and mass transfer coupled with the flow for more than 10 years. Currently, he has published 128 journal articles, in which 108 ones are SCI, with 70 ones as first/corresponding author, and 8 papers were ESI. He was selected into the World's Top 2% Scientists 2020 and 2021 (Singleyr) list.

Dr. QU Minglu, Associate Professor of Department of Building Environment and Energy Engineering, University of Shanghai for Science & Technology, China. Dr. QU received her bachelor and Ph.D degrees in from Tongji University and Hong Kong Polytechnic University in 2007 and 2012, respectively. Then she started the research work in USST. Dr. QU focuses on the defrosting process and defrosting method for air source heat pump. Dr. QU has received the funding supports from the National Natural Science Foundation of China, Shanghai Sailing Program of Shanghai Committee of Science and Technology, Key Laboratory of Refrigeration and Cryogenic Technology of Zhejiang Province. Currently, she has published 50 journal articles, in which 27 ones are SCI, and over 680 times cited.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-211 (invited)

Topic 1: Experiments and simulations on the impact and freezing characteristics of supercooled water droplets on cold substrates

Xuan Zhang, Mengjie Song*
Department of Energy and Power Engineering, School of Mechanical Engineering,
Beijing Institute of Technology, Beijing 100081, China
xuan.zhang@bit.edu.cn; mengjie.song@bit.edu.cn

Abstract
Icing phenomena widely exist in many engineering fields, such as aviation, meteorology, power and communication, and cryogenic engineering and refrigeration. In these icing processes, impact and freezing of supercooled water droplets play a fundamental role. While some recent studies pay attention to the impact and freezing behaviors of room-temperature and supercooled droplets on cold substrates, competition between the fluid flow and heat transfer during the impact and freezing processes remains unclear. Here, we experimentally and numerically explore the impact and freezing characteristics of supercooled water droplets on cold substrates. A numerical model using the VOF (Volume of Fluid) multiphase model and the Solidification/Melting phase change model is established and validated by comparing temporal droplet profile and spreading factor with the experimental results. The contact line of a supercooled droplet spreads and retracts slower than that of a room-temperature one, inducing a smaller maximum spreading diameter. The supercooled droplets finally exhibit three morphologies including full rebound, partial rebound, and full adhesion, which is unified by correlating Weber number, supercooling degree, and contact angle. This work may deepen our understanding of the interaction mechanism between impact droplets and cold surfaces and thus advances the associated applications and technologies in anti-icing frosting and self-cleaning.

Keywords: Impact; Freezing; Supercooled water droplet; Rebound; Adhesion

Short bio:

Dr. ZHANG Xuan is an Associate Professor in the Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology. He received his B.S. and Ph.D. degrees from Beijing Institute of Technology and Tsinghua University in 2014 and 2019, and then worked at Tsinghua University and Nanyang Technological University as a Postdoctoral Researcher before joining Beijing Institute of Technology in 2022. He focuses on the coupling processes of heat/mass and flow, especially phase change problems (e.g., icing/frosting, boiling/evaporation/condensation). He has published/co-authored 33 SCI/EI journal papers, 2 books/chapters, and served as editors and reviewers for 20+ academic journals. He has also been granted International Postdoctoral Exchange Fellowship Program and Postdoctoral Supporting Program (Tsinghua University), and awarded Outstanding Doctoral Thesis (Tsinghua University), Wu Zhonghua Outstanding Graduate Student (Chinese Society of Engineering Thermophysics), and Star Reviewer for Physics of Fluids (AIP Publishing).

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-212 (invited)

Topic 2: Droplet Collection Efficiency Distribution Laws in high speed air flows

Xu Quanyong*
Institute of Aero Engine, Tsinghua University, Beijing, China, 100083
xuquanyong@tsinghua.edu.cn

Abstract

With the continuous development of aviation industry, the icing problem of aircraft and aero-engine is still a major threat to flight safety. It is crucial for the aviation safety to conduct the research of the icing of aircraft and aero-engine, analyze the formation mechanism and influencing factors of icing, so as to grasp the law of icing endangering flight safety. However, exploring the internal law of the droplet collection efficiency (DCE) distribution is still a problem, and there are some defects in existing methods, such as the unclear icing conditions of intake air, poor accuracy of numerical simulation, inadequate grasp of icing growth mechanism and so on. Aimed to the acquisition of the most important collection efficiency in the icing process, this report establishes a droplet impact model based on Euler two-phase flow model. Based on this model, the influence of different incoming flow parameters on DCE are analyzed. The mathematical regularity of DCE distribution is explored through parametric description, and the functional relation of the law between the far field condition and DCE is accomplished. The result shows a highly normal distribution. This distribution can be expressed with a good regularity of Reynolds number and droplet diameter. The research carried out in this paper provides theoretical and methodological guidance for the calculation criteria and simulation specifications of icing simulation.

Keywords: Droplet collection efficiency; Numerical simulation; Methodological guidance

Short bio:

Xu Quanyong, Associate Professor of Institute of Aero Engine, Tsinghua University (THU). He received his bachelor and doctor degree in Power and Energy Department from HEU in 2004and 2010, respectively. After graduation, he worked as a post doctor in Peking University and then worked as a teacher in THU from 2012 till now. His research interest includes aerodynamics, aero engine thermal dynamics, multiphase flows, etc. He has undertaken over 10 projects such as supported from the National Natural Science Foundation of China, and National Key R&D Program of China, etc. He has published over 30 journal/conference papers, authorized 20 invention patents and 5 software copyrights. His research achievements have made important contributions to the development of aircrafts.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-213 (invited)

Topic 3: Investigation on an air source heat pump system with coupled liquid-storage gas-liquid separator regarding heating and defrosting performance

Longxia Ma, Zhihua Wang; Fenghao Wang*;
School of Human Settlements and Civil Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China
wangzh065@xjtu.edu.cn; fhwang@xjtu.edu.cn

Abstract

In recent years, air source heat pump (ASHP), as one of the efficient and promising technologies for space heating, has quickly expanded across the world, but frost accumulation on the outdoor heat exchanger is one of the basic concerns about its operation. Reverse cycle defrosting (RCD) is widely used for defrosting, however, when RCD begins and ends, the four-way reversing valve quickly switches and the system pressure needs to be rebalanced which will cause the incomplete evaporation of refrigerant into the compressor. Thus, it leads to the decrease of the performance of the ASHP system during RCD. In order to improve the performance of RCD, this study proposes an ASHP defrosting system with coupled liquid-storage gas-liquid separator. An obvious advantage of the proposed system is retarding frosting, reducing defrosting time and increasing the heating capacity and coefficient of performance (COP) of the ASHP system thus reducing the number of defrosting cycles. And the proposed system can improve indoor thermal comfort during defrosting. Experiments show that compared with the original system, the proposed system delays frosting by 30 min and reduces the defrosting time by 74 s (22.7%), improving the heating capacity and COP by 6.78% and 12.8% respectively. Moreover, the proposed system with the coupled liquid-storage gas-liquid separator is economically friendly, which further benefits its practical applications.

Keywords: Air source heat pump; Reverse cycle defrosting; Retard frosting; Defrosting time; Coupled liquid-storage gas-liquid separator

Short bio:

Dr. WANG Zhihua is an associate professor at the Xi'an Jiaotong University, China. He received his Ph.D at this University in 2015. His research interests are Building Energy Conservation, Air Source Heat Pump and Renewable Energy Technologies. He has published over 30 peer-reviewed journal papers in Energy and Buildings, Applied thermal and Engineering, Energy Conversion and Management etc. He has received 10 research funds from National Natural Science Foundation of China, China Postdoctoral Science Foundation Funded Projects, Shaanxi Province Postdoctoral Science Foundation Funded Projects, Xi'an Municipal Science and Technology Projects.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-214 (invited)

Topic 4: A systematic study on the condensation frosting characteristics of a horizontal cold plate under forced convection

ZHANG Long[a], SONG Mengjie[a,*], SHEN Jun[a], JIANG Yiqiang[b]

[a] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China (long.zhang@bit.edu.cn, mengjie.song@bit.edu.cn, jshen@mail.ipc.ac.cn)

[b] Department of Building and Thermal Engineering, School of Architecture, Harbin Institute of Technology, Harbin, 150006, China (jyq7245@163.com)

Abstract

Frosting is a common form of heat and mass transfer in nature and engineering applications, and usually brings negative effects on life and production. For a condensation frosting process, most of the related studies only focused on a part of the frosting process and ignored the edge effect of a cold plate on its frosting characteristics. Here, a systematic study on the dynamic characteristics of the entire frosting process on the edge zone of a horizontal cold plate under forced convection is experimentally carried out. In general, significant differences in droplet condensation and frozen stages between edge and inside regions can be observed. Under the condition of air velocity of 0.5 m/s, the equivalent diameter of water droplets at the end of droplet condensation stage on the edge region was around 190.2 μm, while that on the inside region was around 136.5 μm. During the droplet frozen stage, the average freezing wave propagation velocity was around 47.3 μm/s, while that on the inside region was around 18.5 μm/s. As a result, the growth of frost crystals on the frozen water droplets on the edge region was much earlier than that on the inside region. Besides, the experimental results also demonstrated that the aforementioned differences may decrease with an increase in air velocity. The results of this study can help to further understand the frosting characteristics on cold surfaces under forced convection, and hence provide insight into delaying frosting and defrosting.

Keywords: Frosting characteristic; Edge effect; Freezing wave propagation; Frost layer morphology; Forced convection

Short bio:

Dr. ZHANG Long is an assistant research fellow and postdoctoral fellow at the School of Mechanical Engineering, Beijing Institute of Technology. He obtained his dual Ph.D. degrees from The Hong Kong Polytechnic University and Harbin Institute of Technology in 2021. His research interests are focused on the frosting mechanism on cold surfaces, frosting characteristics on heat exchangers, novel defrosting methods and defrosting performances for air source heat pump systems. He has 4 authorized patents and published over 20 SCI journal papers, including 1 ESI highly-cited paper. In 2016, he was awarded the First Prize for Progress in Science and Technology by the Architectural Society of China. He serves as a guest editor of SCI journals: *Sustainability* and *Micromachines*, and EI journal: *Recent Patents on Mechanical Engineering*.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-215 (invited)

Topic 5: Ice breaking by a high-speed water jet impact

Baoyu Ni*
College of Shipbuilding Engineering, Harbin Engineering University, Harbin, China, 150001
nibaoyu@hrbeu.edu.cn

Abstract
Ice breaking has become one of the main problems faced by ships and other equipment operating in the ice-covered water region. New methods are always being pursued and studied to improve ice-breaking capabilities and efficiencies. Based on the strong damage capability, a high-speed water jet impact is proposed to be used to break an ice plate in contact with water in this paper. A series of experiments of water jet impacting ice were done in a transparent water tank, where the water jets in tens meters per second were generated by a self-designed device and circular ice plates in various thicknesses and scales were produced in the cold room. The entire evolution of water jet and ice was recorded by two high-speed cameras from the top and front views simultaneously. The focuses were the responses of the ice plate such as crack development and breakup, under the high-speed water jet loads, involving compressible pressure P_1 and incompressible pressure P_2. According to the main cause and crack development sequence, it was found that the damage of the ice could be divided into five patterns roughly. On this basis, the effects of water jet strength, ice thickness, ice plate size and boundary conditions were also investigated. Experiments validated the ice-breaking capability of the high-speed water jet, which could be a new auxiliary ice-breaking way in the future.

Keywords: Water jet impact; Ice damage; Shock wave

Short bio:

Bao-yu Ni, Professor and Doctoral Supervisor of College of Shipbuilding Engineering, Harbin Engineering University (HEU). He received his bachelor and doctor degree in Naval Architecture and Ocean Engineering from HEU in 2008 and 2012, respectively, during which he visited University College London (UCL) in UK for one year between 2010 and 2011 as a visiting PhD candidate. After graduation, he worked as a teacher in HEU and visited UCL again for two years between 2015 and 2017 as a post-doctor. His research fields of interest include ice-water-ship interaction, motion characteristics of polar ships in ice, bubble dynamics, water impact, etc. He has undertaken over 10 projects such as supported from EU Horizon 2020 Project, the National Natural Science Foundation of China, and National Key R&D Program of China, etc.. He has published 2 monographs and over 60 journal/conference papers, authorized 7 invention patents and 7 software copyrights. He has been as one of the editorial board members for the Journal of Hydrodynamics (JHD), Shock and Vibration, Journal of Marine Science and Application and Chinese JHD. He has been selected into “Youth Talent Promotion Project” of China and “Postdoctoral International Exchange Program” of China, etc.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-216 (invited)

Topic 6: Recent challenges on the fundamental study around frosting and icing

SONG Mengjie*, SHEN Jun, ZHANG Xuan, ZHANG Long
Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China
(mengjie.song@bit.edu.cn, jshen@mail.ipc.ac.cn, xuan.zhang@bit.edu.cn, long.zhang@bit.edu.cn)

Abstract

Frosting and icing are widely seen in nature and industrial fields. In the real applications, they always play negative effects. For example, frosting on the surface of outdoor coil degrades the operation efficiency of air source heat pump, frosting on surface of evaporator extends the time and wastes more energy during liquid natural gas vaporization, icing on the wings' surface changes the aerodynamic profile of aircraft and may result in air crush, and ice accumulated on wind turbine blade surface reduces the power generation efficiency. Moreover, frosting and icing problems are reported in the fields of electricity cables, coal transportation, food or ice storage, etc. Droplet condensation and freezing are at the early stages of frosting and icing, and thus influence their final formation. Therefore, it is fundamental and meaningful to summarize and evaluate the existing experimental and numerical fundamental studies about frosting and icing at different stages and application backgrounds. Based on the summary, recent challenges around frosting and icing will be reported in this talk. It is expected that more scholars could be attracted to frosting and icing investigations, and thus solve the stated problems in real applications.

Keywords: Wind turbine icing; icing numerical computation; icing wind tunnel experiment

Short bio:

Dr. SONG Mengjie, Professor of Department of Energy and Power Engineering, Teli Young Scholar, Director of Frost Lab, School of Mechanical Engineering, Beijing Institute of Technology (BIT), China. He is also the Editor-in-Chief of Recent Patents on Mechanical Engineering (EI, Scopus), Associate Editor of Frontiers in Energy Research (SCI, IF=2.746), DECRA Research Fellow in Sustainable Buildings Research Centre (SBRC), University of Wollongong, Australia, and Guest Professor of Tomas Bata University in Zlín, Czech Republic. Before starting the research work in BIT, he worked in the University of Tokyo as JSPS Research Fellow. Prof. SONG focuses on the mechanism study of heat and mass transfer coupled with the flow for more than 10 years. Currently, he has published 128 journal articles, in which 108 ones are SCI, with 70 ones as first/corresponding author, and 8 papers were ESI. He was selected into the World's Top 2% Scientists 2020 and 2021 (Singleyr) list.

Special Session: Electrolysis process and Membrane transport

Session Description:

The electrolysis process has a good application prospect in power generation, hydrogen production, water treatment and even air dehumidification, especially when high-performance membranes are used. This technology is also suitable for using renewable energy sources such solar or biomass energy. The transport phenomena (heat, mass, momentum and energy transport) at different scales from molecular to macros determines the electrolysis performance and energy efficiency. This session aims to look for the research related to the modeling, material development and performance improvement of electrolysis or photocatalytic process, with priority given to research that occurs in membranes. Topics include, but are not limited to, multiscale modeling of transport phenomena, numerical simulation, system thermodynamics, transport enhancement, system optimization and energy utilization improvements.

Session Organizers:

Professor Ronghui Qi received her Ph. D degree in 2013, and was appointed as postdoctoral in 2013-2016 from the Hong Kong Polytechnic University. She joined the South China University of Technology in 2016 and was promoted to the professor on Sep, 2019. Prof. Qi's main research interests are advanced air dehumidification technologies (e.g. electrolytic and desiccant absorption/adsorption dehumidifiers), heat&mass transfer enhancement mechanism and solar energy utilization. As the first or corresponding author, she has published more than 60 international peer-reviewed papers, including 40 SCI papers. She has received the Distinguished Young Scholar from National Natural Science Foundation. She has in the editorial board of <*International Journal of Green Energy*>, used to be a guest editor of <*Heat Transfer Engineering*> and <*Polymers*>.

Professor Chuanshuai Dong received his Ph. D. from the Department of Building Environment and Energy Engineering, the Hong Kong Polytechnic University, Hong Kong, China. He is currently an Associate Professor in South China University of Technology. Dr. Dong's research focuses on the basic heat/mass transfer of phase change materials and multiphase flows. He has developed several constitutive equations for multiphase flow analysis. Dr. Dong has also authored more than 30 SCI journal papers in well-known journals, such as Physics of Fluids, Energy, and International Journal of Multiphase Flow, etc. As PI, Dr. Dong has presided over several research projects supported by National Natural Science Foundation, National Natural Science Foundation of Guangdong, and China Postdoctoral Science Foundation, etc.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-231 (invited)

Stable and high-performance microgenerator formed by TiO_2/Co-based hydrogel films utilizing ambient air humidity

Ronghui Qi*, Huping Yan, Zhen Liu
dongcs@scut.edu.cn

Abstract:

Utilizing humidity gradients to drive electron motion in nanomaterials and generate usable electricity is promising especially for self-powered electrons and sensors. In this paper, a novel humidity gradient-driven microgenerator (HGMG) was developed that employs TiO_2 nanoparticles coated with Co hygroscopic hydrogel films. The prepared TiO_2 slurry was scraped on a hydrophilic frosted polyethylene (PET) membrane to form the power layer rich in nanochannels, and Co hydrogels were coated on the bottom of the generator to form the stable humidity gradient. SEM, FTIR, Raman, XRD and XPS spectra have been conducted for physical and chemical characterizations. Results showed that by putting in a 25°C, 60% room environment, a single unit of generator can achieve a 0.95 V of the open-circuit voltage and 60 μA of short-circuit current, i.e. 5.78 $\mu W/cm^2$, a significantly improvement compared to previous studies (<1 μA on a single unit). The performance can maintain stable with less than 5% attenuation over 100 hours. Besides, these microgenerators are suitable for use in series, 5 of them can power a calculator, and 7 of them can light an LED for more than a week. The mechanism of humidity gradient-induced power generation was analyzed by numerical simulation. It was found that the hygroscopic hydrogel within the nanomaterial channels can absorb moisture from the air, leading to the separation of positive and negative ions due to the combined effect of electric double layer. Since only a small part of positive ions could move to the upper electrode, the concentration of positive and negative ions across the electrodes were polarized, creating an electrical current in microgenerators. This work provides a brand-new power generation method that can utilize ambient air humidity and have a great application prospect.

Short bio:

Professor Ronghui Qi received her Ph. D degree in 2013, and was appointed as postdoctoral in 2013-2016 from the Hong Kong Polytechnic University. She joined the South China University of Technology in 2016 and was promoted to the professor on Sep, 2019. Prof. Qi's main research interests are advanced air dehumidification technologies (e.g. electrolytic and desiccant absorption/adsorption dehumidifiers), heat&mass transfer enhancement mechanism and solar energy utilization. As the first or corresponding author, she has published more than 60 international peer-reviewed papers, including 40 SCI papers. She has received the Distinguished Young Scholar from National Natural Science Foundation. She has in the editorial board of <*International Journal of Green Energy*>, used to be a guest editor of <*Heat Transfer Engineering*> and <*Polymers*>.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-232 (invited)

Performance intensification and anti-fouling of the two-phase flow enhanced direct contact membrane distillation for seawater desalination

Chuanshuai Dong*
dongcs@scut.edu.cn

Abstract:
Membrane distillation is a promising approach to the fresh water crisis due to the low operating temperature and pressure, and high rejection of non-volatile components. However, it suffers a lot from the polarization effect and membrane fouling, especially in the membrane distillation of high-salinity sea water or waste water. Thus, this paper aims at developing a novel two-phase flow enhanced direct contact membrane distillation (TP-DCMD) system and investigating the effect of two-phase flow behaviors on the heat and mass transfer and membrane fouling comprehensively. First, a novel experimental system of TP-DCMD is developed and well validated using the mass and energy conservations between the hot feed liquid and cold permeate liquid. Then, the effect of flow parameters, such as the superficial gas and liquid velocities, and void fraction on the transmembrane permeate flux and permeate flux multiplier are discussed. The results clearly indicate that the introduction of gas could effectively improve the membrane distillation performance as high as 27 % by increasing the flow turbulence. Third, the relationship between the performance enhancement of the membrane distillation and the two-phase flow regimes is discussed in detail. Both permeate flux and multiplier clouds are proposed based on the two-phase flow regime map. The slug flow demonstrates superior enhancing effect to the other flow regimes due to the low possibility of gas penetration and high flow turbulence of the liquid. Finally, the effect of two-phase flows on the membrane fouling is investigated. The two-phase flow demonstrates excellent anti-fouling effect in the DCMD system, especially in the treatment of high-salinity sea water or waste water. After 420 minutes of accelerating fouling test, the transmembrane permeate flux dropped by 38.2 % in the conventional DCMD system, while it just decreases by 6.6 % in the two-phase flow enhanced DCMD system.

Short bio:

Professor Chuanshuai Dong received his Ph. D. from the Department of Building Environment and Energy Engineering, the Hong Kong Polytechnic University, Hong Kong, China. He is currently an Associate Professor in South China University of Technology. Dr. Dong's research focuses on the basic heat/mass transfer of phase change materials and multiphase flows. He has developed several constitutive equations for multiphase flow analysis. Dr. Dong has also authored more than 30 SCI journal papers in well-known journals, such as Physics of Fluids, Energy, and International Journal of Multiphase Flow, etc. As PI, Dr. Dong has presided over several research projects supported by National Natural Science Foundation, National Natural Science Foundation of Guangdong, and China Postdoctoral Science Foundation, etc.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-233 (invited)

Developing novel multifunctional electrodes for high-efficient water splitting

Zhenye Kang*
zkang@hainanu.edu.cn

Abstract

Sustainable energy resources, including solar, wind, and tide etc., generate electricity intermittently, which lead to the challenges to supply continuous power to the current electrical grid. Therefore, a high-efficiency and robust electrochemical energy storage or conversion system coupled with the sustainable energy resources to accommodate seasonal, daily or even hourly changes becomes critical. Proton exchange membrane electrolyzer cells (PEMECs), which act as a reverse proton exchange membrane fuel cell, have been regarded as a very promising energy storage method for hydrogen production from water splitting. To reduce the loading and improve the utilization rate of the noble metal electrocatalysts for oxygen evolution reaction (OER), several methodologies have been proposed and demonstrated. In this study, iridium (Ir) catalysts are proposed on novel titanium thin/tunable liquid/gas diffusion layers (TT-LGDLs) for serving as anode gas diffusion electrodes (GDEs) in high-efficiency PEMECs or Ir-based catalyst is deposited onto Nafion membrane to form a patterned electrode. Our previous studies revealed that the triple-phase boundary significantly affects the OER sites on catalyst layer in a PEMEC, and there is a large portion of catalysts is not effectively utilized. Therefore, a novel thin/tunable GDE is developed by depositing the catalyst on a tunable pattern that is observed to be active for the OER. The Ir loadings of the novel thin GDEs are varied from 0.027 to 1.307 mg/cm^2, and their *in-situ* electrochemical properties are comprehensively investigated in a PEMEC. The PEMEC performance and efficiency can be improved with higher Ir loading, while the Ir catalyst mass activity increases for the sputter deposited GDEs and decreases for the electroplated GDEs with higher Ir loading. An electroplated GDE with lower Ir loading of only 0.208 mg/cm^2 exhibits a high Ir mass activity of about 2.602 A/mg at 1.6 V. The stability of the GDEs is also examined and analyzed, and the lowest degradation rate that has been obtained is about 24.4 μV/h. The novel thin GDEs and the novel patterned electrode can remarkably improve the catalyst mass activity with an acceptable PEMEC performance by improving the catalyst efficiency with a very simple fabrication process and low cost. In addition, the novel thin GDEs significantly reduce thickness from hundreds of micrometers to only 25μm. This concept shows promise for the future electrodes development in low temperature and high efficiency PEMECs, which will help to greatly reduce the cost, thickness, and weight of the electrode itself and the system as a whole.

Keywords: water splitting, hydrogen production, catalyst mass activity, OER, HER

Short bio:

Zhenye Kang is currently a full professor in School of Chemical Engineering and Technology at Hainan University, China. He received his Ph.D. from The University of Tennessee, Knoxville (UTK), U.S. at 2018 (Supervisor: Dr. Feng-Yuan Zhang), and did his postdoc at National Renewable Energy Laboratory (NREL) U.S. from 2018-2021 (Supervisor: Dr. Guido Bender). He joined Hainan University as an associate professor since Apr. 2021 and has been promoted to professor position in Oct. 2021. His research is focused on hydrogen production, water electrolysis technology and application, micro/nano-scale fluidics and heat transfer, additive manufacturing, novel multifunctional materials, and micro/nano electro-mechanical systems. He has published more than 40 papers in high impact journals, including Energy & Environmental Science, Science Advances, Nano Energy, Applied Energy, etc. He has joined several projects from Department of Energy (DOE), U.S., and has received research grants from National Natural Science Foundation of China, Hainan Province Science and Technology Special Fund, Start-up Research Foundation of Hainan University.

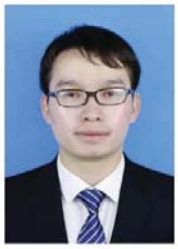
Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-234 (invited)

Exploiting MnO_2 -based Bifunctional Oxygen Catalytic Electrode with Tailored Catalytic Activity for Rechargeable Zn-Air Batteries

Nengneng Xu, Jinli Qiao;
College of Environmental Science and Engineering, Donghua University, Shanghai 201620, China.
E-mail: nengnengxu@dhu.edu.cn, qiaojl@dhu.edu.cn

Abstract
Metal-air batteries, as highly effective clean energy devices, play an important role in current sustainability development. Zn-air batteries are of great interest in future power devices due to eco-friendly, superior safety, cheap and high theoretical energy density. Currently, it remains a significant challenge to exploit low-cost, high-efficient and strong durability bifunctional catalysts to boost the various reactions for Zn-air batteries. 2x2 tunnels α-MnO2 as classic electro-catalyst with unique orthorhombic unit cell structure shows higher oxygen evolution reaction (OER) and oxygen reduction reaction (ORR) activity than other-phase MnO2. In this work, a bifunctional oxygen catalytic self-supported MnO_2-based electrode is well designed, which displays superior oxygen reduction/evolution reactions (ORR/OER) performance ($\Delta E = E_{(j=10)}-E_{1/2}$: 0.69V) over noble metal electrodes. In addition, the as-synthesized $NiCo_2O_4$@MnO_2/CNTs-Ni foam self-supported electrode can be directly used as the oxygen electrode without externally added carbon or binder and shows decent battery performances with high peak power density of 226 mW cm^{-2} and long-term charge-discharge cycling lifetime (5mA for 160h). As expected, the quickly oxygen catalytic intrinsic kinetics and high battery performances of $NiCo_2O_4$@MnO_2/CNTs-Ni foam electrode should be originated from the following points: i) the unique 3D hierarchical structure effectively promotes mass transfer; ii) CNTs combined with Ni foam form a unique "meridian" conductive structure that enables rapid electron conduction; iii) the abundant Mn^{3+} active sites activated by bimetallic ions shorten oxygen catalytic reactions distance between the active sites and reactant, and reduce the surface activity of MnO_2 for O, OH, and OOH species. This work provides an effective mothed to achieve MnO2/CNTs materials with tailored catalytic activity by anchoring different metal oxides, and reveals great potential in the field of high specific energy batteries for portable electronics, electrical vehicles, and wearable devices.
Keywords: Zinc-air battery; Bimetallic activation, Self-supported electrode, Heterojunction, Hierarchical structure

Short bio:



Dr. Nengneng Xu received his PhD degree from Donghua University. From July 2019 to July 2021, Dr. Xu worked as a postdoctoral fellow and then assistant professor in University ofLouisiana at Lafayette. Now, Nengneng Xu is an Associate Professor of the College of Environmental Science and Engineering, Donghua University, China. His current research focuses on the development of nanostructured catalysts for rechargeable metal–air batteries, methane oxidation and solid oxide fuel cells.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-235 (invited)

Constructing optimal Triple-Phase Boundaries for an efficient water electrolysis system

Jinzhan Su
International Research Center for Renewable Energy, State Key Laboratory of Multiphase Flow in Power Engineering, School of Energy & Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China
j.su@mail.xjtu.edu.cn

Abstract

Most renewable energy is a type of process energy which should be converted and stored with an energy carrier. Water splitting is a process that combined energy conversion and mass transformation. The chemical reaction that occurs at the triple-phase boundary is influenced by many factors such as mass flow and exchange rate, electric potential and surface chemical properties. Reducing mass-transport resistance is crucial for improving performance of water electrolysis. In a PEM electrolyzer, a porous transport layer (PTL) is required to ensure efficient the gas/water transport and the electric charges transfer. As the direction of water and gas transfer in a PEM electrolyzer is opposite, favorable mass transport channels for both water and gas are essential. A micron scale water/gas dual-channel porous transport electrode was designed which can greatly reduce mass transfer losses. For an efficient energy conversion in the triple-phase boundary, durable electrocatalysts for hydrogen and oxygen evolution reactions is also a major challenge. We developed a novel hybrid nanostructure with RuCo nanoparticles (NPs) embedded in a N doped carbon nanotube with hollow polyhedron structure. The optimized Ru@Co-N/C show attractive OER and HER activities higher than that of commercial RuO_2 || Pt/C. We also investigated the effect of metal and non-metal substitution in NiFe-based catalysts on the reaction at the three-phase boundary. The incorporation of high-valence cations into NiFe improves the adsorption capacity with active intermediates in the liquid phase, inhibit the transformation of active phase β-NiOOH to inactive phase γ-NiOOH, and thus improve the activity for water oxidation.

Keywords: PEM electrolysis; Triple-Phase Boundaries; Mass transfer; Electrocatalysts.

Short bio:

Dr. Jinzhan Su is currently a professor in Xi'an Jiaotong University. He received his BSc degree in Physics (2005) and Ph.D. degree in Thermal Engineering (2011) at Xi'an Jiaotong University. From Oct. 2008 to Sep. 2010, he worked as a visiting scholar in the Pennsylvania State University, PA, United States. His current research focuses on photoelectrochemical/photoelectrolysis and mass flow properties of catalyst/electrolyte interface and its charge transfer kinetics for the application of fuel cell and water electrolysis. He has published about 90 papers in SCI-indexed internationally peer review journals with more than 3800 citations.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-236 (invited)

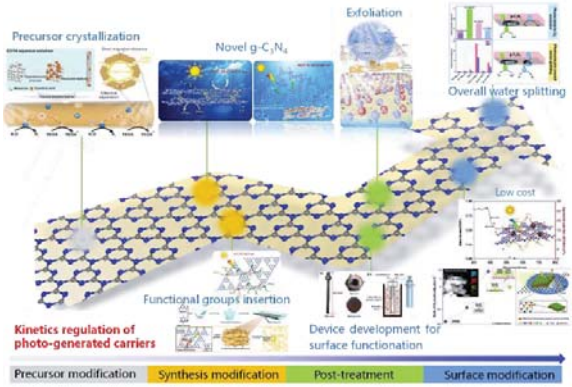
The kinetics regulation of photo-generated carriers in g-C_3N_4 by bulk/surface engineering towards high-efficiency photocatalytic H_2 production

Jinwen Shi*, Cheng Cheng, Yazhou Zhang
State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China
jinwen_shi@mail.xjtu.edu.cn

Abstract

Graphitic carbon nitride (g-C_3N_4) has been extensively studied as a metal-free and visible-light-responsive photocatalyst in the realm of solar catalysis for H_2 production. The unique merits of low cost, good physicochemical stability, regulable electronic band structure and non-toxicity make g-C_3N_4 have significant advantages for the potential industrial application. However, it still remains great challenge to achieve critical breakthrough in H_2-production efficiency due to the low ultilization of photo-generated carriers in g-C_3N_4. Herein, we make a summary of our previous works about the bulk/surface engineering of g-C_3N_4 to adjust the kinetics of photo-generated carriers for promoting photocatalytic H_2 production, including precursor recrystallization, functional groups insertion, novel g-C_3N_4 development, nanosheets exfoliation designation, device development for surface functionation, surface reactive sites adjustment towards low-cost photocatalysis and overall water splitting. We demonstrate a series of research strategies and theories in the understanding of the structure–carriers–photocatalysis relationship of g-C_3N_4, which could provide a meaningful reference for developing highly efficient g-C_3N_4 photocatalytic systems towards solar energy conversion and industrial application.

Keywords: Graphitic carbon nitride; Hydrogen; Photo-generated carriers; Photocatalysis; Water splitting



Short bio:

Dr. Jinwen Shi is currently an associate professor at Xi'an Jiaotong University. His research interest is focused on conversion and utilization of renewable energies, new energy materials, and photocatalysis, especially the development of novel photocatalysts and photocatalytic systems for water splitting under visible-light irradiation. He has published over 100 SCI-indexed papers in international journals and was granted over 10 China invention patents.

Proceedings of the 14th International Green Energy Conference
July 4-8, 2022
Paper No.: IGEC2022-237 (invited)

Sustainable Fuel Production from Ambient Moisture via Semiconductors: Solar-Driven Catalysis System

Lin Yang*, Swee Ching Tan;
Key Laboratory of Optoelectronic Technology and System of Ministry of Education, College of Optoelectronic Engineering, Chongqing University, Chongqing, 400044, P. R. China
yanglin@cqu.edu.cn

Abstract
The major drawbacks associated with the state-of-the-art electrocatalytic and photoelectrochemical water-splitting systems reported so far are the requirement for huge volumes of liquid electrolyte (sea or wastewater) and electrical energy that is required to do water splitting. Continuous research is being carried out with a view of reducing the amount of energy required for achieving overall and complete water splitting process. Here, we have realized a special set of hybrids $BaTiO_3$@Cu_2O, $BaTiO_3$@$BiVO_4$, and $BaTiO_3$@MoS_2 that can perform efficient water oxidation and reduction, respectively. Combining them with an in-house developed and versatile super-hygroscopic hydrogel that harvests enormous amounts of moisture together, we have developed an artificial-photosynthetic system that absorbs the moisture from the ambient air and converts it into hydrogen and oxygen, thereby realizing two benefits – zero-energy dehumidification and energy/fuel (hydrogen) generation from ambient humid air. The application scenarios are low storey, tropics, moist places, and storage box, where a substantial amount of energy is being spent on air-conditioning to maintain thermal comfort. In lieu of this, we have proposed the atmospheric moisture splitting process to achieve maximum thermal comfort by reducing relative humidity and concurrently produce sustainable fuels at zero energy expense.

Keywords: humidity, hydrogel, semiconductor, moisture splitting, dehumidification

Short bio:

Dr. YANG Lin is an associate professor at the Chongqing University, China. He received his Ph.D at this University in 2018 in Department of Physics. His research interests are Atmospheric water harvesting via super hygroscopic hydrogel, Water splitting via photo/electrocatalysis, and Photoelctrochemical interfacial mass transfer. At present, he has published over 40 research papers in Nat. Common., Joule, Adv. Mater., ACS Nano, Energy Environ. Sci., Nano Energy, et. al.

Abstracts of Oral Presentations

Proceedings of the 14th International Green Energy Conference
IGEC2022-013
July 4-8, 2022

IoT BASED POWER THEFT DETECTION, MONITORING AND CONTROL SYSTEM

Dr. Yogesh P. Patil
Associate Professor
Pune, India
yogesh.patil@aissmsioit.org

And

Arpit Ghate
Student
Pune, India
tesla@aissmsioit.org

ABSTRACT

This paper proposes design and combination of different techniques to treat the power theft and losses for monitoring and reporting the same to the control authority for necessary action. Suggested electrical power theft detection unit works on the principle of comparison. The device proposed is an electronic meter comprised of sensors, controllers and wireless modules that are used to detect an unauthorized tapping on distribution lines. Also, it helps to understand tampering of meter cover and tilting of meter. There is no system in existence that is able to identify the exact location of tapping. Also, no system communicates about the tampering to controlling authority as well as customers promptly.

Keyword: Power theft, monitoring, tapping

Proceedings of the 14th International Green Energy Conference
IGEC2022-014
July 4-8, 2022

DEVELOPING LOCAL CAPACITY FOR THERMOCHEMICAL TREATMENT OF BIOMASS FOR SYNTHESIS GAS PRODUCTION IN NIGERIA

Peter E. Akhator[1,*], Albert I. Obanor[2] and Godwin E. Sadjere[3]
[1,2,3] Department of Mechanical Engineering, University of Benin, Benin City, Nigeria.
Authors' e-mails: [1,*]peter.akhator@uniben.edu, [2]aiobanor@yahoo.com, [3]godwin.sadjere@uniben.edu.

ABSTRACT

Nigeria is replete with enormous volume of biomass resources. These resources can be treated thermo-chemically to produce syngas, which can be used to generate energy to ameliorate the energy poverty in the country. Despite advancement in gasification technologies in developed countries, little experience exist in developing countries, including Nigeria, in the effective development and efficient operation of biomass gasifiers for synthesis gas production. A 2017 DFID study on Bioenergy for Sustainable Energy Access in Africa (BSEAA) revealed that although biomass gasification have huge potential for power generation in SSA, such projects have been hampered by several challenges. These challenges include mainly lack of local technical capacity to develop, operate and maintain the gasification systems (which were and are all imported).

An attempt to bridge this capacity gap was made by carrying out the development of a pilot downdraft biomass gasification system. The developed downdraft biomass gasifier is a modified combination of both Imbert and stratified downdraft gasifier designs. This is to take advantage of the merits of both designs, especially the ease of biomass feeding into the gasifier via the open top and the tar cracking effect of the throat. In addition to the open top, provision was made for air inlet through the side of the gasifier close to the top. This air flows through a vertical pipe located at the vertical axis of the gasifier straight to just above the grate. This is to ensure regular and constant supply of air as well as to maintain a high temperature at the oxidation zone. A grate shaker was included to address the problem of feedstock bridging and channeling at the throat. The developed downdraft gasification system comprises a reactor and syngas cleaning unit. The syngas cleaning unit contains a cyclone separator, syngas cooler (a heat exchanger using ambient air as cooling medium), cylindrical drums (2) and a coarse filter (containing wood shavings).

The developed gasification system was operated and tested using wood wastes (chunks) as feedstock and atmospheric air as gasifying medium. The start-up time for the gasifier was about 3 to 4 minutes and it takes 17 minutes to operate steadily. The syngas leaving the gasifier reactor enters the cyclone separator where ash and particulates are removed from it using a centrifugal force and the difference in density between the syngas and particulates. The partially cleaned syngas then enters into the syngas cooler, which facilitates condensation of moisture and some of the tars in the syngas. Unlike most previous studies that utilized direct (contact) cooling systems, like spray towers and water scrubbers, the cooling system used in this study was an indirect (no contact) cooling system, as there are no concerns with waste water disposal (a common problem with direct syngas cooling) and can be used in locations where there are water shortages. The partially cooled syngas then enters into two empty drums linked in series, where condensation of more tar and moisture occur. Finally, the syngas enters the coarse filter at the bottom and exits at the top after passing through a packed bed of wood shavings. The wood shavings, sieved through 2mm wire mesh, served as a filtration medium, which absorbs almost all the tars and remaining moisture in the syngas. The combustion, in a burner, of produced syngas yielded a stable flame, which indicated effectiveness of the syngas cleaning unit. Wood wastes consumption rate was about 3.3kg/h, yielding syngas that burns for about 43 minutes. The highest temperature recorded at the throat was 1068℃.

Keywords: biomass, downdraft gasifier, syngas.

Proceedings of the 14th International Green Energy Conference
IGEC2022-015
July 4-8, 2022

CAN A LINEAR ECONOMY SOLVE THE CLIMATE CRISIS? A GEOTHERMAL CASE STUDY

Birol Kilkis
Polar Technology Inc. and Enover Inc.

ABSTRACT
This paper argues that linear economic rules like the linearized Pareto principle are insufficient tools for decarbonization efforts against the climate crisis and cannot satisfy the Paris Agreement. A new exergy-based second-order economic model is presented, which decouples the Pareto economy from energy, exergy, environment, and social welfare and then couples it back by defining a Carnot cycle equivalency for the economy. The formation of such a holistic model encompasses a circular exergy algorithm and shows that sustainably successful measures against climate crisis are only possible by considering the exergy destructions. Exergy destructions cause nearly-avoidable emissions that are kept unrecognized by the linear economic rules, which can only accommodate the energy efficiency according to the first law of thermodynamics, which is also linear. The paper demonstrates the new approach by presenting a geothermal power plant in Indonesia at a rated capacity of 400 kW. This system seems to be viable according to the Pareto economy, but the new exergy-based second-order model shows that it is not environmentally rational unless it is converted to geothermal cogeneration under specific rationality rules.

Keywords: Low-enthalpy geothermal energy, geothermal power, Organic Rankine Cycle, geothermal cogeneration, district heating, individual cooling, heat-piped radiator

Proceedings of the 14th International Green Energy Conference
IGEC2020-016
July 4-8, 2022

Sustainable Energy Resource for Air Conditioning Systems, A Case Study in Kabul City

Mohammad Azim Rasuli[1*], Shuichi Torii[2]
[1] Mechanical Engineering Department, Faculty of Engineering, Kabul University
Karte-4, District No.3, Kabul, Afghanistan.
E-mail: rasuli.azim@gmail.com
[2] Professor, Department of Mechanical and Mathematical Engineering, Kumamoto University
Division of Industrial Fundamentals, Faculty of Advanced Science and Technology, Kumamoto University, 2-39-1, Kurokami, Kumamoto, 860-8555 JAPAN
E-mail: torii@mech.kumamoto-u.ac.jp

ABSTRACT
Air conditioning accounts for about 20% of total electrical energy use worldwide. The energy required is supplied from various sources i.e., fossil fuel, solar energy, wind energy, hydropower plants, etc. with a major part by city power plants using non-renewable energy resources. Such energy resources are limited, expensive, and cause environmental pollution. In contrast, renewable energy resources which are endless, clean, and environmentally friendly are sustainable, support the local economy, and can aid in social development. Developing countries have a relatively higher vulnerability toward energy shortages and load shedding. Kabul, the capital city of Afghanistan, still faces energy shortages. Yet on average it receives about 4 – 6.5Kwh/m^2/day of solar global horizontal irradiance, which is technically suitable for PV systems power generation. This paper investigates the cost comparison between conventional energy resources and solar energy resources for air conditioning systems in Kabul city. To conduct this research, a 30-person classroom is considered in one of the schools in Kabul city. According to the space thermal energy loses, a 2-ton air conditioner is selected for heating and cooling purposes. Cost calculations for conventional energy consumption and solar energy investment are then performed. In conclusion, a solar-powered air conditioner is economically cost-effective and cheaper than a conventional air conditioning system over a long period of operation.

Keywords: Solar energy, Air Conditioning, Conventional Energy, sustainability

Proceedings of the 14th International Green Energy Conference
IGEC2022-017
July 4-8, 2022

THERMOCHEMICAL SORPTION HEAT STORAGE USING ACTIVATED CARBON BEADS AS A POROUS HOST MATRIX FOR $MGSO_4$ SALT

Minh-Hoang Nguyen[1, 2,] Mohamed Zbair[1,2, *], Patrick Dutournie[1, 2,] Simona Bennici[1,2,]
[1]Institut de Science des Matériaux de Mulhouse (IS2M), Université de Haute-Alsace, CNRS, IS2M UMR 7361, F-68100 Mulhouse, France ;
[2] Université de Strasbourg, France

Authors' e-mails: mohamed.zbair@uha.fr

ABSTRACT
The intrinsic shortcomings of salt hydrates, such as poor thermal conductivity, sintering, limited hydration rate, and significant heat storage density degradation, cannot be overcome. As a result, it's critical to produce a salt hydrate material with better thermal conductivity, heat storage capacity, and water storage content while maintaining strong cycle stability for efficient low-grade heat and home heating. Herein, $MgSO_4$/bead activated carbon composites have been investigated in thermo-chemical sorption heat storage. With a high degree of micro-porosity and a large surface area of about 1300 m^2/g, bead activated carbon (BAC) is a potential candidate for a thermochemical heat storage building application. Three composites have been prepared by wet-impregnation (1.0-$MgSO_4$/BAC, 5.2-$MgSO_4$/BAC, and 7.6-$MgSO_4$/BAC). After impregnation of $MgSO_4$, the specific surface area decreased, but the pore size distribution remained similar to the matrix. The equilibrium water sorption capacity of BAC was 0.144 g/g, while the composite 7.6-$MgSO_4$/BAC adsorbed 2.4 times better due to the dispersion of the salt in the host matrix. An adsorption capacity higher than our expectations was observed, which could have led to condensation of water molecules within the porous structure, and thus a higher thermal energy density than calculated was recorded. The 7.6-$MgSO_4$/BAC composite achieved the highest heat of hydration of 806 J/g. A 10-cycle process (dehydration at 150 °C and hydration at 30 °C at a relative humidity of 60%) confirms the stability of the composite. This new $MgSO_4$/BAC composite material could pave the way for residential heating and future application of $MgSO_4$/BAC.
Keywords: Thermochemical heat storage; magnesium sulfate; bead activated carbon; water sorption.

Proceedings of the 14th International Green Energy Conference
IGEC2022-018
July 4-8, 2022

PERFORMANCE EXAMINATION OF THE GEOTHERMAL ENERGY-SUPPORTED POWER PLANT WITH THE THERMOELECTRIC GENERATORS

Fatih YILMAZ*
*Isparta University of Applied Sciences,
Faculty of Technology, Department of Mechatronics Engineering, Isparta, TURKİYE
fatiyilmaz7@gmail.com

ABSTRACT

In this planned research, a double flash binary geothermal power generation cycle is investigated and proposed. This study consisted of two steam cycles, a Rankine cycle with CO_2 fluid, and two thermoelectric modules (TEG). In this paper, which is designed, the TEG unit is integrated to increase efficiency, and performance comparison is made. This proposed research is examined in respect of energy and exergy analysis approaches. According to the consequences of the study, the energy and exergy performance of this examined cycle without TEG is calculated as 39.68% and 59.41%, while energetic and exergetic efficiency of the cycle with TEG is calculated as 41.55% and 64.89%, respectively. Considering the analysis result, the usage of the TEG, which is simply a component, gives rise to the modeled system's performance

Keywords: Energy, exergy, geothermal, TEG, power

Proceedings of the 14th International Green Energy Conference
IGEC2022-019
July 4-8, 2022

DESIGN AND COMPARATIVE THERMODYNAMIC EXAMINATION of A SMALL-SCALE SOLAR ENERGY-BASED POWER AND HYDROGEN GENERATION PLANT

Fatih YILMAZ*
*Isparta University of Applied Sciences, Faculty of Technology,
Department of Mechatronics Engineering,
Isparta, TURKİYE
fatiyilmaz7@gmail.com

ABSTRACT

To tackle with global warming and environmental troubles, it is inevitable to use renewable energy sources. Therefore, in this designed study, power, heating, and hydrogen production are investigated by integrating the solar-powered transcritical Rankine cycle that includes PEM electrolysis. A comprehensive thermodynamic examination is applied by using the energetic and energetic methods. Moreover, a parametric study is also conducted to examine the impact of some significant factors on the cycle performance. Referring to the analysis's findings, the designed plant can be generated a 2.052 of kW clean power. Furthermore, energetic and exergetic performance of the entire cycle is 37.91% and 40.14%, respectively.

Keywords: Energy, exergy, hydrogen, heating, Solar

Proceedings of the 14th International Green Energy Conference
IGEC2022-021
July 4-8, 2022

THERMAL PERFORMANCE OF LOW EMISSIVITY SOLAR CONTROL FILMS in a COLD CLIMATE

R. St-Jean, N. Potvin, K. Yaacoub, E. Hill, H.M. Teamah*

Department of Building Science, Algonquin College, Center for Construction Excellence, Ottawa, Canada
*Corresponding author email: teamahh@algonquincollege.com

ABSTRACT

The current experimental study was conducted to bridge a gap in knowledge and allow for scientific consensus surrounding the thermal performance of low emissivity window films in Canadian winter climate conditions. The glazing of a test building located in Ottawa, ON was outfitted with Llumar VE50 low emissivity window film. The ambient temperature (indoor and outdoor, ˚C), the energy consumption (KWh) of a simple heating system and the illuminance (lx) were measured and used as performance metrics. After the comparison between the metrics in both the control phase, with no window film, and the second phase, with the window film applied, it is conclusive that the solar thermal window films did not have a significant effect on the heating requirements of the space within the time allotted. As a result of the window film installation the space saw an overall reduction in luminance between the two weeks, of 38,191 lx total.

Proceedings of the 14th International Green Energy Conference
IGEC2022-022
July 4-8, 2022

DESIGN AND ANALYSIS OF DEADBEAT CONTROL STRATEGY FOR MULTI- INPUT DC-DC CONVERTER WITH HYBRID ENERGY STORAGE SYSTEM

Himanshu Srivastava[1], Udaya Bhasker Manthati[1], Arunkumar C R[1]
[1]Electrical Engineering Department, NIT Warangal, Telangana, India.

Corresponding author: Himanshu Srivastava, Department of Electrical Engineering, National Institute of Technology, Warangal 506004, Telangana, India.

E.mail: hsee20107@student.nitw.ac.in , ub@nitw.ac.in, acr_research@student.nitw.ac.in

ABSTRACT

This paper gives an overview of a deadbeat control approach for a hybrid energy storage system (HESS) energy management. The HESS is characterized by a beneficial coupling of two or more energy storage systems with supplementary operating characteristics such as power density, energy density, efficiency, self-discharge rate and lifetime. In our work, two energy sources are used. The battery supplies the average power demand and a supercapacitor for the transient power demand in total load power. This paper briefly discusses the HESS converter, coupling between two energy sources, and the principle approach for power flow between source and load. Using a battery alone as an energy source will increase current stress on the battery during a sudden load change and decrease its lifetime. Conventionally, the power flow between energy source and load is controlled with the help of a PI controller. It has demerits of complexity in tuning and its dependency on operating points. This paper presents a deadbeat control strategy (DCS) for a multiple-input bidirectional DC/DC converter to integrate HESS. Compared to conventional strategy, DCS possesses the benefits such as simplicity, easy implementation, and involvement of nonlinearities and constraints. The dual-input bidirectional DC/DC converter model is developed, and then the deadbeat control strategy is implemented on the converter. MATLAB-Simulink model is made for the converter with resistive load, and a scaled-down experimental setup is developed to verify the proposed control strategy using dSPACE 1104 platform.

Keywords: Bidirectional DC/DC converter, Hybrid Energy Storage System, Deadbeat control strategy, Proportional Integral controller.

Proceedings of the 14th International Green Energy Conference
IGEC2022-023
July 4-8, 2022

THE FEASABILITY OF GEOTHERMAL EARTH TUBE SYSTEMS FOR HEATING IN OTTAWA, ONTARIO

Aidan Di Lello, Andrew Tennian, Conor O'Neill, Hebatallah Teamah

1. ABSTRACT

Geothermal technology has been known for ages. It is well known and commonly used as heating source in places like Europe and Asia. Typical applications use Earth Tubes as heat exchangers for supply air. This experimental research paper aims to determine the feasibility of Earth Tube systems in Ottawa Ontario, Canada. It is important to establish metrics as benchmarks for feasibility. In this research, five metrics are used to determine whether or not this is a feasible heating system in Ottawa Ontario. The metrics are: cost & cost Savings, temperature difference, environmental impact, ease of constructability and Scalability/Flexibility. The objective & purpose of this final year student project is to determine the feasibility of utilizing geothermal earth tube technology in Ottawa Ontario. Certain metrics hold higher value than others. For example, a higher value is placed on the temperature difference metric, the metric which measures how effectively the earth tube conditions air prior to it being introduced to the heat recovery system, compared to the much lower importance of scalability. While the research mainly focuses on residential use of earth tubes, it is important to place value on whether or not the system can be applied to larger scale projects. These metrics will be deeply analyzed in the results and discussion sections found later in the research.

Proceedings of the 14th International Green Energy Conference
IGEC2022-024
July 4-8, 2022

EXPERIMENTAL PROOF OF A SIMPLE APPROACH TO FIND OUT EXCITATION REQUIREMENT IN OFF-GRID POWER APPLICATIONS OF INDUCTION GENERATOR; A BRIEF REPORT

V. B Murali Krishna
Department of Electrical Engineering, Central University of Karnataka
Kadaganchi, Kalaburagi (Gulbarga) – Pin code: 585 367, Karnataka State, India.
Authors' e-mails: muralikrishna.cuk@gmail.com , muralikrishna@cuk.ac.in

ABSTRACT
Induction generators (IGs) are gaining popularity for both grid and off-grid applications due to its low cost, more reliable, rugged construction, ease of operation, and so on. In the case of off-grid operation, the IG requires a minimum amount of reactive power to establish the magnetic field in the core of the machine. In this paper, an efficient and easiest method is presented to calculate the required reactive power for the successful operation of IG for small-scale off-grid power generation. The efficiency of the calculated values is experimentally verified in this article.

Keywords: Induction generator (IG), off-grid mode of operation, reactive power, generated voltage.

Proceedings of the 14th International Green Energy Conference
IGEC2022-025
July 4-8, 2022

AUTOMATED CHARACTERIZATION OF POROSITY OF NANOFIBER MAT BY IMAGE PROCESSING

Erqian Gao[1], Yifu Li[1], Hesheng Yu[1,2], Zhongchao Tan[1*]
[1]Department of Mechanical & Mechatronics Engineering, University of Waterloo, Ontario, Canada
[2]School of Chemical Engineering, China University of Mining Technology, Xuzhou, China
*e-mail: tanz@uwaterloo.ca

ABSTRACT
Nanofibers have been widely used in many energy technologies including battery separators, solar panels, and powering wearable devices. Their performances largely depend on the porosity, which is often experimentally determined at this moment. There is a need of automated tools for fast determination of porosity. An image processing tool using different image segmentation methods to determine the porosity, and the most accurate one is identified by comparing their performances with experiment. It is recommended to use 85% average grayscale plus standard deviation for thresholding during image processing.

Keywords: nanofiber, porosity, automated image processing

Proceedings of the 14th International Green Energy Conference
IGEC2022-026
July 4-8, 2022

Steam gasification of excavated waste residue (EWR) from a landfill bioreactor operated for 15 years

Banjo Stephen Adewunmi[1], Zhongchao Tan[1], J. Patrick A. Hettiaratchi[2]
[1]Department of Mechanical & Mechatronics Engineering, University of Waterloo, 200 University Avenue West Waterloo, Ontario, Canada N2L 3G1
[2]Department of Civil Engineering, Schulich School of Engineering, University of Calgary, Calgary, Alberta, Canada T2N 1N4
Emails: sabanjo@uwaterloo.ca[1], zhongchao.tan@uwaterloo.ca[1], jhettiar@ucalgary.ca[2]

Abstract
Biomass gasification is one of the promising methods of harnessing the energy potential of solid wastes. Steam gasification is a type of biomass gasification that has proven to be the most favorable method among the various methods of converting biomass to energy. The process results in products with minimum environmental effect and therefore plays an important role in achieving a circular economy. Steam gasification is a thermochemical method of converting biomass into useful gases such as hydrogen (H_2), methane (CH_4), carbon monoxide (CO), and char. This study examines the effects of temperature, residence time, and steam to biomass ratio on the steam gasification process of biomass comprised of municipal solid waste. The steam gasification experiment was carried out in a horizontal lab-scale furnace and the design of experiment was done using the Response Surface Methodology (RSM) based on the Box-Behnken method to determine the number of test runs, main effects of each variable and the interactions of all the variables on the gasification products. The results show that the highest product yield is obtained at 1000 ^{0}C, 45 minutes of residence time, and steam to biomass ratio of 1.55. The level of confidence of the observed values will be tested using regression analysis and analysis of variance (ANOVA). This study will show how temperature, residence time, and steam to biomass ratio affect steam gasification product output and enable us to understand the energy potential of the excavated waste residue (EWR) obtained from mining the Calgary Biocell; a landfill bioreactor operated in Calgary for 15 years before mining. Future work should look at how to improve the quality and quantity of the product gas, the usefulness of the product gas, and solid residue.

Keywords: Biomass gasification, Steam gasification, Biomass-to-energy.

Proceedings of the 14th International Green Energy Conference
IGEC2022-027
July 4-8, 2022

A SHORT REPORT ON INFLUENCING FACTORS OF EXCITATION PHENOMENA IN SELF EXCITED INDUCTION GENERATOR

[*1]V. B Murali Krishna
[*1]Dept. of Electrical Engineering, Central University of Karnataka, Kadaganchi, Kalaburagi (Gulbarga), Pin code: 585 367, Karnataka State, India. Authors' e-mails: muralikrishna.cuk@gmail.com , muralikrishna@cuk.ac.in
[2]V. Sandeep
[2]Dept. of Electrical Engineering, National Institute of Technology (NIT), Tadepalligudem, Pin code: 534 101, Andhra Pradesh, India. Authors e-mails: sandeep@nitandhra.ac.in

ABSTRACT
An induction generator (IG) is not a self-started generator in the off-grid mode of operation and it requires the proper reactive power excitation from the external circuit arrangement to magnetize the generator core and hence generate the voltage and desired frequency. The generated voltage is depending on the speed of the rotor and the amount of the reactive power connected across the stator terminals of IG under no-load conditions. In this paper, an exclusive experimental study is presented for making the IG as a self-started (or self-excited) generator for off-grid power generation. The allowable upper and lower limits of the effecting factors of self-excitation are experimentally investigated in this paper.

Keywords: Induction generator (IG), off-grid mode of operation, reactive power, rotor speed, voltage, frequency.

Proceedings of the 14th International Green Energy Conference
IGEC2022-028
July 4-8, 2022

The Best Energy Source to Save our Planet: Incineration of Plant Materials to Generate Power

George Yang, Ph.D.
Department of Engineering Technology
Missouri Western State University
4525 Downs Drive
St. Joseph, MO 64507
yang@missouriwestern.edu

Abstract:

Generating electricity by incineration of plant materials through thermal power generation processes is the greenest energy source. This energy source is absolutely renewable, and net zero carbon emission. While every kind of energy sources has its drawbacks causing environmental harm one way or another, this energy source has the least environmental impact. This study is not discussing open burning, or burning in a fireplace to provide heat for a building, or bio-waste or construction waste burning, it is rather focused on large-scale power generation using modern coal-firing power plant technology with state-of-the-art exhaust control, and raw materials supplied by agriculture. One third of US farmland can generate all the electricity the country needs. There will be no energy crisis, no environment crisis.

Keywords: plant material incineration, electric power generation, green energy

Proceedings of the 14th International Green Energy Conference
IGEC2022-029
July 4-8, 2022

EFFECT OF IONOMER CONTENT WITHIN CATHODE CATALYST LAYER ON OVERALL PERFORMANCE OF A PROTON EXCHANGE MEMBRANE FUEL CELL

Rui Jiao YU, Hang GUO*, Hao CHEN, Fang YE,
MOE Key Laboratory of Enhanced Heat Transfer and Energy Conservation, and Beijing Key Laboratory of Heat Transfer and Energy Conversion, College of Energy and Power Engineering, Beijing University of Technology, Beijing 100124, China
* Corresponding author, E-mail: hangguo@sohu.com, Tel.: +86-10-67391612 ext. 8311

ABSTRACT
Ionomer content is an important parameter inside catalyst layer, the content affects catalyst layer properties and cell performance. In this work, a 3D agglomerate model is established to explore the influence of constant value and stepped non-uniform distribution on cell performance. The results show that higher ionomer content increases cell performance in ohmic loss region but reduces the performance in concentration loss region. Higher ionomer content significantly increases the homogeneity of reaction rate distribution along thickness direction. Ionomer content has a great effect on reaction rate around inlet region with sufficient reactants. The effect of stepped distribution on cell performance mainly occurs in higher current density region. Uniform distribution structure has the highest peak power density. The content decreasing along main gas flow direction is most conducive to cell performance improvement compared with the results obtained from the other two directions. The content reducing from under rib to channel and the content stepped distribution along thickness direction all can better improve cell performance. The influence of stepped non-uniform distribution with two segments or three segments on cell performance is different.

Keywords: Ionomer content, catalyst layer, cell performance, proton exchange membrane fuel cell.

Proceedings of the 14th International Green Energy Conference
IGEC2022-030
July 4-8, 2022

COMPARISON OF AIRCRAFT EMISSIONS FOR DIFFERENT ENGINE ALTERNATIVES: A CASE STUDY

Murat AYAR
Eskisehir Technical University
muratayar@eskisehir.edu.tr

Selcuk EKİCİ
Igdır University
selcukekici@gmail.com

T. Hikmet KARAKOÇ
Eskisehir Technical University,
Istanbul Ticaret University
hkarakoc@eskisehir.edu.tr
thkarakoc@ticaret.edu.tr

ABSTRACT
The threat of global warming is getting more and more serious every day. The biggest cause of global warming is greenhouse gases resulting from the use of fossil fuels. Considering the total greenhouse gas emissions in the world, emissions from aviation stand out. For this reason, authorities and governments set targets and take measures in this regard. In this study, the emission productions of the aircraft are encountered for four scenarios where four mostly used aircraft engines are used for the same aircraft and the same route. It has been concluded that 6% improvement can be made for NO_X emission and 3% for total gas emission. In addition, it has been determined that CO_2 and H_20 emissions for all four aircraft engines constitute 99% of the total greenhouse gas emissions.
Keywords: Global warming, aircraft emissions, aircraft engine.

Proceedings of the 14th International Green Energy Conference
IGEC2022-031
July 4-8, 2022

THERMAL FLUID FLOW CHARACTERISTIC OF GRAPHENE/WATER AND SILICA/WATER NANOFLUIDS

Aima Shibata[a], Kotaro Fujimoto[b], and Shuichi Torii[c]
[abc]Department of Mechanical and Mathematical Engineering, Kumamoto University
2-39-1 Kurokami, Kumamoto, 860-8555, Japan
[a]219d8462@st.kumamoto-u.ac.jp, [b]208t2231@st.kumamoto-u.ac.jp, [c]torii@mech.kumamoto-u.ac.jp:

ABSTRACT
Heat transfer performance of working fluid is important parameter for cooling devices. Experimental study is conducted on heat transfer performance of next generation working fluid, nanofluid, in turbulent flow region. Turbulence heat transfer performance of nanofluids is evaluated by Nusselt number and friction factor in turbulent flow region. The working fluid flow in the horizontal circular tube which is heated under constant heat flux condition. As the working fluid, graphene/water nanofluid with volume fraction of 0.1 vol.% and silica/water nanofluid with volume fraction of 1.0 vol.% are employed. Graphene nanofluid is prepared by using pulsed discharge, and silica nanofluid is prepared by dilution of the colloidal silica. Nusselt number of graphene/water nanofluid and silica/water nanofluid improve by 43.1-50.2 % and 30.9–33.3 % compared with that of Gnielinski model. In contrast, there is not substantial increase of friction factor, and the difference between nanofluids and water is less than 2.95 %.

Keywords: nanofluid, thermal flow, pipe flow, convective heat transfer, pulsed discharge.

Proceedings of the 14th International Green Energy Conference
IGEC2022-032
July 4-8, 2022

TECHNO-ECONOMIC PERFORMANCE COMPARISON OF WIND TURBINES WITH DIFFERENT RATED POWER AT THE GWADAR WIND CORRIDOR USING RET SCREEN 4

Muhammad Muddasar
Department of Energy Systems Engineering, U.S.-Pakistan Centre for Advanced Studies in Energy (USPCAS-E), National University of Sciences & Technology (NUST), Sector H-12, Islamabad, 44000, Pakistan
mmuddasarese19.ces@student.nust.edu.pk

ABSTRACT

This rigorous study is based on a techno-economic performance analysis of wind turbines with different rated power (2MW & 3MW) for Gwadar using RETScreen 4 software. The software collects climatic data from its database and requires input parameters including wind shear exponent, wind turbine selection, hub height, and some costs to generate outcomes required for financial and technical analysis. Hellman power law is used to extrapolate wind speed at the required height. It is verified that the speed of wind significantly gets stronger with an increase in height. The techno-economic analysis is subdivided into three analyses named energy production, financial, and emission analysis and then comparative analysis of both wind turbines is performed for each analysis to select the best turbine for the Gwadar site. Comparative analysis of 2MW & 3MW wind turbines is performed based on a capacity factor, the electricity that can be exported to the grid, Net Present Value, Internal Rate of Return, payback period, annual savings, and greenhouse gases emission reduction. The study indicates that the 3MW wind turbine is a suitable and profitable option to be installed at Gwadar.

Keywords: Wind energy, Gwadar wind corridor, wind turbines, RETScreen 4, Techno-economic Analysis

Proceedings of the 14th International Green Energy Conference
IGEC2022-033
July 4-8, 2022

SIMULATIONS FOR THE COOLING OF METALLIC BIPOLAR PLATE PROTON EXCHANGE MEMBRANE FUEL CELLS

Xingbao Lv
Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, Dalian University of Technology
No.2 Linggong Road, Dalian 116024, China
Email: 1157595609@qq.com

Zheng Huang
Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, Dalian University of Technology
No.2 Linggong Road, Dalian 116024, China
Email: 1585126537@qq.com

Xuanyu Liu
Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, Dalian University of Technology
No.2 Linggong Road, Dalian 116024, China
Email: liuxuanyu277335470@163.com

Yubai Li*
Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, Dalian University of Technology
No.2 Linggong Road, Dalian 116024, China
Email: liyubai2021@126.com

ABSTRACT
PEMFC is one of the promising power sources for future electric vehicles (EVs). As an electrochemical power generation device, the PEMFC inevitably generates heat during its operation. For today's PEMFC which can generate higher current density, the amount of accompanying waste heat also surges. Thus, propriate cooling solution for the PEMFC is needed, which poses the motivation for PEMFC thermal management research. Liquid cooling is the main method for automotive PEMFC cooling. Numerical modeling is helpful for better understanding effect of liquid cooling on the internal physical field distributions and the PEMFC performance. For the macro-scale heat transfer modeling of PEMFCs, the most common method is to assign constant temperature condition on the bipolar plate and focuses on the through-plane temperature distribution. However, for the real case, the in-plane or along-channel temperature is highly non-uniform. The non-uniformity comes from the temperature distribution of the liquid water, and the inlet to outlet temperature difference may be as large as 10-20°C. Such large temperature difference may alter the temperature for each through-plane cross section to be different. Thus, considering the along-channel temperature distribution is important, and one approach is to model the liquid water heat transfer problem with conjugate heat transfer model. The conjugate heat transfer model solves the fluid flow equation and heat transport equation in the liquid water domain while solves conduction equation in the solid domain, thus, resolves the heat transfer problem more directly. With the conjugate heat transfer model added to the multi-physics PEMFCs model, the liquid water cooling for the PEMFCs is investigated in this work. Specifically, the cooling flow inlet temperature, the cooling flow rate, and the direction of the cooling flow are analyzed and discussed. The impacts for the cooling flow conditions on the PEMFC internal physical field distributions are discussed. The present work can provide fundamental understanding for the temperature distribution in PEMFCs and its consequences on fuel cell performance. At the meantime, it can shed light on the engineering designing for the liquid cooling of automotive PEMFCs.

Keywords: PEMFC, metallic bipolar plate, liquid cooling, modeling, conjugate heat transfer

Website: http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

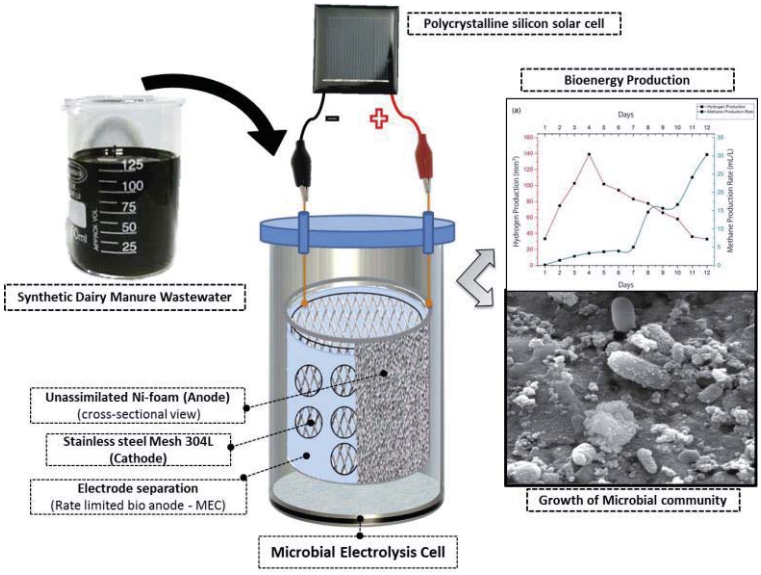
Proceedings of the 14th International Green Energy Conference
IGEC2022-035
July 4-8, 2022

SOLAR-POWERED MICROBIAL ELECTROLYSIS CELL FOR BIOHYDROGEN PRODUCTION FROM DAIRY WASTEWATER

Muhammad Muddasar[1], Rabia Liaquat[2]
U.S-Pakistan Centre for Advanced Studies in Energy, National University of Sciences and Technology, Islamabad, Pakistan 44000
[1] mmuddasarese19.ces@Student.nust.edu.pk
[2] rabia@uspcase.nust.edu.pk

ABSTRACT

The Microbial Electrolysis Cell (MEC) is a novel technology for wastewater treatment to produce bioenergy. Typically, an assimilated biofilm is required by the MEC bio-anode to break down the organic content, but biofilm assimilation is a time-consuming process. This study used an unassimilated nickel-foam anode in a single-chamber MEC and reported successful bioenergy production at the end of the first cycle. Synthetic Dairy Manure Wastewater (SDMW) was used as a substrate as well as an inoculum in this solar-powered tubular MEC. Microbes break down the organic substrate at the anode surface and produce electrons and protons. Electrons move through the external circuit and protons via dairy wastewater toward the cathode where they combine to generate biohydrogen. The effects of the exposed surface area of the bio-anode on bioenergy production were also evaluated, using rate-limited bio-anode - MEC and fully exposed bio-anode - MEC separation techniques. The former technique achieves a maximum methane production rate of 30.35 ± 0.03 ml/l, 14.2% more than that achieved by the later mentioned technique (26.4 ± 0.05 ml/l). Hydrogen production was approximately 800 ± 5 mm^3 in both experimentations. The maximum generated current in the rate-limited bio-anode – MEC was 35.5 mA. Scanning Electron Microscope (SEM) images confirmed the formation of rod-shaped along with round-shaped microbial communities on the anode surface and, interestingly, round-shaped bacteria were also grown on the cathode surface.



Keywords: microbial electrolysis cell, biohydrogen, MEC, bioelectrochemical systems, dairy wastewater

Proceedings of the 14th International Green Energy Conference
IGEC2022-036
July 4-8, 2022

IMMOBILIZED FERROCYANIDE COORDINATION ADDITIVES AS ANTIOXIDANT FOR CHEMICAL STABILITY ENHANCEMENT OF PROTON EXCHANGE MEMBRANES

Na Xie, Shuoyao Yin, Haotian Liu, Runfei Yue, Jie Yao, Xin Liu, Junfeng Zhang, Yan Yin*
State Key Laboratory of Engines, School of Mechanical Engineering,
Tianjin University, Tianjin, 300072, People's Republic of China
*e-mail: yanyin@tju.edu.cn (Y. Yin)

ABSTRACT
Proton exchange membranes (PEMs) with excellent chemical stability are highly desired for their practical applications in proton exchange membrane fuel cells (PEMFCs). Recently, we discovered ferrocyanide (Fc (II)) as an effective antioxidant to improve the chemical stability of PEM, but currently can't realize general feasibility and reliable retention because of its water-solubility. Here, an immobilized Fc (II) (IFc) supported by water-insoluble silica (SiO_2) is synthesized as the upgraded antioxidant, which could be widely used via physically incorporation with reliable retention in PEMs. The individual IFc exhibits a superior ability of consuming free radicals during the free radical scavenging test. After incorporated into PEM, its positive efficacy to the chemical stability is confirmed by investigating the degradation time, weight, ion exchange capacity and proton conductivity changes of membranes soaked in Fenton's reagent, where the hybrid membranes show much less performance loss than the pristine membrane. The hybrid membranes also possess appropriate comprehensive performances with the IFc additive.

Keywords: Chemical stability, Proton exchange membrane, Ferrocyanide, Antioxidant, Reliable retention.

Proceedings of the 14th International Green Energy Conference
IGEC2022-037
July 4-8, 2022

AN EXPERIMENTAL AND NUMERICAL STUDY OF TURBULENT HEAT TRANSFER ENHANCEMENT FOR GRAPHENE NANOFLUIDS

Kotaro Fujimoto[a], Aima Shibata[a*], Shuichi Torii[a]
[a]Department of Mechanical System Engineering, Kumamoto University
2-39-1 Kurokami, Kumamoto, 860-8555, Japan

208t2231@st.kumamoto-u.ac.jp, 219d8462@st.kumamoto-u.ac.jp, torii@mech.kumamoto-u.ac.jp

ABSTRACT

The development of more energy-carrying working medium will contribute to the creation of an environmentally friendly society. Therefore, the purpose of this paper is to identify the physical parameters that contribute to the heat transfer enhancement effect of nanofluids to seek the optimal heat transfer mechanism. Within this study, experimental and numerical investigations of the turbulent heat transfer performance of graphene nanofluids in a horizonal circular tube which is subjected to constant heat flux are conducted. The experimental investigation is conducted to evaluate the turbulent heat transfer performance of graphene nanofluids which is made by pulse discharge and to compare them with numerical results. In the numerical investigation, the finite volume method with Realizable k-ε model and Two layer model is employed to solve the continuity, momentum, energy conservation in two dimensional domains. The thermal conductivities of graphene nanofluids used in this study at concentrations of 0.1 vol.% are derived by the Nan's model correlation, and the viscosity coefficient is gained by a rotational viscometer. The reliability of the numerical results is ensured from the close agreement to the wall function and the Dittus-Boelter model. As a result, experimental investigations show a 33% increase in the Nu number of graphene nanofluid compared to water as the flow rate and heat flux increased. Numerical investigations confirm changes in the properties (Turbulent kinetic energy, Velocity distribution, Temperature distribution) of the continuous phase due to physical interactions between the dispersed and continuous phases. It is also shown that these changes contribute to the improved turbulent heat transfer performance of the nanofluid and that the aggregation of particles into the center of the tube is responsible for these changes. Finally, when comparing the experimental and numerical investigation results, the numerical results show 6.8% to 10.4% lower turbulent heat transfer performance. In this numerical investigation, the graphene particles are assumed to be spherical in shape, but they are essentially sheet-like. Therefore, it can be considered that the shape of the particles as well as their aggregation in the center of the tube could be one of the parameters that contribute to the improvement of the turbulent heat transfer performance of nanofluids.

Keywords: Nanofluid, Numerical analysis, Two-phase model, Convective heat transfer, Graphene

Proceedings of the 14th International Green Energy Conference
IGEC2022-038
July 4-8, 2022

Electrodeposition of ZIFs onto carbon nanotube film for high-performance Zn-air battery

Haotian Liu, Weikang Zhu, Runfei Yue, Ran Li, Junfeng Zhang*, Yan Yin*
State Key Laboratory of Engines, School of Mechanical Engineering
Tianjin University, Tianjin, 300072, People's Republic of China
*e-mail: geosign@tju.edu.cn (J. Zhang); yanyin@tju.edu.cn (Y. Yin)

ABSTRACT
Developing a non-precious metal catalyst is a possible way to reduce the cost of air electrodes. Recently, extensive work has been focused on designing non-precious catalyst layers with high density of active sites, durability and good mass transfer properties. In the established method, the powdered catalyst is mixed with an ion-conducting binder in a volatile solvent and transferred to the gas diffusion layer (GDL) to obtain the GDE. The synthetic process is time-consuming and the final porous structure of CL is challenging to control. Here, the Co-ZIF precursor is deposited onto CNT film by the electrodeposition method. After carbonization, a binder-free CNT-based GDE is obtained with high oxygen reduction reaction (ORR) site density and excellent mass transfer properties. When applied in a Zn–air cell, the CNT air–cathode shows excellent performance (249 mW cm^{-2}) with high cycling stability compared to the commercial Pt/C electrode.

Keywords: Zeolitic imidazolate frameworks, Carbon nanotube film, Oxygen reduction reaction, Zn-air batteries.

Proceedings of the 14th International Green Energy Conference
IGEC2022-039
July 4-8, 2022

Influence of mixed solvent on the microstructure of Co/Fe-N-C catalyst layers

Yabiao Pei, Weikang Zhu, Runfei Yue, Haotian Liu, Shuoyao Yin, Junfeng Zhang* and Yan Yin*
State Key Laboratory of Engines, School of Mechanical Engineering,
Tianjin University, Tianjin, 300072, People's Republic of China
geosign@tju.edu.cn; yanyin@tju.edu.cn

ABSTRACT
The microstructure of the catalyst layer (CL) is crucial to the water management and performance of anion exchange membrane fuel cells (AEMFCs), particularly the CL composed of non-precious metals. As sacrifice composition, the dispersion solvent plays an important role in the CL formation process. Herein, the mixture of isopropanol and tetrahydrofuran in different volume ratios (1:1, 1:2 and 2:1) is selected as dispersion solvents to study its influence on the aggregate state of ionomer and catalyst. Although no apparent difference can be observed in the solution state, different morphology is formed in the final CL. Due to fast volatilization and low ink viscosity, the CL prepared by isopropanol: tetrahydrofuran = 1:2 (v/v) shows homogeneous ionomer, catalyst distribution and rational pore size. The power density of 281.3 mW cm^{-2} at 80 ºC is achieved because the CL with high moisture adsorption content and long desorption time. We anticipate our results can guide the design of non-precious metal CLs with improved microstructure to achieve high-performance AEMFC.

Keywords: Non-precious metal catalyst layer; Mixed solvents; Membrane electrode assembly; Anion exchange membrane fuel cell

Proceedings of the 14th International Green Energy Conference
IGEC2022-040
July 4-8, 2022

THE INFLUENCE OF DISPERSION SOLVENT ON ANODE CATALYST LAYER FOR PROTON EXCHANGE MEMBRANE WATER ELECTROLYZER

Shuoyao Yin[1], Shuo Zhao[1], Weikang Zhu[1], Yabiao Pei[1], Junfeng Zhang[1]*, Yingjie Feng[2]*, Yan Yin[1]*
1. State Key Laboratory of Engines, School of Mechanical Engineering,
Tianjin University, Tianjin, 300072, China
2. SINOPEC Beijing Research Institute of Chemical Industry, Beijing 100013, China
*e-mail: geosign@tju.edu.cn (J. Zhang); fengyj.bjhy@sinopec.com; yanyin@tju.edu.cn (Y. Yin)

ABSTRACT
The catalyst layer (CL) is the core component for the proton exchange membrane water electrolyzer (PEMWE), determining the water electrolysis efficiency. In this work, the influence of dispersion solvents and ionomer content on the anode CL was investigated. Different solvents, such as methanol, tetrahydrofuran, acetone and n-propanol are chosen for the ionomer dispersion. The results indicate that the CL prepared with n-propanol dispersion solvent exhibits excellent performance due to uniform morphology and controllable microstructure. To further improve CL performance, a high current density of 2A cm^{-2} at 2.3V was achieved with the ionomer content of 20wt%. Our work may provide some insights into the rational design and optimization strategies of anode CL for PEMWE.
Keywords: Proton exchange membrane water electrolyzer; Dispersion solvent; Catalyst layer

Proceedings of the 14th International Green Energy Conference
IGEC2022-041
July 4-8, 2022

Design of automatic opening and closing devise for energy-saving handrail disinfection

Jing Li, Wenjian Zhang*, Hong Ji*
Tianjin Vocational College of Mechanics and Electricity,
Tianjin, 300350, People's Republic of China
zwj0834@163.com; 13802016083@126.com

ABSTRACT
Escalators and moving walkways are widely used in shopping malls, supermarkets, hospitals, public transportation, etc. The surface of the handrails on which viruses could be attached could possibly provide a way for viruses to spread through physical contact by the passengers' hands, particularly during the Covid-19 pandemic. Herein, we designed a self-generating disinfection device for handrail cleaning. The wiping structure adopts a parallelogram mechanism to control the opening and closing of the mechanism to disinfect the front and side of the handrail regularly. This design could avoid the wiping structure always in contact with the handrail and increase the extra load of the elevator. In terms of energy-saving, the kinetic energy of the handrail was utilized to generate electrical energy, which can meet the energy supply of disinfection work without an external power supply.

Keywords: Handrail disinfection, Automatic opening and closing, Energy-saving, Escalators

Proceedings of the 14th International Green Energy Conference
IGEC2022-042
July 4-8, 2022

FEASIBILITY STUDY ON CONVERTING LOW VALUE MUNICIPAL SOLID WASTE TO HIGH VALUE HYDROGEN PRODUCT IN MALAYSIA

Saiful Anuar B M Mokhtar*, Lee Chin Yee**, Wee Jia Sheng***, W Syamsul Fauzee B W Zin****
Petroliam Nasional Berhad (PETRONAS) PD&T GTS
Level 16, Petronas Tower 3, Kuala Lumpur City Centre, 50088 Kuala Lumpur
saifulmokhtar@petronas.com.my*, ChinYee.Lee@petronas.com**, wee.jiasheng@petronas.com.my***,
fauzee.zin@petronas.com.my****

ABSTRACT

Around 40 - 50 thousand tons of municipal solid waste are generated in Malaysia every day and the quantity is increasing every year. Dumping municipal solid waste to landfill is the easiest and the cheapest way to manage the waste, however, landfill waste poses a lot of threat to the environment by emitting significant amount of greenhouse gases, toxins and leachate. As a result, circular economy which supports sustainability agenda has become prominent in the recent years.

On the other hand, the global hydrogen demand is forecasted to increase tremendously in the future as hydrogen has been identified as the clean energy source that could help bring the world to Net-Zero Emissions in the coming decades.

This paper discusses the feasibility study on converting low value municipal solid waste to high value hydrogen product in Malaysia (Waste to Hydrogen). Waste to Hydrogen addresses the issue of waste pollution in Malaysia, minimizing CO2 emission whilst generating revenue through hydrogen production. Findings from the study include the feasibility of waste to hydrogen in Malaysia, comparison of carbon level & economy of waste-based hydrogen vs steam methane reforming & electrolysis, challenges & success factor of waste to hydrogen. This study provides additional benchmark & reference for low carbon hydrogen production, other than conventional steam methane reforming & electrolyser where natural gas & renewable energy is limited/non-sustainable.

Keywords: hydrogen, waste, carbon level of waste-based hydrogen, challenges & success factor of waste-based hydrogen

Proceedings of the 14th International Green Energy Conference
IGEC2022-043
July 4-8, 2022

NUMERICAL STUDY ON FLOW INSTABILITY OF SUPERCRITICAL CARBON DIOXIDE

Ye Weijie, Chen Yalou, Li Xiaojia, Tan Zhicheng, Yu Guopeng, Ming Pingjian*
Sun Yat-sen University, Sino-French Institute for Nuclear Energy and Technology
Zhuhai, Guangdong, China
mingpj@mail.sysu.edu.cn

ABSTRACT (FONT, ARIAL, SIZE 9.5, BOLD)

The physical properties of carbon dioxide (CO_2) will change dramatically near the critical point, especially the density will decrease sharply and the specific heat capacity changes dramatically. This may lead to instability of flow rate in the natural circulation loop. In order to study flow instability phenomenon, numerical simulations have been carried out with different heating methods, wall roughness, heating power and working pressures. The results show that the mass flow will fluctuate in two directions when using uniform heating, while the frequency of this two-way fluctuation can be reduced by using linear heating and cos distribute heating; Increasing the roughness of the wall will lead to more severe flow instability; Increasing the heating power will lead to more severe flow instability; When the pressure is low, the flow instability will be more intense. This study shows that the flow instability of SCO_2 natural circulation can be effectively reduced by using higher pressure, smaller wall roughness, smaller heating power and non-uniform heating way.

Keywords: Supercritical carbon dioxide, natural circulation, flow instability, non-uniform heating

Proceedings of the 14th International Green Energy Conference
IGEC2022-044
July 4-8, 2022

FACILE SYNTHESIS OF LIGNIN-BASED 3D HIERARCHICAL POROUS CARBON FOR ENERGY STORAGE DEVICES

Muhammad Muddasar[1], Maurice N Collins[2], Mario Culebras [3]
[1,2] Stokes Laboratories, School of Engineering, Bernal Institute, University of Limerick, Limerick, Ireland
[3] Institute of Material Science, University of Valencia, Valencia, Spain
[1] muhammad.muddasar@ul.ie
[2] maurice.collins@ul.ie
[3] mario.culebras@uv.es

ABSTRACT
Lignin, one of the most abundant natural polymers, holds significant potential as a sustainable source of carbon materials. Lignin-based 3D porous carbon material can be used for electrochemical applications as a high-performance, low-cost electrode material. This study employed a unique synthesis route for the preparation of 3D carbon material having a hierarchical porous structure. Organosolv lignin was dissolved in a 3.3 M NaOH solution with the addition of PEGDGE crosslinker a hydrogel forms. Various lignin concentrations (25 wt.% to 45 wt.%), as well as crosslinker ratios (0.2 g/g_{lignin} to 0.8 g/g_{lignin}), were tested to select the most optimum parameters for hydrogel preparation. Subsequently, hydrogels were swollen in deionized water, frozen unidirectionally, and freeze-dried to obtain a three-dimensional hierarchical porous structure. The materials were then stabilized and carbonized to obtain a 3D porous carbon material. Samples with 35 wt. % lignin and 0.6 g/g_{lignin} cross-linker ratio demonstrated the most promising results in terms of structural integrity and uniform porosity (15 to 30 µm). These results indicate that this innovative preparation approach can be used to obtain a high-performance electrode material at low production costs.

Keywords: lignin, energy storage devices, 3D porous carbon, electrode material

Proceedings of the 14th International Green Energy Conference
IGEC2022-045
July 4-8, 2022

PERFORMANCE EVALUATION OF DUAL-PURPOSE IMPROVED COOKSTOVE

Ujjiban Kakati[a], Imlisongla Aier[a], Priyanka Kaushal[a] *
[a]Clean Energy Laboratory, Centre for Rural Development and Technology, Indian Institute of Technology Delhi
Mahatma Gandhi Gramodaya Parisar, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016 (India)
Authors' e-mails: rdz208714@iitd.ac.in, rdz198447@iitd.ac.in, *priyankak@iitd.ac.in

ABSTRACT
The current study was carried out in a prototype pyrolysis cookstove for the production of biochar/bio coal to provide dual benefits of cooking at high efficiency and biochar production for application as cooking fuel. The evaluation of efficiency was conducted by performing water boiling tests using biomass Prosopis Juliflora and biochar/bio coal was produced simultaneously. The analysis of fuel properties for the raw biomass and biochar found that the value of biochar calorific value had increased by 22.6% from raw biomass and the carbon composition increased by 53.07% and nitrogen by twice that of raw biomass. From the water boiling test of the cookstove, the efficiency was 18.7% when biomass was used as cooking fuel and 21% when biochar was used as cooking fuel. The Water Boiling Test (Cold start, Hot start, and simmering phase) was conducted for a duration of 77-82 minutes which resulted in the range of biochar yield of 34.45-37.46%. The maximum temperature attained inside the pyrolysis chamber when the water boiling test (WBT) was conducted was recorded as 472 °C. From the cost economics analysis, the payback period of the pyrolysis reactor was 3 months and the net profit was 87 USD. The study concluded that a pyrolysis reactor is an effective intervention to provide clean cooking fuel and an additional source of income to the users.

Keywords: Improved cookstove, biochar, pyrolysis, water boiling test

Proceedings of the 14th International Green Energy Conference
IGEC2022-046
July 4-8, 2022

HOW NO_X ADSORBS ON BA SITES IN PROXIMITY TO PT OVER Γ-AL_2O_3(100)

Shilong Li, Zhijun Li, Xuebao Wang, Zhiyang Su, Miansun Yang
State Key Laboratory of Engines, Tianjin University
Tianjin, China
lishilong@tju.edu.cn

ABSTRACT

The LNT (Lean NO_x Trap) is one of the most promising technologies for De-NO_x in light-duty vehicles. Inside the LNT, gas-solid heterogeneous catalytic reactions occur, including adsorption, redox and desorption of NOx. The proximity of BaO to Pt sites has a strong influence on the NO_x reaction process. In this paper, a slab model of the proximity of Pt_3 and $(BaO)_2$ clusters supported by γ-Al_2O_3(100) was developed based on the DFT (density functional theory) to investigate how the proximity between Pt and Ba sites affects the adsorption of NO/NO_2 and the potent greenhouse gas N_2O. By analyzing the electronic structures of the different adsorption configurations, the nature of the differences in NO_x adsorption on proximal Pt-Ba is explained in terms of more microscopic bonding and orbitals. This also further explains the nature of phenomena and results such as the changes in NO_x storage capacity caused by the proximity of Pt-Ba in experimental and kinetic studies.

Keywords: LNT, DFT, NO_x adsorption, Pt-Ba proximity

Proceedings of the 14th International Green Energy Conference
IGEC2022-047
July 4-8, 2022

MODELING AND SIMULATION OF VEHICLE INTEGRATED THERMAL MANAGEMENT SYSTEM FOR A FUEL CELL HYBRID VEHICLE

Qiao Yang
School of Automotive Engineering, The State Key Laboratory of Mechanical Transmissions, Chongqing Automotive Collaborative Innovation Centre, Chongqing University
Chongqing, 400044, China
qyang@cqu.edu.cn

ABSTRACT
One of the major challenges for developing fuel cell vehicles is the vehicle thermal management. Temperature of each crucial system within the vehicle should be regulated to ensure continuous operation and high efficiency. The main objective of this study is to propose a comprehensive vehicle integrated thermal management system model and apply cooling strategies under different driving conditions. The proposed model, which is based on a fuel cell SUV powered by a 55kW PEMFC stack and a Li-ion battery with a capacity of 15kWh, considers the cooling of the driving system, fuel cell stack, battery and passenger compartment through pumps, circulation pipes, radiators and air-condition system. Different control strategies were developed to cope with kinds of typical driving conditions. The results showed that the temperature of each component can be controlled to its required range and the system efficiency and response time were affected by the ambient conditions. The proposed model can be used to analyze the basic thermal behavior of major components within a fuel cell vehicle and investigate system coupling at vehicle level from the perspective of both cooling and heating scenarios.

Keywords: Thermal management, Fuel cell vehicle, Cooling, Control strategy.

Conference Website*:* http://www.iage-net.org/igec2022.
IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-048
July 4-8, 2022

MODELING FREIGHT TRAFFIC DEMAND AND HIGHWAY NETWORKS FOR HYDROGEN FUELING STATION PLANNING: A CASE STUDY OF U.S. INTERSTATE 75 CORRIDOR[1]

Majbah Uddin, Yuandong Liu, Fei Xie, Vivek Sujan, Adam Siekmann
National Transportation Research Center, Oak Ridge National Laboratory
2360 Cherahala Blvd, Knoxville, TN 37932, USA
{uddinm, liuy, xief, sujanva, siekmanna}@ornl.gov

ABSTRACT

The use of hydrogen as an alternative transportation fuel has gained much interest in recent years. Hydrogen can be utilized in electric vehicles equipped with hydrogen powertrains (including hydrogen internal combustion engines or fuel cells). Given that most of the freight in the U.S. is transported via diesel trucks, transition to hydrogen fuel would help achieve significant environmental benefits as well as accelerate the decarbonization of the freight transportation sector. This paper presents the methodology and results of a case study on modeling freight traffic demand and highway networks based on publicly available data for the Interstate 75 freight corridor. The purpose of this study is to prepare input traffic and network data that can support the planning of a hydrogen fueling station infrastructure. In particular, the data can be used for siting and characterizing an optimized framework of hydrogen fueling stations from candidate diesel stations along the Interstate 75 corridor. The methodologies developed and presented in this paper may be readily expanded and applied to any transport corridor given the data availability. This paper is the first in a series that will build out a comprehensive model to optimize a consolidated national hydrogen refueling infrastructure eco-system targeted at commercial vehicles.

Keywords: Hydrogen fueling station, freight traffic, highway network, freight corridor, infrastructure planning

Proceedings of the 14th International Green Energy Conference
IGEC2022-049
July 4-8, 2022

THERMAL PERFORMANCE ANALYSIS OF NANOFLUIDS FOR DIRECT SOLAR ABSORPTION

Oguzhan Kazaz[1], Nader Karimi[1, 2], Shanmugam Kumar [1], Gioia Falcone[1], Manosh C. Paul[1*]
[1]Systems, Power & Energy Research Division, James Watt School of Engineering, University of Glasgow, Glasgow, G12 8QQ, UK
[2]School of Engineering and Materials Science, Queen Mary University of London, London, E1 4NS, United Kingdom
Corresponding author: Manosh.Paul@glasgow.ac.uk

ABSTRACT

Most of the energy needed today is provided from hydrocarbon-based natural resources such as coal, natural gas, and oil, called fossil fuels [1]. Although the use of fossil fuels has the highest rate in the energy sector, uncertainties and environmental impacts arising from the use of these fuels are growing. Gases such as CO_x and NO_x, which are harmful to human health, are released into the atmosphere as a result of combustion of hydrocarbons in the structure of fossil fuels [2]. Therefore, these gases, which cause the greenhouse effect, cover the atmosphere, and prevent the sun rays coming to the earth from reflecting and returning to the space [3]. Renewable energy, also called clean energy sources, is expected to overcome these problems as it does not produce an environmentally hazardous by-product. Natural events that have the potential to be converted into useful work such as sun, wind or wave motion are considered as renewable energy sources. Since solar energy is one of the effective solutions to supply energy, solar radiation must be converted into thermal energy. In flat-plate solar collectors, the efficiency of the collector decreases due to heat losses while the heat gained by the absorber is transferred to the heat transfer fluid [4]. In volumetric solar collectors, however, the efficiency of the collector is higher since the fluid acts as both a heat transfer fluid and an absorbing medium [5].

The objective of the present work is to analyse and understand the effect of combined radiation and convective heat transfer on the thermal performance of a volumetric solar collector system. A direct absorption solar collector model is developed by Computational Fluid Dynamics (CFD) to further examine the heat transfer and fluid flow processes occurring the inside the collector with operating conditions to get the best results. Since radiative transport equation includes scattering, emitting and absorbing factors, the Discrete Ordinates (DO) method is used to solve the radiation equation. Since inside of the collector is translucent, there may be a change in the path of the energy from the radiation, as the scattering effect of the nanoparticles causes both a decline and a raise in energy. Nanoparticles have higher optical properties than pure liquids such as water. Therefore, when the nanoparticles are added to pure fluids, the radiation absorption capacity of nanofluids increases, and so fluid's average temperature and the average volumetric heat generation increase. Thus, the performance of the collector is enhanced. Besides, since various types of nanoparticles have different optical properties, the extinction capacities of the nanofluids are different from each other. Thus, they affect the thermal performance of the collector differently. Furthermore, hybrid nanofluids can be taught as new heat transfer fluid. Since the absorption capacity of the hybrid nanofluids is higher than mono nanofluids, there is more improvement in the thermal performance of the collector. Moreover, as the solar energy capture capacity of the system will increase with the increase of the collector efficiency, the amount of sensible heat that the collector can produce will also increase.

Keywords: Solar energy, direct absorption, nanofluids, radiative heat transfer

Acknowledgement
Support for this research provided by the Turkish Ministry of National Education, Republic of Turkey.

References

[1] Nejat, P., Jomehzadeh, F., Taheri, M. M., Gohari, M., & Majid, M. Z. A. (2015). A global review of energy consumption, CO_2 emissions and policy in the residential sector (with an overview of the top ten CO_2 emitting countries). *Renewable and Sustainable Energy Reviews*, 43, 843-862.
[2] Chu, S., Cui, Y., & Liu, N. (2017). The path towards sustainable energy. *Nature Materials*, 16(1), 16-22.
[3] Abdulrahman, F., Aziz, M. M. A., Saidur, R., Bakar, W. A. W. A., Hainin, M. R., Putrajaya, R., & Hassan, N. A. (2017). Pollution to solution: Capture and sequestration of carbon dioxide (CO_2) and its utilization as a renewable energy source for a sustainable future. *Renewable and Sustainable Energy Reviews*, 71, 112-126.
[4] Lenert, A., & Wang, E. N. (2012). Optimization of nanofluid volumetric receivers for solar thermal energy conversion. *Solar Energy*, 86(1), 253-265.
[5] Bertocchi, R., Karni, J., & Kribus, A. (2004). Experimental evaluation of a non-isothermal high temperature solar particle receiver. *Energy*, 29(5-6), 687-700.

Proceedings of the 14th International Green Energy Conference
IGEC2022-050
July 4-8, 2022

MODELLING THE THERMAL PERFORMANCE OF AN INCLINED VOLUMETRIC SOLAR COLLECTOR

Oguzhan Kazaz[1], Nader Karimi[1, 2], Shanmugam Kumar[1], Gioia Falcone[1], Manosh C. Paul[1*]
[1]Systems, Power & Energy Research Division, James Watt School of Engineering, University of Glasgow, Glasgow, G12 8QQ, UK
[2]School of Engineering and Materials Science, Queen Mary University of London, London, E1 4NS, United Kingdom
Corresponding author: Manosh.Paul@glasgow.ac.uk

ABSTRACT
Due to the limited availability of fossil fuels and their harm to the environment, the importance of sustainable energy production has been revealed. In this context, inexhaustible energy can be obtained by using environmentally friendly renewable energy sources. It offers a good solution in energy production due to the lesser effects of solar energy on the environment. Thanks to the improvements and developments in nanotechnology, the thermal performance of solar collectors is improved by adding nanoparticles to the base fluids. In this study, two-dimensional heat transfer and fluid flow are investigated by modelling an inclined volumetric solar collector using different nanoparticles. The Discrete Ordinate Method is chosen as the radiation model to examine the absorption, scattering, and emitting effects of nanofluid. The results show an increase in heat storage by increasing the temperature of the nanofluid, whose radiation absorption capacity increases with the addition of nanoparticles, increasing the heat gain in the collector.

Keywords: solar energy, direct absorption, finite volume method, hybrid nanoparticles, radiative heat transfer

Proceedings of the 14th International Green Energy Conference
IGEC2022-051
July 4-8, 2022

A COMPREHENSIVE STUDY OF THE IRO_2 CATALYST LAYER PREPARED BY CATALYST-COATED MEMBRANE (CCM) METHODS OF PROTON EXCHANGE MEMBRANE-BASED AIR DEHUMIDIFICATION

Lijuan Huang, Ronghui Qi*
Key Laboratory of Enhanced Heat Transfer and Energy Conservation of Education Ministry, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou, China
381 Wushan Road, Tianhe District, Guangzhou City, Guangdong Province
m15901188726@163.com, *qirh@scut.edu.cn

ABSTRACT
For proton exchange membrane-based air dehumidification, it is necessary to find a suitable catalyst coated membrane (CCM) method to improve catalyst utilization and contact between the layers of membrane electrode assembly. In this work, three CCM methods for fabricating dehumidifier assemblies with IrO_2 catalyst layer (CL), including doctor blade method, decal method, and electrostatic spraying method, were applied. Physical and electrochemical properties of as-prepared CLs were characterized and compared. SEM results showed that the catalyst particles agglomerated easily in the doctor blade method, which was not favorable to exposing active sites. The pore size of the anode CL prepared using the decal method was too small (<300 nm), hindering the transfer of reactants and resulting in a low overall mass transfer coefficient of the dehumidifier (2.75×10^{-3} m/s). The dehumidifier with anode CL prepared using the doctor blade method showed higher overall mass transfer coefficient than that using the decal method due to better pore structure. The CL produced by the electrostatic spraying was porous but did not integrate well with PEM, exhibiting the highest overall transfer coefficient (4.19×10^{-3} m/s) and the largest charge-transfer resistance (166.6 $m\Omega/cm^2$). The charge transfer resistance and ohmic resistance of the dehumidifier with anode CL prepared using the doctor blade method is 53.5 $m\Omega/cm^2$ and 42.5 $m\Omega/cm^2$, respectively, which is the lowest one. We draw a conclusion that a loose pore structure and close contact with the PEM and the diffusion layer are two essential elements for a well-performing electrolyte membrane dehumidifier. This study provides guidance for further optimization of CCM suitable for electrolyte membrane dehumidification.

Keywords: catalyst coated membrane, catalyst layer, electrolyte membrane dehumidification, EIS, overall mass transfer coefficient

Proceedings of the 14th International Green Energy Conference
IGEC2022-052
July 4-8, 2022

DESIGN AND ANALYSIS OF A 20 MWP GRID CONNECTED PV SOLAR PLANT AT DIFFERENT GEOGRAPHICAL LOCATIONS IN BANGLADESH

Md. Nazmul Haque
American International University-Bangladesh
Dhaka, Bangladesh
E-mail: haquenazmul112@gmail.com

Md. Maksudur Rahman Numan
American International University-Bangladesh
Dhaka, Bangladesh
E-mail: numan.aiub17@gmail.com

Farjana Akhter Munni
American International University-Bangladesh
Dhaka, Bangladesh
E-mail: farjana.munni428@gmail.com

ABSTRACT
Electricity has become one of the essential needs of our daily life. In Bangladesh, most of the power plants are coal-based or gas-based. Despite pricing, these power plants are considered a threat to the environment. The greenhouse effect is a hot topic nowadays. Generating electricity from a renewable source like photovoltaic cells is considered green energy and a pollution-free method, and that is also very cost-effective compared to other conventional power plants (gas, coal, nuclear, etc.). In this paper, a 20 MW grid-connected solar plant will be designed and analyzed using PVsyst software. In this simulation, three different places Chittagong (Mirsharai), Jamalpur (Sharishabari), and Kurigram (Dhorla) of Bangladesh have been selected for the 20 MW plant. Two renowned solar panel manufacturing brands (LG and Sun power) have also been chosen to analyze the overall performance of those solar PV modules including yearly energy production, specific production, and performance ratio. The primary objective of this paper is to design and analyze a 20 MW solar PV plant in different geographical locations of Bangladesh with two different companies' PV modules to observe how the energy production varies with locations and PV modules. Another objective of this paper is to suggest the most optimum option to help to choose the location and PV module for better energy production.

Keywords: Solar PV, Renewable Energy, PVsyst, Grid-connected solar plant, LG Solar, Sunpower Solar

Proceedings of the 14th International Green Energy Conference
IGEC2022-053
July 4-8, 2022

EXPERIMENTAL INVESTIGATION OF BIOMASS PARTIAL GASIFICATION FOR BIOCHAR AND GAS COGENERATION IN A FLUDIZED BED

Xiaoxu Fan [a, b]*, Liguo Yang [a, b]
[a] Energy Institute, Qilu University of Technology (Shandong Academy of Sciences), Shandong Provincial Key Laboratory of Biomass Gasification Technology,
Jinan, 250014, PR China
[b] School of Energy and Power Engineering, Qilu University of Technology (Shandong Academy of Sciences),
Jinan, 250014, PR China
fanxiaoxu@sderi.cn

ABSTRACT

The abundant biomass have been attracting great interest because of their short CO_2 cycle and conversion to electricity, heat and chemicals etc. Biomass partial gasification cogeneration is a promising technology to produce biochar and fuel gas from biomass-derived fuels . A pilot fludized bed partial gasifer was built. Sawdust was used as feedstock that was converted into biochar and fuel gas through partial gasification. The experiments on partial gasification characteristics were carried out and the effects of temperature and gas recirculation on the characteristics of the biochar and gas compositions were studied. The results show that axial temperature profile and bottom temperature fluctuation of gasifier are obviously different under different working conditions. The temperatures are closely related to changes in ER, feeding rate and recirculation gas flow.Under the condition of no gas recirculation, the minimum operating temperature of the gasifier is 610℃, the yield of biochar decreases with the increase of temperature, the content of fixed carbon in biochar increases first and then decreases, and the gas yield and heat value increase with the increase of temperature. Under the condition of gas recirculation, the lowest temperature at which the gasifier can operate stably is 520 ℃, and yield and fixed carbon content of biochar are improved.The energy balance analysis shows that under the optimal working condition, 88.3% of the energy in biomass enters gas and biochar, and the maximum conversion of biomass fixed carbon to biochar is 89.6%.

Keywords: biomass partial gasification, cogeneration, fludized bed, biochar.

Proceedings of the 14th International Green Energy Conference
IGEC2022-054
July 4-8, 2022

THERMOCHEMICAL CONVERSION OF MUNICIPAL SOLID WASTE BIOMASS (MSWB): PRODUCT CHARACTERISATION AND ENERGY POTENTIAL

Ravi Kumar[1], Abhijeet Anand[1], K K Pant[2], Priyanka Kaushal[1*]

[1]Clean Energy Laboratory, Centre for Rural Development and Technology, Indian Institute of Technology Delhi, Hauz Khas New Delhi- 110016 (India)

[2] Waste to Wealth Technologies Laboratory, Department of Chemical Engineering, Indian Institute of Technology Delhi, Hauz Khas New Delhi- 110016 (India)

[*] Author e-mails: rdz218261@iitd.ac.in; Abhijeet.anand@rdat.iitd.ac.in; kkpant@chemical.iitd.ac.in; priyankak@iitd.ac.in

ABSTRACT

Metropolitan areas have been witnessing ever-growing energy demands and colossal waste generation, posing a significant threat to the sustainable environment. Thermochemical conversion of municipal solid waste biomass (MSWB) is a sustainable approach toward the safe disposal of MSWB and clean energy supply, reducing dependence on fossil fuels which are the primary emitter of greenhouse gases (GHGs). The present study aimed at the thermochemical conversion of MSWB through slow pyrolysis at 300, 400, 500 & 600 ºC, biochar characterization, and its suitability as a clean solid fuel for energy generation. Biochar yield decreased from 60.53 % to 24.73 % on increasing temperature from 300 ºC to 600 ºC, while pyrolysis gas yield increased from 9.13 % to 30.6 %. Bio-oil yield varied between 30 % to 50.27 %. Biochar ultimate analysis showed that C, H, N, & O content varied between 35.8 - 46.1 %, 1.9 - 5.7 %, 1.5 - 2.8 % & 47.8 - 60.7 %, respectively. Biochar proximate analysis showed that volatile content decreased from 53.7 % to 3.6 % on increasing temperature from 300 ºC to 600 ºC, while ash content increased from 33.7 % to 62.2 %.

It was observed that energy consumption increased significantly from 3.14 kWh to 6.5 kWh as the pyrolysis temperature increased from 300 to 600°C for producing biochar from 0.5 kg sample. However, utilizing bio-oil and pyrolysis gas for processes heating could significantly decrease energy load for biochar conversion of MSWB. Also, biochar energy yield decreased from 68.63 to 26.24 % and fuel ratio increased from 0.23 to 9.51 in the same temperature zone. Other fuel characteristics such as calorific value and energy densification ratio of biochar varied between 17.7 % to 22.2 % and 1.06 to 1.33, respectively. It was estimated that biochar produced from MSWB at 500 ºC was most appropriate for the use as clean solid fuel. The results of the present study find its twin significance in MSWB management and simultaneously supplying clean solid fuel to the community.

Keywords: Municipal solid waste biomass, Pyrolysis, Biochar, Energy potential, Waste valorization

Proceedings of the 14th International Green Energy Conference
IGEC2022-055
July 4-8, 2022

Effects of solvent evaporation temperature on the microstructure and electrochemical properties of catalyst inks in proton exchange membrane fuel cell

Enrui Zhang, Yanhong Liu, Yanzhou Qin*, Yan Yin
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT
The fuel cell performance is greatly influenced by the microstructure of the catalyst layer. Industrial camera and optical microscope are used to observe the drying process and deposition of catalyst inks, and electrochemical tests are performed by linear sweep voltammetry. The drying kinetics of catalyst inks and microstructure formation are investigated with fixed isopropanol content in solvent under different temperature conditions. It is found that a coffee ring is formed at the edge of the deposition and the deposition height is slightly different in the diameter direction under different temperatures. The height of the deposition is larger at the edge and the height at the center is more uniform for higher temperature. The deposition diameter of the droplets decreases slightly with temperature, but the deposition patterns are similar at different temperatures, and the microstructure and fuel cell performance of the sprayed catalytic layer are slightly better with increasing temperature.
Keywords: Catalyst ink, Solvent evaporation, Drying kinetics, Catalyst layer, Microstructure, Temperature, Proton exchange membrane fuel cell.

Proceedings of the 14th International Green Energy Conference
IGEC2022-056
July 4-8, 2022

THE CONTRIBUTION OF GREEN BUILDINGS IN REDUCING ASTHMA MORBIDITY AMONG CHILDREN

Auni Nur Sabrina Kamaru Azman, Amal A.M. Elgharbawy*

Institute of Medical Science Technology, Universiti Kuala Lumpur (UniKL), Kajang, 43000, Selangor, Malaysia; email: auninursabrinaa@gmail.com

*Corresponding author: Amal A.M. Elgharbawy, International Institute for Halal Research and Training (INHART), International Islamic University Malaysia (IIUM), Gombak, 53100, Selangor, Malaysia; email: amalgh@iium.edu.my

ABSTRACT

Green buildings are designed to use less energy and resources to increase productivity for their residents and occupants, recycle materials and reduce the disposal of toxic substances. There are a few aspects of green buildings which are energy, water, materials, site, and indoor air quality. It is well-known in environmental health circles that we spend up to 90% of our time indoors. Because this covers the vast majority of our exposure time, and concentrations of numerous indoor pollutants are higher indoors than outdoors, it follows logically that indoor environments influence our health. Indoor environmental stressors that can be found in residential settings include second-hand smoke, gas stove emissions, dust mites and cockroach allergens, and air pollutants such as ozone (O_3), and nitrogen dioxide (NO_2). The potential for adverse health effects from these indoor pollutants' exposures includes asthma. Asthma is the most common chronic disease of childhood worldwide and is responsible for significant morbidity and mortality in children. Asthma results from interactions between genetic and environmental factors. Poorly-controlled asthma is associated with persistent symptoms, accelerated decline in lung function, and a greatly increased risk of future attacks, which may be life-threatening. Hence, this study is being conducted to investigate the relationship between asthma morbidity and the green buildings in terms of indoor air quality, among children. This study is being conducted using the literature review approach. Journal manuscripts that focus on childhood asthma and green building were analyzed, and the papers that are related to this study are being selected. The findings demonstrate that green building design also focuses on improving human health, especially through the implementation of good indoor quality, apart from minimizing environmental impacts largely through energy and water conservation measures, and limiting local impacts to the building site. Moreover, indoor environment quality is a very important parameter to be considered for green buildings as it directly affects the health of residents. Recent studies also stated that in buildings with good environmental quality, the likelihood of respiratory diseases, such as asthma, is less. The lower rates of asthma morbidity have also been proven in several past studies as indoor allergen exposures are important risk factors for asthma development in children. Great indoor air quality in green buildings can be one of the most promising interventions in reducing asthma morbidity among children by producing a long-term benefit from decreasing indoor allergens and triggers. It is expected that this review will give insights into the environment as green buildings assist in the indoor environment in decreasing numerous exposures that have the potential to influence asthma morbidity. Besides, green buildings can result in significant economic savings from the improvement in health as it leads to low health costs and assists in overcoming the challenges in other trials to improve asthma control. Green buildings can also benefit the society through the creation of a healthy indoor environment such as better air quality. This is particularly important for those who have asthma, as it could prevent its symptoms.

Keywords: childhood asthma, green building, indoor air quality, sustainability.

Proceedings of the 14th International Green Energy Conference
IGEC2022-057
July 4-8, 2022

INVESTIGATION OF TILTED ROTOR WAKE STEERING FOR WIND FARMS IN NEUTRAL AND UNSTABLE ATMOSPHERIC BOUNDARY LAYERS USING LARGE EDDY SIMULATION

Jeffrey Johnston*, Juliana Early, Dominic Chandar
School of Mechanical and Aerospace Engineering, Queen's University Belfast
Ashby Building, Stranmillis Road, Belfast, BT9 5AG, United Kingdom
*jjohnston496@qub.ac.uk

ABSTRACT

Turbine wakes in wind farms cause a decrease in the power production of other turbines downstream. A lesser investigated method for mitigating this loss is to tilt the upstream rotor axis at a significantly greater angle to the ground than current horizontal axis turbine designs. Previous research suggests that "down-tilt", where the rotor is tilted forwards is a particularly promising configuration. In this case, the wake is deflected downwards, increasing the vertical entrainment of momentum from the faster moving air above the turbines. While the upstream turbine's power production is reduced, the downstream turbine's is increased, and a net increase in power production can be achieved compared to an un-tilted configuration. Existing experimental and numerical research of tilted rotors is, so far as the author is aware, limited to non-atmospheric or neutrally stratified atmospheric boundary layer (ABL) inflows.

Following the methodology of Fleming et al., 2015 [1], large eddy simulations are performed using the SOWFA-2.4.x extension of OpenFOAM developed by NREL. Precursor simulations are used to generate neutral and unstable (convective) ABL inflows with a controlled wind speed of 8m/s at the turbine hub height (90m). The actuator line method is used to represent an array of two aligned NREL 5MW turbines with a spacing of seven turbine diameters. In the tilted cases, the upstream rotor's axis was inclined at 30° to the ground. The effect of mesh resolution in these simulations is considered for the first time.

Available results indicate that in the neutral ABL, the total power production is increased from 2.8MW to 3.0MW when the upstream turbine is tilted – a 7% gain, which is in general agreement with previous findings. For the unstable ABL, power decreased from 3.3MW to 3.2MW – a loss of 4%. It was expected that due to increased turbulent mixing and faster wake recovery, that the benefit of using tilted rotors in an unstable ABL would be more limited. In fact, these results show it to be detrimental to the performance of the wind farm. This study suggests that the potential for tilted rotor turbines to improve wind farm efficiency, that has been demonstrated on previous occasions may not carry over to more typically encountered convective flows. The presently available results do suggest that the tilt angle used may be too large as the downstream turbine produced more power than the upstream turbine. A smaller angle of tilt may yield better total performance.

Keywords: Wind Energy, HAWT, LES, ABL, SOWFA, OpenFOAM

References:

[1] Paul Fleming, Pieter M.O. Gebraad, Sang Lee, Jan-Willem van Wingerden, Kathryn Johnson, Matt Churchfield, John Michalakes, Philippe Spalart and Patrick Moriarty. *Simulation comparison of wake mitigation control strategies for a two-turbine case*. Wind Energy, (2015), 2135-2143, 18(12)

Proceedings of the 14th International Green Energy Conference
IGEC2022-058
July 4-8, 2022

IMPROVING THE PERFORMANCE OF A CI ENGINE POWERED BY BIOMASS-DERIVED PRODUCER GAS BY ADDING THE OXYHYDROGEN: MODELING-OPTIMIZATION USING BOX-BEHNKEN DESIGN

Prabhakar Sharma[1], Bhaskar J Bora[2]
[1]School of engineering sciences, Delhi Skill and Entrepreneurship University, Delhi-110089, India.
psharmahal@gmail.com
[2]Energy Institute, Bengaluru, Centre of Rajiv Gandhi Institute of Petroleum Technology, Bangalore- 560064, Karnataka, India
bhaskorb3@gmail.com

ABSTRACT
Biomass gasification is one of the primary facilitators of the successful attainment of sustainable development goals. The producer gas generated by the thermochemical processing of waste biomass is an appealing alternative fuel for diesel engines. The current study aims to investigate and optimize the effects of engine load, injection advance, and gaseous fuel flow rate on the combustion characteristics of a diesel engine. In this work, the combustion and exhaust characteristics of a mid-sized diesel engine running in the tri-fuel mode were examined. Diesel was employed as an injected fuel, while Kikar (Vachellia Nilotica) biomass-derived producer gas and a water-derived oxy-hydrogen gas combination were used as inducted fuel. To limit the number of tests, the Box-Behnken design (BBD) was adopted. ANOVA was used to derive new correlations for each parameter. Except for NO_x, the usage of oxyhydrogen improved combustion and lowered engine emissions. Desirability-based optimization resulted in the ideal engine operating parameters of 29° crank angle advance, 4.88 bar BMEP, and 0.825 liters per minute HHO flow rate. At these optimal operating ranges, the engine's performance and combustion output were 21.34% BTE, 3.78 MJ/kWh BSEC, 65.76% diesel savings, 84.37 ppm CO, 101.7 ppm HC, and 303 ppm NO_x emission. The use of oxyhydrogen improved combustion, resulting in lower total engine emissions. The use of response surface methodology helped in the identification of optimum orating parameters, development of correlations, and optimization.

Keywords: Biomass gasification, oxyhydrogen, optimization, emission, green fuel

Proceedings of the 14th International Green Energy Conference
IGEC2022-059
July 4-8, 2022

THE STUDY ON CASCADE HEAT STORAGE FOR SPACE HEATING IN INNER MONGOLIA

Yan Liu [a, b], Li Zhang [b], Jun Zhao [c], Shaopeng Guo [a, b,*]
[a] School of Building Services Science and Engineering, Xi'an University of Architecture and Technology, 710055 Xi'an, China
[b] School of Energy and Environment, Inner Mongolia University of Science and Technology, 014010, Baotou, China
[c] Key Laboratory of Efficient Utilization of Low and Medium Grade Energy, MOE, Tianjin University, 300072 Tianjin, China
Authors' e-mails: guoshaopeng@163.com

ABSTRACT

Inner Mongolia locates in the cold climate zones of China with long heating period, large heating demand, and also high energy consumption and carbon emission. On the other hand, Inner Mongolia is rich in solar energy resources, which is suitable for clean heating usage. However, the solar energy is always intermittent. A heat storage unit is necessary. The traditional heat storage option only sets a single-stage heat accumulator. The solar radiation changes hourly in a day, resulting in the fluctuations in the heat storage performance. Therefore, this paper focuses on the cascade heat storage for space heating in Inner Mongolia. The experimental research on the cascade heat storage is carried out. The characteristics of the cascade heat storage process are analyzed. The results can provide reference for the development of efficient heat storage technology suitable for solar heating in Inner Mongolia.

Keywords: cascade heat storage, phase change, space heating, solar energy.

Proceedings of the 14th International Green Energy Conference
IGEC2022-060
July 4-8, 2022

ENERGY SYSTEM OPTIMIZATION USING ASPEN UTILITY PLANNER

*Shu Qi NYAN[1], Kai Seng KOH[1 *], Lik Yin NG[2], Vui Soon CHOK[3]*

[1] SCHOOL OF ENGINEERING AND PHYSICAL SCIENCES, HERIOT-WATT UNIVERSITY MALAYSIA, 1, JALAN VENNA P5/2, PRECINCT 5, 62200, PUTRAJAYA, WILAYAH PERSEKUTUAN, MALAYSIA
[2] DEPARTMENT OF CHEMICAL & PETROLEUM ENGINEERING, FACULTY OF ENGINEERING, TECHNOLOGY AND BUILT ENVIRONMENT, UCSI UNIVERSITY (KUALA LUMPUR CAMPUS), UCSI HEIGHTS, 1, JALAN PUNCAK MENARA GADING, TAMAN CONNAUGHT, 56000, CHERAS, KUALA LUMPUR, MALAYSIA
[3] KL-Lepong Oloemas Sdn. Bhd, Pulau Indah 42920, Malaysia
Authors' e-mails: sn35@hw.ac.uk ; k.koh@hw.ac.uk ; ngly@ucsiuniversity.edu.my ; vs.chok@klkoleo.com
* AUTHOR TO WHOM CORRESPONDENCE SHOULD BE ADDRESSED.

ABSTRACT

The oleochemical production has been rising rapidly across Malaysia, making Malaysia as the second largest oleochemical producer and exported globally. However, large amount of energy consumption and carbon emission are still one of the major challenges faced by many oleochemical production plant in Malaysia. Therefore, it is crucial to optimize the energy management system within the production plant as it has acquired a significant priority in the steam power plant within the production plant. Previous research has been conducted proposing a framework of optimization of energy management system by considering only a few specific operating conditions which leads most of the simulation-based modelling were constructed selectively without optimizing the entire energy system holistically. To fill in this gap, this research study has proposed new approach to analyze the fuel consumption by developing an efficient energy consumption strategy using ASPEN Utility Planner software. Our results show that using natural gas as fuel feed for boilers operating is able to achieve both carbon emission reduction and cost saving with a total amount of 282 tonne/yr and RM 161,485. Besides, using renewable fuel source such as biomass (wood pellet) is also considered in this study, hoping to provide a general idea on comparison between using non-renewable and renewable fuel source. Biogenic carbon flows and carbon emitted by wood chips is not considered in this study which is expected to be done in the future work.

Keywords: Optimization, Energy Management System, ASPEN Utility Planner, Carbon Dioxide Emission Reduction.

Proceedings of the 14th International Green Energy Conference
IGEC2022-061
July 4-8, 2022

Evaluation of The Effects of Pilot Fuel Injection Ratio on Combustion Products in a Diesel Engine Using Ethanol/Diesel Mixtures

Mustafa Vargün [1,], Ahmet Necati Özsezen [2] and Cenk Sayın [3]*

[1]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: mustafa.vargun@marmara.edu.tr

[2]Department of Automotive Engineering, Technology Faculty, Kocaeli University, 41100, Izmit, Turkey, e-mail: nozsezen@kocaeli.edu.tr

[3]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: csayin@marmara.edu.tr

[*]Corresponding author: e-mail: mustafa.vargun@marmara.edu.tr

ABSTRACT
Aim of this study, investigation of effects of pilot injection strategies with use of ethanol-butan2ol-diesel fuel on combustion and exhaust emission characteristics in a single cylinder diesel engine. In addition, in diesel-ethanol fuel blends, to prevent phase separation butan2ol was added as a solvent. Engine tests were conducted in a single cylinder, common rail diesel engine at constant 50% engine load, 1200 rpm constant engine speed conditions. The tests were completed by changing the injection application and fuel type. It was seen that the maximum cylinder gas pressure increased with 10% pilot injection application for each test fuel. Moreover, it was determined that the maximum pressure rise rate significantly decreased for all fuels as a result of 10% pilot injection application. While, a slight decline was seen in CO_2 emission with use of blends, a significant increase was observed in NO emission with use of FBDF, E10B2 and E15B3 fuel at 10% pilot injection applications. On the other hand, at all injection application, use of FBDF caused more NH_3 emission than blend fuels.

Keywords: Combustion, Diesel Engine, Fuel Blends, Pilot Injection, Exhaust Emissions.

Proceedings of the 14th International Green Energy Conference
IGEC2022-062
July 4-8, 2022

ASSESSMENT OF ENVIRONMENTAL IMPACT OF HYBRID PROCESS OF PRODUCING BIODOESEL AND BIOGAS FROM JATROPHA THROUGH LIFE CYCLE APPROACH

Sanjeev Kumar*, Amit Pal
Department of Mechanical, Production & Industrial and Automobile Engineering,
Delhi Technological University, Delhi-110042 (India)
Ersanjeevkumar124@gmail.com, amitpal@dce.ac.in.

ABSTRACT

Biodiesel is considered as one of the best alternative diesel engine fuel for replacing petroleum-diesel due to its comparable properties with petro diesel. Mostly Biodiesel is produced by the chemical process of transesterification of fatty substances. Biodiesel feedstocks may be a variety of edible and nonedible vegetable oils and/or algae oils etc. Extraction of biodiesel from edible feedstock can lead to scarcity of food for living being including human, hence extraction of biodiesel from nonedible feedstock like Jatropha, Karenja, Thumba, Mahua, Argemony Maxicana and Algae is preferred to counter the environmental pollution, scarcity and skyrocketing price of conventional diesel. From the fruit of these feedstock only 25 to 40% oil is obtained and remaining 60 to 75% biomass is wasted. However, the residue biomass in the form of fruit husk, seed husk, and seed cake has significant energy content, and thus it can be utilized to produce biogas, which can further be used for energy requirements such as IC Engines and other energy requirements.

In present work Jatropha, Karenja and Algae are considered as feedstock for biodiesel production. The energy required for the production of biodiesel and energy output for biodiesel and energy equivalent of the cost of the byproduct i.e. glycerin is considered. Similarly the energy required for the operation of a biogas plant, the energy of the biogas produced and the energy equivalent of the cost of byproduct i.e. manure is also considered. An attributional life cycle analysis (ALCA) approach was applied to indicate on the changes of either using hybrid process of biodiesel production with biogas production in substitution of conventional biodiesel production. This study compares these two processes of biodiesel production from feedstocks. Gabi software is used for assessment of energy and environmental indicators, as well as RP (resource depletion), CCP (climate change potential), AP (acidification potential), EP (Eutrophication potential) and PMP (particulate matter potential), were evaluated. In terms of all indicators, the hybrid process of biodiesel production and biogas production is found more environmentally friendly than conventional biodiesel production.

Keywords: Biodiesel feedstocks, Biogas, ALCA, Energy, Environmental impact.

Proceedings of the 14th International Green Energy Conference
IGEC2022-063
July 4-8, 2022

SIMPLIFIED LEVELIZED COST OF HYDROGEN ANALYSIS FOR THE LOW-GRADE HEAT TO HYDROGEN CONVERSION USING A REVERSE ELECTRODIALYSIS – AIR-GAP DIFFUSION DISTILLATION SYSTEM

Youwen Zhang, Xi Wu*, Shiming Xu**
Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, School of Energy and Power Engineering, Dalian University of Technology
No.2 Linggong Road, Dalian City 116024, China
*: xiwu@dlut.edu.cn; **: xsming@dlut.edu.cn

ABSTRACT
Low-grade heat is converted to hydrogen energy by the integrating reverse electrodialysis (RED) and heat engine of air-gap diffusion distillation (AGDD). Economic viability is among the main criteria for deciding whether to launch a project, thus, a levelized cost of hydrogen (LCOH) model of a RED-AGDD system for hydrogen production is proposed in this work. The capital costs include the RED stacks capital cost, AGDD capital cost, the construction and land capital cost and other capital costs required to operate the system. The IEMs replacement cost is one of the vital operational maintenance costs. The influence of relevant parameters including ion exchange membranes (IEMs) cost, IEMs lifetime and the number of the RED stacks (n) in a serial system on the LCOH are studied. The results show that LCOH is a linear function of IEMs cost. The use of a RED-AGDD system for hydrogen production is uneconomical at present due to the high IEMs cost. With increasing of IEMs lifetime, the LCOH decrease significantly at high IEMs cost and decreases slightly at low IEMs cost. Compared with the single-stage RED stack system, the muti-stage RED system has a lower LCOH at below 10 \$ m^{-2} IEMs cost for 3 stages.

Keywords: reverse electrodialysis, distillation, hydrogen production, levelized cost.

Proceedings of the 14th International Green Energy Conference I
GEC2022-064
July 4-8, 2022

NUMERICAL ANALYSIS OF THE EFFECT OF CHAMBER HEIGHT AND WALL TEMPERATURE ON THE SPRAY WALL INTERACTION FOR THE GDI SYSTEM

Santu Dolui
DESE, IIT Delhi
New Delhi, India
esz208173@ces.iitd.ac.in

Akhil Ailaboina
DESE, IIT Delhi
New Delhi, India
esz188513@iitd.ac.in

Kaushik Saha*
DESE, IIT Delhi
New Delhi, India
kaushiksaha@dese.iitd.ac.in

ABSTRACT
Gasoline direct injection (GDI) engines provide better fuel economy and performance compared to port fuel injection (PFI) engine. Downsizing an engine with a turbocharger or supercharger boost helps achieve equivalent power outputs as larger engines. A downsized GDI engine with high injection pressure increases the possibility of spray impingement on the wall. A wall film forms on the top of the piston wall due to spray wall interaction (SWI). The generated wall film will burn inefficiently, which led to more pollution and less power from the engine.The present work aims to numerically study the effect of wall temperature on the spray wall interaction. The impact of wall temperature on the fuel adhesion characteristics such as wall film width and wall film thickness has been discussed. The computational fluid dynamics (CFD) simulation results were validated by experimental data from the literature. After the validation, the number of rebounded parcels and splashed parcels were compared with different operating conditions. Additionally, the effect of chamber height on the film thickness, rebounded parcels, and splashed parcels was studied in this work. In this work the commercial CONVERGE CFD code was used. The Lagrangian-Eulerian spray model was adopted in the current study. The turbulence effect was captured using the unsteady Reynolds-Average Navier-Stokes (URANS) turbulence model. The Kuhnke wall film model has been used to study the effect of wall temperature on the fuel adhesion characteristics.The O'Rourke model was used to figure out how the height of the chamber affects the spray wall interaction.

Keywords: Gasoline direction injection, Spray-wall interaction, Film thickness, Film width, Kuhnke model

Proceedings of the 14th International Green Energy Conference
IGEC2022-065
July 4-8, 2022

Reduced and exfoliated graphene oxide supported Ni for Electro-Oxidation of Ethylene Glycol

Saptarshi Gupta[1], Mahuya De[12]
[1]School of Energy Science and Engineering, [2]Department of Chemical Engineering
IIT Guwahati, Assam, India
g.saptarshi@iitg.ac.in, mahuya@iitg.ac.in

ABSTRACT

Alcohol fuel cell is one of the promising options for generation of green energy due to zero emission of carbon dioxide and other toxic products. The use non-noble metals as electro-catalysts give an opportunity to lower the cost of catalysts. Nickel is one of the promising component and has been used for oxidation of methanol and ethanol [1-2]. Reduced graphene oxide (RGO) has been reported to be good support material due to its high surface area and high conductivity [3]. The ethylene glycol is favored as fuel due to its high energy density, availability, economic viability, abundance and low toxicity [4]. This study investigated the performance of reduced and exfoliated graphene oxide supported Ni for electro-oxidation of ethylene glycol. The Ni was impregnated on GO and treated in H_2 (Ni/EGO-H_2) and Ar (Ni/EGO-Ar) environments, while Ni impregnated RGO was treated in H_2 environment (Ni/RGO-H_2). All gaseous treatment was done at 350°C. The final Ni loading in the catalysts varied in the range 20.4 to 22.8 wt% as obtained from EDX analysis. The surface area followed the trend as Ni/EGO-H_2 (185 m^2/g) < Ni/RGO-H_2 (200 m^2/g) < Ni/EGO-Ar (227 m^2/g). A wider range (3.7-15 nm) of pores were observed in both Ni/EGO samples compared to that of Ni/RGO-H_2 (1 to 4.4 nm). Ni/EGO-Ar had higher pore volume compared to Ni/EGO-H_2. Number of graphene layers for Ni/RGO-H_2 (8 layers) was more than that of Ni/EGO (4 and 5 layers). Ni/EGO (Ar and H_2) formed uniform stacked porous structure, while Ni/RGO showed more agglomerated porous structure The average metal particle size was lowest for Ni/EGO-Ar (4.7 nm) followed by Ni/EGO-H_2 (7.5 nm) and Ni/RGO-H_2 (10.1 nm). The cyclic voltammetry of different catalysts is shown in Fig 1. The onset potential of different catalysts was between 0.47 to 0.67 V in 0.1M KOH medium. The Ni/RGO-H_2 showed an oxidation peak at 0.6 V with a current density of 140 mA/cm^2mg_m. In presence of EG, the same catalyst showed an enhanced current density of 157 mA/cm^2mg_m at 0.6V. At the same potential, Ni/EGO-Ar generated a current density of 218 mA/cm^2mg_m in presence of EG. The chronoamperometry analysis for 30 min at 0.6V in presence of 0.5M EG and 0.1M KOH showed better stability for Ni/RGO-H_2. From the study it may be concluded that the Ni/EGO-Ar has better potential as electro-oxidation catalyst of EG in direct alcohol fuel cell.

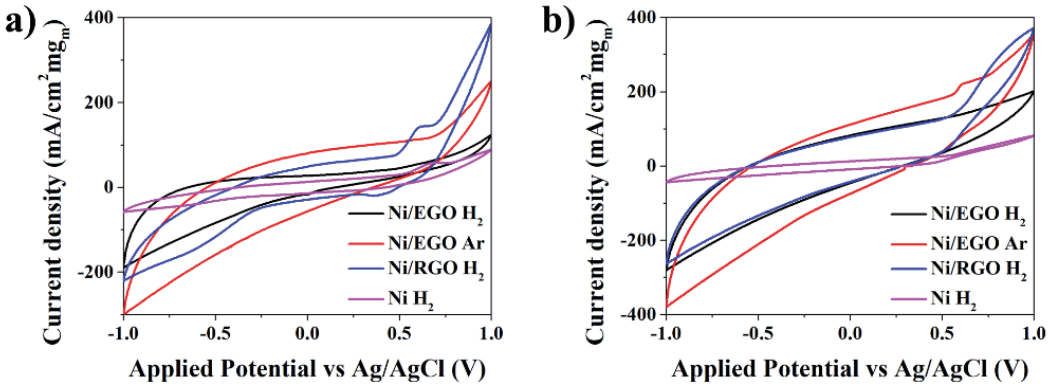


Fig 1 Cyclic Voltammetry of different catalysts in a) 0.1M KOH and b) 0.5M EG 0.1M KOH

Keywords: Nickel, reduced graphene oxide, exfoliated graphene oxide, electro-oxidation, ethylene glycol, alcohol fuel cell.

References
[1] X. Cui, W. Guo, M. Zhou, Y. Yang, Y. Li, P. Xiao, Y. Zhang, X. Zhang, *ACS Appl. Mater. Interfaces* **2015**, *7*, 493-503
[2] A. N. Vyas, G. D. Saratale, S. D. Sartale, *Int. J. Hydrog. Energy* **2020**, *45*, 5928-5947.
[3] C.H.A. Tsang, D. Leung, *Solid State Sci.* **2018**, *75*, 21-26.
[4] J. Qi, N. Benipal, C. Liang, W. Li, *Appl. Catal. B* **2016**, *199*, 494-503.

Proceedings of the 14th International Green Energy Conference
IGEC2022-066
July 4-8, 2022

Study on the trans-critical CO_2 refrigeration cycle integrated medium-high temperature geothermal ORC system with pressure drop

Na Zhang[1,*], Siqi Tan[1], Qinggang Wang[1]

1. School of Civil Engineering and Architecture, East China Jiaotong University, Nanchang, China

*Corresponding author: zhangna881127@163.com. Tel: 0791-87046053

Abstract: For typical medium (GR-I) and high (GR-II) temperature type geothermal, this paper integrates the trans-critical ORC power cycle (TORC) with the trans-critical CO_2 (TCO_2) refrigeration cycle, selects six organic work substances, and constructs a three-level fuzzy decision model based on system safety and environmental protection, thermodynamics, and techno-economic performance with consideration of pr. According to the evaluation results, R1270+CO_2 performs best in the medium temperature (GR-I) geothermal system, with a maximum net output power of 1205.077kW, a maximum cooling coefficient of 4.71, a predicted payback period of 2.074 years, and a return-on-investment ratio of 5.668. With a maximum net output of 1874.43kW, a maximum cooling factor of 4.52, a projected payback period of 1.18 years, and a benefit-to-investment ratio of 9.599 in the high-temperature (GR-II) geothermal system, R290+CO_2 performs best.

Keywords: Geothermal energy; Trans-critical ORC; Trans-critical CO_2; Fuzzy decision method;

Proceedings of the 14th International Green Energy Conference
IGEC2022-067
July 4-8, 2022

POSSIBLE INFLUENCE OF THERMOPHYSICAL PROPERTIES OF SUPERCRITICAL CO2 NEAR CRITICAL AND PSEUDOCRITICAL POINT ON HEAT TRANSFER

Sambhaji T Kadam, Ebraheem Alanazy, Zahra Hajabdollahi Ouderji, Zhibin Yu
James Watt School of Engineering, University of Glasgow, University Avenue, G12 8QQ.United Kingdom
sambhaji.kadam@glasgow.ac.uk

ABSTRACT
Growing concern about environment degradation have posed unique opportunity to re-think over the use of chronic but faithful natural refrigerants; a natural refrigerant carbon dioxide (CO2) founds its suitability in HVAC-R sector. Because of low critical temperature (close to atmospheric temperature) and relatively high vapor pressure the process of heat rejection or heat absorption in refrigeration or heat pump cycle is more likely to be in supercritical region. In this context, the behavior of thermophysical properties of supercritical CO2 near critical temperature and pseudocritical temperatures corresponding to different pressures have been discussed. Moreover, the possible influence of these properties in the vicinity on heat transfer process has been address. It is observed that, for given flow velocity of supercritical CO2 and diameter, the Reynolds number for different pressures is almost constant at pseudocritical temperature, contrary, Prandtl number at pseudocritical temperatures degreases with increase in pressure. From the discussion, it can be concluded that interesting behavior of thermophysical properties near pseudocritical temperatures may affect the design of the components used in system; either power generating system (Brayton cycle) or power consuming system (refrigerator and heat pump).

Keywords: Supercritical, pseudocritical, CO2, Heat transfer.

Proceedings of the 14th International Green Energy Conference
IGEC2022-068
July 4-8, 2022

PROVIDING LEVELIZED COST AND WAITING TIME INPUTS FOR HDV HYDROGEN REFUELING STATION PLANNING: A CASE STUDY OF U.S. I-75 CORRIDOR[1]

Yuandong Liu, Adam Siekmann, Vivek Sujan, Majbah Uddin, Fei Xie, Shiqi Ou
National Transportation Research Center, Oak Ridge National Laboratory
2360 Cherahala Blvd, Knoxville, TN 37932, USA
{liuy, siekmanna, sujanva, uddinm, xief, ous1}@ornl.gov

ABSTRACT

Widespread use of diesel fuels in freight transportation leads to greenhouse gas (GHG) emissions that play an important role in air pollution. The air pollution, as well as the energy crisis, drives the transition from diesel fuel to cleaner and more energy-efficient fuels such as hydrogen fuels. With such a transition, the strategic planning and optimization of supporting refueling infrastructure along the national highway for heavy-duty vehicles (HDVs) become a necessity. Cost and service level are two essential factors to be considered in hydrogen refueling station location and capacity optimization. The service level in this study is assessed by the delay (waiting time) at fueling stations as well as the fueling demand fulfilled. To this end, this study presents a methodology to provide waiting time (delay) and levelized hydrogen fuel cost inputs under different station configurations (number of dispensers and fill rates) for hydrogen refueling station planning. Determining the station configurations based on the trade-off between the two inputs is further discussed. Particularly, this study points out that the levelized cost and waiting time are affected by hourly demand patterns and estimates the two inputs under different peak hour fueling demand scenarios. The results suggest that, with the same daily demand, the cost, as well as the waiting time, increases obviously with the peak hour demand. In the case study, the cost grows at least 30% when the peak hour visit frequency of the daily total visits increases from 5% (evenly distributed pattern) to 10% (the most common pattern for existing diesel fueling stations along I-75). Accounting for this peak hour effect in hydrogen refueling station planning is recommended. Overall, the waiting time model and cost analysis provide key inputs for optimizing hydrogen refueling station location and configurations based on anticipated refueling demand patterns. The paper is the second in a series that aims to build a comprehensive modeling plan and optimize hydrogen refueling infrastructure along the Interstate 75 (I-75) corridor for HDVs.

Keywords: Hydrogen refueling station, heavy-duty vehicle, waiting time modeling, levelized hydrogen fuel cost, hourly demand fluctuations

Proceedings of the 14th International Green Energy Conference
IGEC2022-069
July 4-8, 2022

THERMO-ECONOMIC ASSESSMENT OF A TRANS-CRITICAL CO_2 HEAT PUMP

Zahra Hajabdollahi[1], Sambhaji Kadam[1], Narges Hassani Mokarram[1], Zhibin Yu[1]

[1]James Watt School of Engineering, University of Glasgow, University Avenue, G12 8QQ.United Kingdom

Zahra.HajabdollahiOuderji@glasgow.ac.uk

ABSTRACT

To protect the environment, it makes sense to use compatible technologies. Challenges such as ozone depletion and the phenomenon of global warming by typical refrigerants have revived the interest in using natural refrigerants. In recent years, carbon dioxide as a natural refrigerant with unique environmental properties against the adverse effects of industrial refrigerants on the ozone layer and climatic conditions has been considered by researchers.

In this research, a trans-critical CO_2 heat pump has been simulated and the thermodynamic and economic models of the system are presented. The economic model is based on the investment and operation cost method. A thermodynamic objective function of the coefficient of performance (COP), an economic objective function of the total annual cost of the system, four decision variables and related constraints are selected for the optimization purpose. Decision variables are included of gas cooler pressure, gas cooler outlet temperature, evaporator outlet temperature and the compressor efficiency. The bound of variations for the gas cooler temperature is between 32 and 45 °C with the pressure of 7.5 to 14 MPa. The evaporator temperature and compressor efficiency are selected to be between 5 °C and -5 °C and 70% and 100%, respectively.

A total of three optimal designs are presented, which include a single-objective optimized design with thermodynamic objective function, an optimized single-objective design with economic objective function, and a multi-objective optimized design with thermodynamic and economic objective functions. In the case of multi-objective optimization, a decision-making process will be required to select the optimal point from among Pareto's optimal front points. It was concluded that thermo-economic assessment is a general form of single-objective optimization that considers both economic and thermodynamic criteria equally, and the final solution of multi-objective optimization depends on the decision-making process. However, the results will be between the results of single-objective economic and thermodynamic optimizations. Finally, for a better understanding a final optimum point is defined using the LINMAP method.

Keywords: Heat pump, CO_2, trans-critical, thermo-economic optimization, final optimum point.

Proceedings of the 14th International Green Energy Conference
IGEC2022-070
July 4-8, 2022

HYBRID BATTERY AND HYDROGEN ENERGY STORAGE FOR A 100% WIND POWER MICROGRID

Michael Giovanniello, XiaoYu Wu
Department of Mechanical and Mechatronics Engineering, University of Waterloo
200 University Avenue West, Waterloo, ON, Canada N2L 3G1
magio1@mit.edu, xiaoyu.wu@uwaterloo.ca

ABSTRACT
Microgrids enable the deployment of distributed renewable energy resources with low requirements for transmission and distribution infrastructure. In a microgrid supplied entirely by variable renewable energy resources, such as wind or solar, the intermittent and variable nature of electricity generation results in mismatches between supply and demand. Energy storage technologies can bridge these mismatches, and different technologies are better suited for storing energy in various quantities and over different timescales. Lithium-ion batteries and hydrogen are promising technologies for short- (hourly) and long-duration (weekly, monthly, and seasonal) energy storage, respectively. An optimized combination of battery and hydrogen energy storage systems could thus offer a more cost effective and reliable solution to renewable intermittence. Existing literature has modeled these hybrid storage systems; however, it remains unknown how cost reductions and performance improvements for both technologies will impact overall system cost and composition in the long term. Here we developed a two-step mixed integer linear programming (MILP) model for sizing the components (wind turbine, electrolyser, fuel cell, hydrogen storage, and lithium-ion battery, etc.) of a 100% wind-power microgrid in Canada. We conducted sensitivity analysis to determine how cost reductions and technological improvements will impact overall system cost and composition. Results show that the costs of wind turbines and lithium-ion batteries has the highest impact on system cost. Turbines and the hydrogen system (electrolyser, fuel cell, and hydrogen storage) account for the greatest share of overall system cost. Furthermore, in all cases, a combination of hydrogen and battery technologies is the most cost effective, with fuel cell capacity remaining largely constant and electrolyser and battery capacity being inversely related. These results illustrate that when it comes to storage for 100% renewable microgrids, neither lithium-ion battery nor hydrogen alone can achieve the minimum system cost. Instead, a hybrid energy storage system will remain the most cost-effective solution even in the cases where the development of either hydrogen or lithium storage outpaces the other.

Keywords: Hydrogen, electrolyzer, fuel cell, microgrid, wind energy, lithium batteries, energy storage.

Conference Website*:* http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-071
July 4-8, 2022

A NEW CONTROL DRIVER APPROACH BASED ON ENERGY EFFICIENCY MANAGEMENT FOR HEATING DEMAND OF INDUSTRIAL PROCESSES

M.Ziya Sogut[1], Hamit Mutlu[2]

[1]Maritime Faculty, Piri Reis University, Tuzla, Istanbul, Turkey, mzsogut@gmail.com
2 Director of Mechanical Project Company, Bursa, Istanbul hamit@mekanikproje.com.tr

ABSTRACT

Today, energy poverty gains value for sectoral structures, and one of the most effective tools for the development of economic and environmental sustainability for businesses will be energy efficiency and managerial approaches to be developed accordingly. The sectoral needs for enterprises to develop control strategies and to define control tools related to these are a necessity, especially for operational processes. This study is primarily based on the development of a new control driver for an enterprise with an average of 300 TOE/month heat energy consumption potential. In this study, the climatic temperature driver was developed as a new approach for operational heat demand management and was found to be used as an effective and dynamic tool in a real field application. In this context, a comparative analysis was conducted between the two cases using the thermo-economic analysis method. In the study, it has been determined that the approach developed using the annual consumption potential of the enterprise provides a savings of 48%. At the end of the study, energy management opportunities were evaluated by developing management procedures related to the driver approach.

Keywords: Heat demand, Climatic temperature, Energy, Efficiency, Sustainability

Proceedings of the 14th International Green Energy Conference
IGEC2022-072
July 4-8, 2022

DEMAND MANAGEMENT STRATEGY BASED ON ENERGY EFFICIENCY FOR COGENERATION SYSTEM OF GAS ENGINE DRIVE

M.Ziya Sogut[1], T.Hikmet Karakoç[2]
[1]Maritime Faculty, Piri Reis University, Tuzla, Istanbul, Turkey, mzsogut@gmail.com
2 Eskisehir Technical University, Faculty of Aero. and Astronautics, Eskisehir, Turkey,
hikmetkarakoc@gmail.com; Information Technology Research and Application Center, Istanbul Ticaret University,
Istanbul, Turkiye, thkarakoc@ticaret.edu.tr

ABSTRACT

The processes brought about by global effects, the management of energy cost effects by energy management for businesses define direct resource management as one of the important issues. Resource management, especially in industrial enterprises, makes a great contribution to increasing energy efficiency in institutional structures. In recent years, with the widespread use of natural gas for the manageability of institutional demands, interest in the use of power technologies that allow electricity and heat energy production in industrial establishments has increased. However, energy production costs are increasing day by day under crisis conditions. In this context, the economic impact of natural gas-based energy management should be constantly monitored. A thermo-economic analysis of the gas engine driven cogeneration system in an industrial establishment has been made, based on real consumption data. As a result of the analysis, the total irreversibility consumption of the system is 37%, while the system evaluation for economic predictions is discussed. In this study, it has been determined that the performance of the cogeneration system is low from the perspective of demand management. In this study, the action plan developed in the context of energy management and the related implementation results are presented.

Keywords: Industrial Processes, Cogeneration, Energy Management, Efficiency, Thermo-Economic Analysis.

Proceedings of the 14th International Green Energy Conference
IGEC2022-073
July 4-8, 2022

ENTROPY MANAGEMENT STRATEGY FOR HEAT DEMAND OF SMART BUILDINGS

M.Ziya Sogut[1],
[1]Maritime Faculty, Piri Reis University, Tuzla, Istanbul, Turkey, mzsogut@gmail.com

ABSTRACT

Energy efficiency and energy management have become an important criterion of sustainability in terms of environmental impacts as well as energy costs of enterprises or institutions. Especially in corporate structures, the management of heating demand, which reaches about 65%, is important in terms of the effective and efficient use of energy. In recent years, although smart building applications are based on energy efficiency, it is seen that they create problems in practice and trigger the production of entropy, which is the main cause of environmental pollution. In this study, first of all, the energy performance analysis of a building complex managed with a smart building structure is discussed. In the study, based on the heat demand approach, the entropy generation of the campus was examined over the exergetic performance. In the study, the loss potential due to irreversibility obtained from two separate boiler lines was found to be 31.53% and 46.85%, respectively. Emission potentials caused by entropy production were also evaluated in the study. At the end of the study, suggestions for entropy management for corporate strategies have been developed.

KeyWords: Smart buildings, energy management, efficiency, sustainability, environment

Proceedings of the 14th International Green Energy Conference
IGEC2022-074
July 4-8, 2022

ALCOHOL-ENHANCING STRATEGY TOWARD NEUTRAL ELECTROLYTE: IMPROVING EFFICIENCY AND CAPACITY FOR REDOX FLOW BATTERIES

Chao He[1], Rui Wang[2] Yinshi Li[1,3]*
[1]School of Future Technology, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[2]School of Chemical Engineering and Technology, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[3]Key Laboratory of Thermo-Fluid Science and Engineering of MOE, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[1]Authors' e-mails: chao.he@stu.xjtu.edu.cn
*Corresponding author: ysli@mail.xjtu.edu.cn
*This work was supported by the National Natural Science Foundation of China (52176204)

ABSTRACT
Redox flow battery (RFB) is emerging rapidly due to its suitability for renewable energy storage system. Particularly, aqueous rechargeable zinc-iodine redox flow battery (ZIRFB) is of interest because of the safe and environmentally friendly with great theoretical capacity, high energy and power density. Nevertheless, the ZIRFB system encounters with slow kinetics of I_3^-/I^- redox couple due to high positive electrode polarization and a relatively low electrolyte utilization (I^- to I_3^-) because of the insoluble nature of I_2, resulting in the low efficiency and limited energy density. Here we reported alcohol (ethanol) as an additive solvent to reduce the electrode polarization for I_3^-/I^- redox couple and improve the solubility of iodine which releases iodide ions and increases the battery capacity. With this strategy, the ZIRFB demonstrated a high CE, VE, and EE of 98%, 85% and 84% at 20 mA cm^{-2}, even at 40 mA cm^{-2}, EE could reach 77%. Additionally, the ZIRFB yielded a high capacity of 107.2 Ah/L (2M $ZnCl_2$ + 4M KI), higher than the vanadium redox flow battery's capacity (25 Ah/L). Besides, alcohol (ethanol) induces ligand formation between oxygen on the hydroxyl group and the zinc ions, which extended battery's cycle life over 200h. This facile, yet effective strategy, alcohol added ZIRFB with high efficiency and capacity, provides a new research idea for improving the performance of RFB as a very promising candidate for large scale energy storage.

Keywords: energy storage, zinc-iodine redox flow battery, electrolyte, alcohol, efficiency and capacity.

Proceedings of the 14th International Green Energy Conference
IGEC2022-075
July 4-8, 2022

POROUS ELECTRODE ALLOWING ENHANCED REDOX REACTION AND MASS TRANSPORT PROCESSES FOR FLOW BATTERIES

Rui Wang[1]*, Chao He[2], Fazheng Chong[3], Zhengjun Tu[3], Yinshi Li[2,3]
[1] School of Chemical Engineering and Technology, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[2] School of Future Technology, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[3] Key Laboratory of Thermo-Fluid Science and Engineering of Ministry of Education, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
* Authors' e-mails: ruiwang@xjtu.edu.cn

ABSTRACT
In recent years, rechargeable grid-scale energy storage systems (ESS) have been regarded as the key to solve the intermittency and uncertainty of renewable energy conversion and output. The all-vanadium redox flow battery (VRFB), due to its rapid response for the energy conversion, long life in the actual operation and design flexibility for various energy systems, is considered as one of the promising large-scale energy storage technologies. In the charge-discharge processes of VRFB, the electrolytes consisted of vanadium ions flow onto the surface of carbon-base electrodes and occur redox reactions to realize the transformations of chemical energy and electric energy. To develop high-performance flow batteries, it is critical to design reasonable electrode structure to synergistically enhance the mass transformation and redox reaction. In this work, a multiscale-pore-structured graphite felt electrode was proposed and developed via a facile thermally treating method. This facile method allows the mesoscale and nanoscale pores formed on the surface of graphite felt electrode. Thanks to the reasonable pore structure of electrodes, in the mass transport process, the electrolyte flow onto the surface of electrodes through the pristine microscale pores of graphite felt and then diffusion to the nanoscale pores through the mesoscale pores. In the vanadium redox reacting process, the enlarged surface offer much more active sites for the vanadium ions redox reactions. Hence, the multiscale-pore-structured graphite felt electrode exhibits promoted electrochemical activity of the towards both V^{2+}/V^{3+} and VO^{2+}/VO_2^{+} redox reactions in the cyclic voltammetry tests, and thus shows advantageous energy efficiency at the current density as high as 500 mA cm^{-2} in the charge-discharge test. Moreover, the multiscale-pore-structured graphite felt electrode was observed superior stability in a long-time cycling test. This work opens a new approach to develop multiscale-pore-structured graphite felt electrode for the cost-effective all-vanadium redox flow battery.

Keywords: energy storage, flow batteries, porous electrode, redox reaction, mass transport.

Proceedings of the 14th International Green Energy Conference
IGEC2022-076
July 4-8, 2022

A CELLULAR-MATERIAL-BASED FLOW FIELD FOR ENHANCING UNDER-RIB MASS TRANSFER IN PROTON EXCHANGE MEMBRANE FUEL CELLS

Shipei Deng[1], Mingsheng Hao[1], Yinshi Li[1,*]
[1]Key Laboratory of Thermo-Fluid Science and Engineering of Ministry of Education, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[*]Corresponding author's e-mail: ysli@mail.xjtu.edu.cn
[*]This work was supported by the National Natural Science Foundation of China (52176204)

ABSTRACT
Proton exchange membrane fuel cells (PEMFCs) that directly convert chemical energy of reactants into electricity with high efficiency meet the demand of the green and sustainable energy supply. Currently, the large-scale commercialization of PEMFCs is still up against the challenges of the high cell performance. The oxygen starvation and water flooding are two key issues that cause the serious concentration loss, resulting in decreasing the cell performance at high current density. Flow field can effectively transport and distribute oxygen and remove water, which significantly affects the cell performance. However, limited by the base material, typically the metals and graphite, the relative worse mass transfer under solid ribs in conventional solid-material-based flow fields (sm-FFs) is responsible for the primary concentration loss. Herein, a cellular-material-based flow field (cm-FF) that grooves the flow channel in metal foam is proposed for the PEMFCs to improve the gas transport and water removal under the ribs, thereby boosting the cell performance. Concerns on the adverse impact of the cm-FF on electron and heat conduction could be relieved owing to the favorable electric and thermal conductivity in the chosen cellular metal material. The multi-physical processes and cell performance are investigated via a three-dimensional multi-phase non-isothermal PEMFC model along with a micro-scale catalyst layer model. Numerical results show that the limiting current density and peak power density for the cm-FF-based PEMFC are increased by 15% and 9% respectively in comparison with the sm-FF-based PEMFC. Moreover, a higher oxygen concentration and a lower liquid saturation under the cellular ribs are obtained in the cm-FF-based PEMFC, in addition to the improved uniformities of both oxygen concentration and current density. The proposed cm-FF is promising to improve the cell performance via enhancing mass transfer.

Keywords: PEMFC, flow field, cellular-material, mass transfer.

Proceedings of the 14th International Green Energy Conference
IGEC2022-077
July 4-8, 2022

EXERGY ECONOMIC ANALYSIS OF ENVIRONMENT-FRIENDLY THERMOACOUSTIC ENGINE

Qing E[1,2,*], Ting Lei[1]
1. School of Optical Information and Energy Engineering, Wuhan Institute of Technology, Wuhan 430205, China;
2. Institute of Thermal Science and Power Engineering, Wuhan Institute of Technology, Wuhan 430205, China;
*Corresponding author' e-mails: eqinghust@163.com

ABSTRACT
Thermoacoustic technology can provide new refrigerators, heat engines and heat pumps which have the advantages of low loss, no pollution, long service life, simple structure and reliable working conditions. Compared with traditional machines, it is more friendly to the environment. In this paper, the exergy economic performance analysis (EEPA) method in finite time thermodynamics is used to analyze the relationship between various parameters in thermoacoustic microcirculation. The influences of irreversible factors and heat leakage are also considered through the simultaneous solution of working medium wave equation, internal energy variation equation, ideal gas state equation and energy conservation equation. The results show that there must be a critical point where the heat absorption rate of gas working medium is zero to make the thermoacoustic engine vibrate. And in order to optimize the efficiency and profit rate of thermoacoustic engine, the pressure drive ratio needs to be controlled. When the optimal profit rate exists, there is an exact linear relationship between the optimal profit rate and the price ratio. At the same time, the range of pressure drive ratio that makes both the profit rate and efficiency optimal is also given.

Keywords: exergy economic performance analysis, thermoacoustic engine, optimal

ACKNOWLEDGEMENT
The research work of this paper is supported by the China Scholarship Council (202008420030) and the Scientific Research Foundation of Wuhan Institute of Technology (K201919).

Proceedings of the 14th International Green Energy Conference
IGEC2022-078
July 4-8, 2022

EFFECTS OF PT ELECTRODE CHARGE ON THE STRUCTURES OF IONOMER FILMS IN PROTON EXCHANGE MEMBRANE FUEL CELLS

Yuewen Zhang, Linhao Fan*, Kui Jiao
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin, China, 300350
*Corresponding author: lhfan@tju.edu.cn; tel: +86-22-27404460; fax: +86-22-27383362:

ABSTRACT
The effects of Pt electrode charge on the interfacial structures of ionomer films on Pt electrode of proton exchange membrane fuel cell (PEMFC) have been studied by molecular dynamics simulations. It can be found that the distributions of water molecules and fluorosulfonic acid (PFSA) molecules change under the electric field. And water molecules rotate their dipoles under the electric field. The rearrangement of charged atoms results in a change in the charge distribution and thus a change in the potential distribution of ionomer films. And the effects on the molecule density, charge density and potential distributions of ionomer films on the Pt electrode become more pronounced under the larger applied electric field. The changed structures may help to enhance reactant transport through ionomer films due to the suppression of dense structures. These findings inspire to design novel electrodes by strengthening the local electric field.

Keywords: PEMFC, Electric field, Structure, Molecular dynamics simulations.

Proceedings of the 14th International Green Energy Conference
IGEC2022-079
July 4-8, 2022

MELTING PERFORMANCE ENHANCEMENT OF PHASE CHANGE MATERIALS FOR LATENT HEAT THERMAL ENERGY STORAGE USING NOVEL FIN CONFIGURATIONS

Peiliang Yan[a], Weijun Fan[a], Chuang Wen[b,*]
[a] School of Energy and Power Engineering, Beihang University, Beijing, PRC
[b] College of Engineering, Mathematics and Physical Sciences, University of Exeter, Exeter, UK
*Corresponding author: c.wen@exeter.ac.uk

ABSTRACT
Phase change material (PCM) has promising applications as an energy storage material in thermal energy storage (TES) systems. However, the low thermal conductivity of PCM limits its application possibilities. To reduce the response time of TES systems, the present study proposes a novel fin configuration to improve the heat transfer performance of PCM. Y-structured fins, a common structure in nature, are investigated to evaluate the structural parameters and the effect of HTF on melting time. A numerical research method based on the enthalpy method is used for the study. The numerical model of the study is validated using experimental data in the literature. Simulation results including solid-liquid interface contours, isotherm contours and evolution of the PCM liquid fraction have been obtained. The results of the study show that the melting process is divided into three main stages, In the first stage the main mode of heat transfer is heat conduction, in the second stage the solid-liquid interface starts to deform and thermal convection comes into effect, fluid impact on the solid leads to solid deformation, in the third stage, the solid sinks and the liquid rises and the melting rate decreases. By calculating the melting time, the improvement in melting performance of different structural parameters is quantified. The splitting of the PCM solid by the novel fins effectively reduces the melting time. For a fixed total fin area, reducing the fin thickness increases the contact area between the fins and the PCM. Increasing the angle of the fins allows for a more even division of the PCM by the fins. An increase in HTF temperature can increase the temperature gradient between the wall or fin and PCM. All of the above contribute to a reduction in PCM melting time. As the fins restrict the movement of the PCM solids, the buoyancy effect causes the heated fluid to flow in the upper portion of the model, and the lower half of the solid PCM melts at a slower rate, making solid depositions happens, which could be avoided when installing the fins by changing the installation angle. The heat exchange enhancements investigated in this paper all have a diminishing returns effect, which makes it necessary to evaluate the choice of parameters for the new fin structure and the heat transfer effect it can achieve. This study provides potential structural options for new industrial products in the future.
Keywords: Energy storage; Phase change material; PCM; Latent heat thermal energy storage; Novel fins, Heat transfer enhancement

Website: http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-080
July 4-8, 2022

A SUPERHYDROPHOBIC SOLAR ABSORBER SPONGE FEATURING DIRECTIONAL THERMAL TRANSFER FOR DESALINATION

Kun Liu[1], Yinshi Li[1]*
[1]Key Laboratory of Thermo-Fluid Science and Engineering of MOE, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[1]Authors' e-mails: kun-liu@stu.xjtu.edu.cn
*Corresponding author: ysli@mail.xjtu.edu.cn
*This work was supported by the National Natural Science Foundation of China (52176204)

ABSTRACT
Emerging desalination by solar steam generation holds great potential in response to global water scarcity. Many new materials have been developed for photothermal desalination, but the development of cost-effective and easy-to-manufacture materials that can convert solar irradiation into exploitable thermal energy and ensure excellent flexibility is still a significant challenge. Here, one-step approach is developed to construct a melamine sponge evaporator (MSE) with superhydrophobic, self-floating and directional thermal transfer, which designed for effective water treatment. The superhydrophobic interface hindered the interfacial wettability at a gas-liquid boundary between MSE and water, and allows the rapid delivery steam to escape while maintaining the water supply. The self-floating effect is attributed to superhydrophobic to ensure structural integrity and prevent channel blockage. The MSE floating on the water surface could maintain a stable temperature gradient and directional thermal transfer via parallel nanoscale channels and the preferred thermal transport direction is decoupled to reduce the heat loss. Additionally, the MSE demonstrated high efficiency and continuous operation, and a high evaporation rate of 1.12L m^{-2} h^{-1} were achieve under one sun, which meets one person drinking. This study offers a low-cost and promising strategy for seawater desalination.

Keywords: solar steam generation, desalination, superhydrophobic, directional thermal transfer.

Website: http://www.iage-net.org/igec2022.
IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-081
July 4-8, 2022

INNOVATING RECHARGEABLE ZINC-AIR BATTERIES FOR LOW CHARGING VOLTAGE AND HIGH ENERGY EFFICIENCY

Siyuan Zhao[a#], Yang Wang[a,b#], Zengjia Guo[a], Meng Ni[a*]
a Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China
b State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin, China
Authors' e-mails: siyuan.zhao@connect.polyu.hk, 3012201316@tju.edu.cn, guozengjia.guo@connect.polyu.hk, meng.ni@polyu.edu.hk
*Corresponding author, #Equal contribution

ABSTRACT (FONT, ARIAL, SIZE 9.5, BOLD)
The commercialization of rechargeable zinc-air batteries (ZABs) is significantly impeded by their high charging voltage and low energy efficiency. In this work, soluble KI is applied to ZABs to change the oxidation pathway from oxygen evolution reaction (OER) to I^- oxidation reaction (IOR) with faster kinetics and lower oxidation potential. Besides, we surprisingly find commercial cost-effective carbon black delivers satisfactory bifunctional oxygen reduction reaction (ORR) and IOR activity. Density functional theory (DFT) calculation is provided to reveal the reaction mechanism of I^- oxidation by carbon black. Finally, the KI modified coin-type ZABs with carbon black exhibit a low charging voltage of 1.79 V (2.0 V for conventional ZABs), improved energy efficiency of 65.3% (60% for conventional ZABs), and long cycle life of over 120 hours at 5 mA cm^{-2}. Further characterizations have also illuminated the reason behind the extended battery cycle life. This work can significantly facilitate the future commercialization of rechargeable ZABs.
Keywords: carbon black, charging voltage, energy efficiency, zinc-air battery

Proceedings of the 14th International Green Energy Conference
IGEC2022-082
July 4-8, 2022

SENTIMENT ANALYSIS OF ONLINE COMMENTS ON SOCIAL MEDIA FOR HUALONG NO. 1 NUCLEAR POWER PLANT

Hong Xu
Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University
Sun Yat-sen University Zhuhai Campus, Guangdong Zhuhai, 519082, China
E-mails: xuhong7@mail.sysu.edu.cn

Guopeng Yu
Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University
Sun Yat-sen University Zhuhai Campus, Guangdong Zhuhai, 519082, China
E-mails: yugp3@mail.sysu.edu.cn

ABSTRACT
Hualong No. 1 technology is developed by China through its own independent research and innovation. The first Hualong No. 1 NPP in the world started commercial operation on January 30, 2021. Simultaneously, the technology has been exported to several countries and is under evaluation by the UK for import. Under this situation, the sentiment of the public in the world regarding this technology is a meaningful topic both for the Chinese government to develop its export policy/strategy and for the countries, interested in the import of this technology, to consider the corresponding energy policy. This work focuses on the sentiment analysis of Hualong No. 1 technology based on the online comments on social media. The results showed that the majority of the comments were in positive sentiment. The most concerning issue of the public is “waste” in negative sentiment and secondly “innovative” in positive sentiment. This work introduced three methods to classify the sentiment of comments automatically and found that CNN got the highest accuracy 88.9%. The proposed method in this work may be a reference for the governments, enterprises, or other agencies to make related energy (not only for nuclear energy but also for other types of green energy) policy decisions and act based on the public tones of social media.

Keywords: Energy policy, Nuclear Power Plant, Sentiment analysis, Convolutional neural network (CNN), Support vector machine (SVM), Social media.

Proceedings of the 14th International Green Energy Conference
IGEC2022-083
July 4-8, 2022

PLATINUM-BASED ALLOY NANOPARTICLES EMBEDDED N-P CO-DOPED CARBON NANOFIBERS AS EFFICIENT OXYGEN REDUCTION ELECTROCATALYST

Na Zhou[1], Yinshi Li[1]*
[1]Key Laboratory of Thermo-Fluid Science and Engineering of MOE, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China
[1]Authors' e-mails: zhouna3116195001@stu.xjtu.edu.cn
*Corresponding author: ysli@mail.xjtu.edu.cn
*This work was supported by the National Natural Science Foundation of China (52176204)

ABSTRACT
Tuning the surface structure of catalysts at the atomic level is essential for the development of efficient and stable oxygen reduction reaction electrocatalysts used in renewable energy storage systems. In this study, a system containing supramolecular coordination polymers polyacrylonitrile (PAN) and polyphosphonitrile (HCCP) was synthesized by simple and scalable electrostatic spinning and carbonized to obtain nitrogen-phosphorus doped metal-carbon nanofibers were used to encapsulate low-platinum (Pt) alloy nanoparticles. The unique multi-channel carbon nanofiber morphology facilitates faster electron transfer while the layered porous structure enriches the active sites of the catalyst. This low-Pt alloy carbon nanofiber (PtNi-PCNFs) has high ORR catalytic performance due to the synergistic electronic effect of Pt, Ni and P atoms, and its mass activity (0.88 A mg_{Pt}^{-1}) and specific activity (1.89 mA cm^{-2}) were 4.8 and 6.3 times higher than those of commercial Pt/C, respectively. The catalyst exhibited excellent stability after 10,000 accelerated durability cycles. Physical and electrochemical characterization revealed that electron transfer from the metal nitrogen-phosphorus doped carbon nanofibers (Ni-PCNFs) to their supported Pt nanoparticles would weaken the adsorption of O_2 on the Pt surface, thus improving the ORR catalytic activity in acidic media. The strong interaction between the carbon matrix and the PtNi alloy contributes to the formation of excellent stability of the catalyst. This investigation could provide a novel strategy to prepare ORR electrocatalysts.

Keywords: Oxygen reduction reaction, Surface-modulated Pt, PtNi alloy nanoparticles, N-P co-doped carbon nanofibers.

Website: http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-084
July 4-8, 2022

Novel mini-channel cold plate with different shapes of pin fins for effective battery thermal management

Zengjia Guo[1], Yang Wang[1], Siyuan Zhao[1], Meng Ni[1,*]

[1] Department of Building and Real Estate, Research Institute for Sustainable Urban Development (RISUD) and Research Institute for Smart Energy (RISE), The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China

First author: guozengjia.guo@connect.polyu.hk (Z.GUO)

Co-first author: 3012201316@tju.edu.cn (Y. Wang)

Corresponding author: meng.ni@polyu.edu.hk (M. Ni)

ABSTRACT

Battery thermal management systems (BTMS) with high cooling performance are essential for safe and efficient operation of lithium-ion battery for electrical vehicles. In this study, a novel BTMS is proposed by introducing vertically and horizontally arranged square pin fins (SPFs), circular pin fins (CPFs) and ellipse pin fins (EPFs) into the cold plate. All these three pin fins have the same hydraulic diameters (2.62mm). The overall cooling performance (efficiency index: EI) of the proposed BTMS is evaluated numerically, considering both heat transfer and pressure loss. It is found that BTMS with SPFs always achieve the best heat transfer performance but is also penalized with the highest pressure loss, and EPFs arranged BTMS can achieve the lowest pressure loss due to the excellent streamlined structure of EPFs but its heat transfer performance is also the lowest among the 3 different pin fin shapes. For the vertical arrangement, the maximum temperature of SPFs arranged BTMS was 2.01K, 1.83K, 1.67K, 1.48K and 1.32K lower than that of EPFs arranged BTMS, 1.16K, 1.08K, 1.01K, 0.91K and 0.84K lower than that of CPFs arranged BTMS. However, the SPFs caused the highest normalized friction factor, which was higher than that of CPFs by 0.9, 1.02, 1.05, 1.07 and 1.07, than that of EPFs by 1.01, 1.12, 1.15, 1.15 and 1.15. As for BTMS with horizontally arranged SPFs, the maximum temperature was lowered by 5.77K, 3.27K, 2.48K, 2.08K and 1.91K as compared to the BTMS with EPFs, 3.54K, 1.85K, 1.25K, 0.96K and 0.82K as compared to the BTMS with CPFs. SPFs still caused the highest normalized friction factor, which was higher than that of CPFs by 1.94, 1.87, 1.29, 0.96 and 0.91, than that of EPFs by 2.42, 2.79, 2.65, 2.52 and 2.59. Considering both heat transfer and pressure loss, CPFs can be the best choice for BTMS when pin fins are vertically arranged, due to the highest EI which was higher than that of SPFs by 0.012, 0.014, 0.022, 0.029 and 0.034, higher than that of EPFs by 0.069, 0.095, 0.112, 0.114 and 0.119. However, the pressure loss is larger for all horizontally arranged pin fins. Considering both heat transfer and friction factor, SPFs are recommended for BTMS because of the best performance in EI, which was higher than that of CPFs by 0.143, 0.146, 0.142, 0.141 and 0.141, higher than that of EPFs by 0.199, 0.202, 0.201, 0.206 and 0.211.

Keywords: Battery; Thermal management system; Pin fins; Modeling; Cooling; Pressure loss.

Proceedings of the 14th International Green Energy Conference
IGEC2022-085
July 4-8, 2022

SILICON-SUBSTITUTED AMORPHOUS/CRYSTALLINE SEMICONDUCTOR NANOWIRES FOR ENERGY CONVERSION AND STORAGE

Ting He[a,], Xiao Yan[a], Jingkun Bi[a], Ya Tang[a], Hongbin Zhao[a], Jinhu Yang[b]*

[a]Department of Chemistry, Institute for Sustainable Energy, Department of Physics College of Sciences, Shanghai University, Shanghai, 200444, PR China
[b]School of Chemical Science and Engineering, Tongji University, Shanghai 200092, P. R. China
*Corresponding author e-mail: heting@shu.edu.cn

ABSTRACT
Elemental manipulation at the atomic level can directly change the intrinsic bonding environment of atoms in a material, thus imparting novel physical and chemical properties for specific applications. Herein, we propose a novel site-specific heteroatom substitution strategy, through a solution-phase ions-alternative-deposition route, to prepare silicon-substituted amorphous/crystalline nanowires with tunable band structures. The amorphous nanowires with a narrowed bandgap exhibit significantly enhanced performance in photoelectrochemical water splitting, such as higher and more stable photocurrent, and faster photoresponse and recovery, while the crystalline nanowires exhibit significantly enhanced lithium storage performance, such as high specific capacity, excellent rate capability, and superlong cycling stability. This work provides a novel strategy for phase engineering and band structure tailoring over semiconductor materials toward high-efficiency energy generation, conversion and storage.

Keywords: substitution, amorphous, crystalline, phase engineering, energy

Proceedings of the 14th International Green Energy Conference
IGEC2022-086
July 4-8, 2022

MODELLING OF PROTONIC CERAMIC FUEL CELLS FOR POWER-ETHYLENE COGENERATION

Zheng Li, Qijiao He, Meng Ni*
Department of Building and Real Estate, Research Institute for Sustainable Urban Development (RISUD) & Research Institute for Smart Energy (RISE), The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China
The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China
ZLDreamania1996@outlook.com; meng.ni@polyu.edu.hk

ABSTRACT

Achieving power-chemicals cogeneration in protonic ceramic fuel cells (PCFCs) possesses tremendous environmental and economic attractiveness. Power-ethylene cogeneration via C_2H_6-PCFCs is receiving growing attention due to ethylene's pivotal role in the chemical industries [1]. However, the lack of relevant numerical studies results in an insufficient understanding of C_2H_6-PCFC operation. To this end, a 2D model is developed to provide a comprehensive description of the thermo-electrochemical behavior of C_2H_6-PCFC. The model solved by the finite element method simulates the detailed chemical/electrochemical reactions and mass/charge/heat transfer in the PCFC. A series of quantitative evaluations of the effects of working potential, anodic inlet flow rate as well as temperature on the power-ethylene cogeneration performance is conducted. Modelling results indicate that electrochemical reaction in the PCFC can markedly affect the ethylene generation from two aspects: 1) H_2 consumption favors ethane dehydrogenation; 2) electrochemical/Ohmic heat favors endothermic ethane dehydrogenation. The ethane conversion in PCFC increases with the decreasing operating potential, reaching 33% at 0.4 V, with a maximum power density of 146 mW cm^{-2}. The inlet temperature is found to be an important factor in promoting electrochemical and chemical reactions. As shown in Figure 1 (a), when the temperature increases from 923 K to 973 K, the maximum power output is enhanced by approximately 96.0% while ethane conversion at 0.4 V is doubled. Additionally, H2 depletion in the anode can substantially impair the local electrochemical performance of the C_2H_6-PCFC. In Figure 1 (b), as temperature increases, although the highest H_2 molar fraction in the cell increases by 41.7%, the H_2 molar fraction (< 1%) drops dramatically in the vicinity of the outlet.

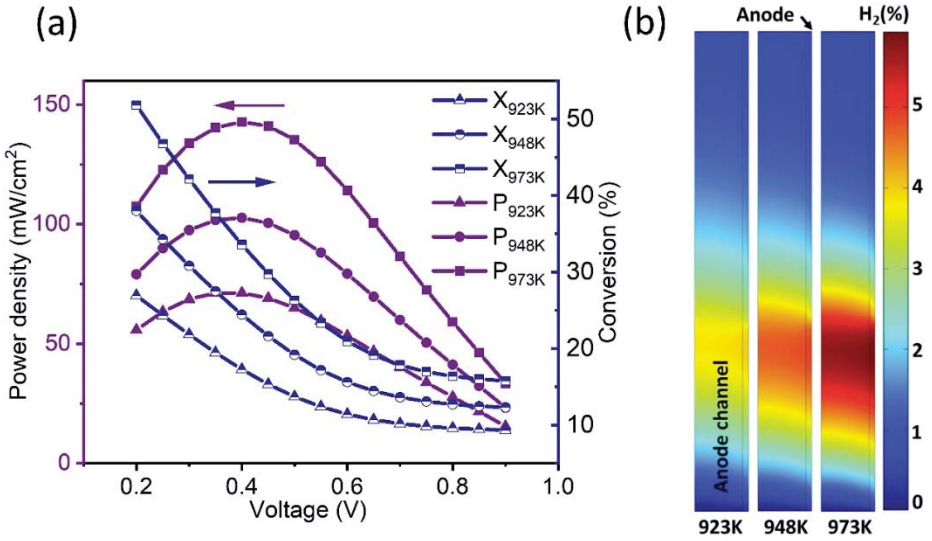


Fig. 1 (a) Effects of working potential on the power density and ethane conversion; (b) H_2 mole fraction distribution in the anode.

Keywords: protonic ceramic fuel cells, power-ethylene cogeneration, numerical model.

References:

[1] Y. Gao *et al.*, "Recent advances in intensified ethylene production—a review," *ACS Catalysis*, vol. 9, no. 9, pp. 8592–8621, 2019, doi: doi.org/10.1021/acscatal.9b02922.

Proceedings of the 14th International Green Energy Conference
IGEC2022-087
July 4-8, 2022

EXPERIMENTAL INVESTIGATION ON EFFECT OF DRYING FOR A PROTON EXCHANGE MEMBRANE FUEL CELL AT HIGH CURRENT DENSITY

Zi Rui GUO, Hang GUO*, Hao CHEN, Fang YE
(MOE Key Laboratory of Enhanced Heat Transfer and Energy Conservation, and Beijing Key Laboratory of Heat Transfer and Energy Conversion, College of Energy and Power Engineering, Beijing University of Technology, Beijing 100124)
* Corresponding author, E-mail: hangguo@sohu.com, Tel.: +86-10-67391612 ext. 8311

ABSTRACT
To enhance water management capacity of proton exchange membrane fuel cells, the influence of fuel cell flooding and membrane drying on the performance in different voltage ranges is investigated by experiment. The current density decreases with the decrease in voltage at the concentration polarization range is observed. By analyzing performance profiles of different temperature, humidity, and flow rate, the results demonstrate that the reason why the current density decreases with the decrease of voltage in the concentration polarization range is not the flooding but the drying of the anode membrane. Although the current density in the concentration polarization region is high, the water generation is large, and the cathode is more easily flooded. But the more protons and water are transferred from anode toward cathode, causing the membrane to dry up, which has a greater impact on the current density. Meanwhile, the increase of the internal temperature in the proton exchange membrane fuel cell further decreases the current density at high overpotential and decreases the membrane water content. It indicates that not only in the activation polarization region and ohm polarization region but also in the concentration polarization region, performance of the proton exchange membrane fuel cell will be limited by the membrane water content.

Keywords: Proton exchange membrane fuel cells, water management, membrane drying, high current density, concentration polarization.

Proceedings of the 14th International Green Energy Conference
IGEC2022-088
July 4-8, 2022

GREEN TRANSITION STRATEGY WITH FUEL PREFERENCE AND THERMO-ECONOMIC EVALUATIONS OF LNG USED FOR BULK CARRIER

M.Ziya Sogut[1]
[1]Maritime Faculty, Piri Reis University, Tuzla, Istanbul, Turkey, mzsogut@gmail.com

ABSTRACT

The maritime sector is a sector whose sectoral responsibilities are increasing rapidly with the effect of increasing competition. In particular, the targets for reducing emissions due to fossil fuel-based energy have highlighted alternatives based on the change of existing ship technologies in sectoral use. It is seen that the choice of KNG on ships can be an effective alternative for short-term forecasts. The aim of this study is to compare the performance of HFO and LNG fuels based on consumption data of a dry cargo ship. In this context, thermo-economic analyses were conducted and evaluations based on needs analyses were made. According to the analysis made, it is seen that the LNG conversion has a 20% improvement potential for the fuel performance for the reference ship, and significant savings can be achieved in the emission load. At the end of the study, the framework structure of this change in ships was examined and sectoral projections were created.

Keywords: Ships, Bulk Carrier, LNG, Thermo-Economic Analysis, Efficiency

Proceedings of the 14th International Green Energy Conference
IGEC2022-089
July 4-8, 2022

EXPERIMENTAL INVESTIGATION ON IN-PLANE NONUNIFORM CATALYST LOADING OF CATALYST LAYERS IN PROTON EXCHANGE MEMBRANE FUEL CELLS

Mengyao Li, Chasen Tongsh, Linhao Fan*, Fuqiang Bai*, Kui Jiao
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin, China, 300350
*Corresponding author: lhfan@tju.edu.cn (L. Fan); bbfq@163.com (F. Bai)

ABSTRACT

Catalyst layers provide the sites for electrochemical reactions in proton exchange membrane fuel cell (PEMFC). In this study, a new catalyst distribution pattern was developed in cathode catalyst layers. Different platinum loading was distributed under the channel and land, thereby improving the utilization rate of catalyst. The performance of different catalyst distributions were tested by assembling a fuel cell of 25 cm^2, and the performance optimization was analyzed via the electrochemical impedance spectroscopy (EIS). Furthermore, the performance of different platinum loading under different operating conditions (cathode inlet air flow rate and backpressure) was studied. By testing the membrane electrode assembly(MEA) with an average platinum loading of 0.15 mg cm^{-2} and different channel-land platinum distributions, under the same platinum loading gradient, more platinum under land will get better performance. The optimal distribution is that the platinum loading under land is 0.2 mg cm^{-2} and 0.1 mg cm^{-2} under channel, the highest power density is 18% higher than the uniform distribution.

Keywords: proton exchange membrane fuel cell, catalyst layer, catalyst distribution, performance

Proceedings of the 14th International Green Energy Conference
IGEC2022-090
July 4-8, 2022

ELECTROLYTE USING PROPYLENE CARBONATE FOR SODIUM-ION BATTERIES WITH IMPROVED LOW-TEMPERATURE PERFORMANCE

Caixia Li[1] , Yufeng Zhao [1,*]
[1] Department of Chemistry, College of Sciences, Shanghai University
199 Shangda Road, Shanghai 200444, PR China
21720251@shu.edu.cn; yufengzhao@shu.edu.cn

ABSTRACT
With the limited resources and ever-increasing prices for lithium, great attention had been paid to rechargeable sodium-ion batteries (SIBs) as an alternative to lithium-ion batteries (LIBs). The electrolyte plays the pivotal role in transferring and balancing charges between electrodes and its composition determines the low temperature performance by forming favorable solid-electrolyte interphase (SEI) film and controlling operational kinetics of charge transference. However, low-temperature operation is a great challenge facing rechargeable batteries. Therefore, design and research of the electrolytes occupy the key position for low temperature SIBs. Previous study shows that low temperature performance of SIBs can be improved by the addition of PC which owns low freezing point and low viscosity at low temperature to suppress EC crystallization. Furthermore, PC is conductive to the formation of porous and elastic SEI film with less charge transfer resistance. Herein, we proposed an multi-component carbonate-based electrolyte formulation of 1 M NaPF6 in ethylene carbonate (EC) : propylene carbonate (PC) : ethylmethyl carbonate (EMC) =1:1:1,vol%.

Keywords: Sodium-ion batteries, carbonate-based electrolyte, low temperature performance, solid-electrolyte interface, propylene carbonate.

Proceedings of the 14th International Green Energy Conference
IGEC2022-091
July 4-8, 2022

NANOSTRUCTURED TiB_2 NANO SHEET / CARBON QUANTUM DOT COMPOSITES FOR ENHANCED PERFORMANCE IN LITHIUM-SULFUR BATTERIES

Jingkun Bi[1], Hongbin Zhao[1], Ting He[1, *]

[1]Department of Chemistry, College of sciences, Shanghai University,
[1]No.99 Shangda Road, Shanghai 200444, PR China
bjk@shu.edu.cn; heting@shu.edu.cn

ABSTRACT

Due to the problems of volume expansion and "shuttle effect", the performance of lithium sulfur battery in terms of energy density, power density and cycle life is still far from the expectation. Herein, metallic and polar TiB_2 nanosheets combined with carbon quantum dots are applied as sulfur hosts for lithium sulfur batteries. The TiB_2 nanosheets with both high conductivity and catalytic nature could effectively suppress the shuttle effect and accelerate the transformation of polysulfides. While the carbon quantum dots containing oxygen functional groups on the surface of TiB_2 could also adsorb polysulfides dissolved in the electrolyte. As a consequence, the developed TiB_2/C based sulfur cathode exhibit appealing electrochemical performance with an impressive specific capacity of 709 mAh g^{-1} at 0.5 C (more than twice than that of the commercial TiB_2 electrode), excellent rate capability and superior cycling stability up to 900 cycles at the current density of 2 C with a low fading rate of 0.048% per cycle.

Keywords: Lithium sulfur battery, Titanium Boride, Shuttle effect, Polysulfides transformation

Proceedings of the 14th International Green Energy Conference
IGEC2022-092
July 4-8, 2022

THE TITLE: ECO-FRIENDLY NANOFLUIDS AND ITS RECENT ADVANCES IN THERMAL SYSTEMS: UPTAKE IN ENVIRONMENTAL IMPLICATIONS

L.Harish Kumar[a] , S.N.Kazi[b], H.H.Masjuki[c,d], M. N. M. Zubir[e]

[a,b,d,e] Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia
[c] Department of Mechanical Engineering, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
Authors' e-mails:

Author Name	**L. Harish Kumar**	**S.N. Kazi**	**H.H. Masjuki**	**M.N.M. Zubir**
Email-id	harishsanjeetha@gmail.com	salimnewaz@um.edu.my	masjuki@iium.edu.my	nashrul@um.edu.my

ABSTRACT

Highly efficient, ever-lasting thermal systems are always crucial to tackle the augmented energy demand. Moreover, efficient systems help to overcome the severe climatic conditions caused due to continuous rise in global temperature. In the past two decades, colloidal suspensions of nanoparticles termed nanofluids with enhanced thermal and optical properties have been studied for augmenting the thermal performance of such systems. Studies show that the incorporation of nanofluids results in corrosion of equipment in addition to safety and health concerns as they are more reactive in solvents and due to the presence of strong chemicals. Therefore, developing facile methods for the synthesis of cost-effective, less toxic, and environmentally friendly nanofluids has garnered greater interest amongst researchers. Eco-friendly nanofluids in thermal applications are very constrained and have larger scope in future research and developments toward promising safer practical applications. The morphology of green nanoparticles is greatly affected by the factors that influence the synthesis and characterization methods. The natural extracts act as a stabilizer and reducing agent in the preparation of green nanoparticles. Also, phenolic-rich natural extracts enhance the surface modification of carbon-based nanostructures. Thus, cost-effective, enhanced thermal and optical properties, high surface area, less toxicity, good stability, and safe handling provision make them a favorable candidate for augmenting the thermal performance of systems. Moreover, eco-friendly nanofluids act as a potential alternative working fluid in providing sustainability in various thermal systems by reducing the harmful substances released to the surroundings. This comprehensive review unbolts the recent trends on the various prospects of eco-friendly techniques in the preparation of eco-friendly nanofluids and their effective use in thermal applications. Also, the economic, and environmental assessment is highlighted, and the challenges and future directions are emphasized concerning the safety of human health and surroundings with better energy and money savings.

Keywords: Nanoparticles, natural extracts, eco-friendly nanofluids, thermal systems, environmental effect

Proceedings of the 14th International Green Energy Conference
IGEC2022-093
July 4-8, 2022

STUDY ON THE BOUNDARY CONDITION OF K-EPSILON-FP TURBULENCE MODEL FOR WIND TURBINE WAKE SIMULATION

Tao Chen, Hang Meng, Xin Yu
North China Electric Power University
No. 2, Beinong Road, Changping District, Beijing
837391230@qq.com; windsimu@163.com; xinyu@ncepu.edu.cn

ABSTRACT
Wind turbine wake has a great impact on the power output and fatigue damage of the whole wind farm. As a result, wind turbine wake simulation has attracted attentions from both researchers and engineers for decades, in which turbulence modelling is the key point. Among all the turbulence modelling methods for wind turbine wake, k-epsilon-fp, a RANS model proposed by van Der Laan in 2015, can balance well between efficiency and accuracy. In the current research, the boundary condition of k-epsilon-fp turbulence model has been studied. Four simulation cases have been carried and compared with field measurement results. It was found that the roughness z0 is the most important factor for the determination of boundary condition. Considering the wind shear around wind turbine rotor, a new determination method for roughness z_0 of the ground has been constructed, which corrects the wind profile prediction under high wind shear conditions. This research will contribute to the micrositting of future large wind farms.

Keywords: wind turbine wake, k-epsilon-fp turbulence model, RANS

Conference Website*:* http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-094
July 4-8, 2022

RESEARCH PROGRESS ON LOCALIZED HIGH CONCENTRATION ELECTROLYTES FOR LI BATTERIES

Tonghui Xu[1], Ting He[1], Hongbin Zhao[1,*]
[1]Department of Chemistry, College of Sciences, Shanghai University
[1]99 Shangda Road, Shanghai 200444, PR China
xth@shu.edu.cn; hongbinzhao@shu.edu.cn

ABSTRACT
With the continuous development of lithium batteries, commercial electrolytes can no longer meet the existing demand. As an important medium for ion conduction in lithium batteries, electrolyte plays a vital role in enhancing the cycle performance and safety of lithium batteries. Compared with traditional low concentration electrolyte, high concentration electrolyte systems have received wide attention because of their unique solvent structure and excellent physicochemical properties. Localized high concentration electrolytes (LHCE) is a dilute reagent added to the solution, which not only retains the excellent characteristics of high concentration electrolyte, but also has the advantage of excellent wettability and low cost. In recent years, the functional application of LHCE in lithium batteries has been widely reported. Herein, we review the latest scientific progress in LHCE. The chemical structure and properties of the solutions were analyzed by a combination of commonly used characterization methods and computational simulations. The article highlights the functional applications of LHCE, including flame retardancy, low temperature, high voltage resistance and inhibition of polysulfide shuttle effect. Finally, the main problems of LHCE are briefly analyzed from both basic scientific research and applied research, and their future development are prospected.

Keywords: Localized high concentration electrolyte, Solvation structure, Functional application, Li batteries

Proceedings of the 14th International Green Energy Conference
IGEC2022-095
July 4-8, 2022

RESEARCH PROGRESS AND PROSPECT OF ELECTROLYTES FOR AQUEOUS ZINC-ION BATTERIES

Xiao Yan[1], Hongbin Zhao[1], Ting He[1, *]

[1]Department of Chemistry, College of sciences, Shanghai University,
[1]No.99 Shangda Road, Shanghai 200444, PR China
yanxiaox@shu.edu.cn; heting@shu.edu.cn

ABSTRACT
Rechargeable aqueous zinc-ion batteries (AZIBs) have attracted tremendous attention in the next energy storage devices due to their high safety, low cost, abundant resources and eco-friendliness. As an important component of zinc-ion battery, electrolyte plays a vital role in the electrochemical properties of zinc-ion battery since it will provide a pathway for the migrations of the zinc ions between the cathode and anode, and determine the ionic conductivity, electrochemically stable potential window and reaction mechanism. In this review, a brief introduction of the recent advances of aqueous electrolytes for AZIBs, including high-concentration electrolytes, additives, and gel electrolytes are also summarized, then deeply analyzed its existing issues (narrowed electrochemical window, anode dendrite, cathode dissolution). The final section clarified the existing challenges and perspectives for further improvements and guidance of electrolytes in AZIBs

Keywords: Aqueous zinc-ion batteries; electrolytes; gels; additives; energy storage

Proceedings of the 14th International Green Energy Conference IGEC2022-097
July 4-8, 2022

HYBRID STOCHASTIC RECONSTRUCTION OF CATALYST LAYERS IN POLYMER ELECTROLYTE MEMBRANE FUEL CELLS

Pascal Ruzzante and Xianguo Li
Fuel Cell and Green Energy Lab
Department of Mechanical and Mechatronics Engineering
University of Waterloo, Waterloo, Ontario N2L 3G1 Canada
pascal.ruzzante@uwaterloo.ca; xianguo.li@uwaterloo.ca

ABSTRACT
Polymer Electrolyte Membrane Fuel Cells (PEMFCs) show promise in a wide variety of applications and their commercialization would aid the global effort to achieve net-zero emissions. The catalyst layer of PEMFCs is a source of significant efficiency loss due to resistance to transport and reaction mechanisms in its porous structure. A computationally reconstructed model of the porous microstructure is required in order to study and better understand the applicable pore-scale phenomena. This work presents an efficient hybrid stochastic reconstruction approach which combines a sphere-packing approach with simulated annealing and simultaneously optimizes the solid and pore microstructure using the two-point correlation and the lineal path distribution in solid and void phases. The approach is demonstrated by reconstructing a three-dimensional catalyst layer from 2D focused-ion beam scanning electron microscope (FIB-SEM) experimental images. The model is validated by comparing the pore size distributions of the reconstruction to those of the experimental images. Surface area and mean chord length estimates are extracted from the reconstruction and reported, generally showing good agreement with experimental data.

KEYWORDS:
Catalyst Layer Stochastic Reconstruction, PEM Fuel Cell, Simulated Annealing

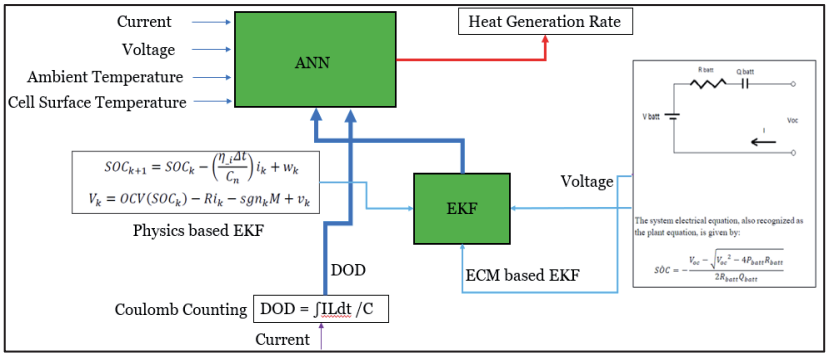
Proceedings of the 14th International Green Energy Conference
IGEC2022-098
July 4-8, 2022

HYBRID DATABASED MODELING APPROACH TO PREDICT THERMAL BEHAVIOR OF LI-ION BATTERIES

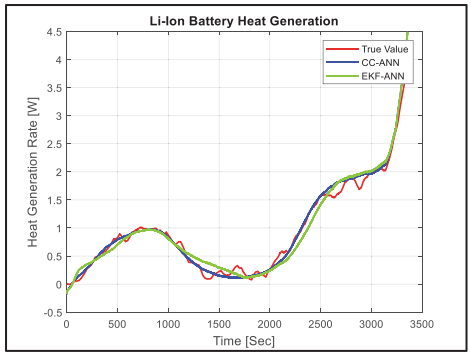
Adithya Legala and Xianguo Li
Department of Mechanical and Mechatronics Engineering, University of Waterloo
200 University Avenue West, Waterloo, Ontario, Canada N2L 3G1
Xianguo.Li@uwaterloo.ca

ABSTRACT

The world has seen a significant emphasis on transitioning to green energy to combat global warming and Lithium-Ion Battery (LIB) technology is at the forefront of this process. However, like all other electrochemical energy storage devices, LIB has its share of challenges such as thermal runaway which can be mitigated by understanding and accurately predicting the LIB thermal behavior (heat generation rate). This knowledge of heat generation rate is essential to designing an efficient thermal management system to improve the battery performance and associated fail-safe safety systems. LIB generates a varying amount of heat during discharge depending on the operational conditions such as discharge current, voltage, ambient temperature, cell surface temperature, and the State of Charge (SOC) /Depth of Discharge (DOD) of the LIB (which represents the currently available battery capacity). This study presents a novel approach to using an Artificial Neural Network (ANN) for predicting the heat generation rate coupled with an Extended Kalman Filter (EKF) to estimate the corresponding SOC/DOD of the LIB. The data for the development and calibration of the ANN and EKF model in MATLAB is obtained experimentally by discharging a commercially available prismatic Li-ion battery (LiFePO4) from A123 at various operating conditions. A shallow neural network utilizing Marquette-Levenberg algorithm in MATLAB is designed and calibrated using over 8000 cases of the testing data where discharge current, voltage, ambient temperature, cell surface temperature, and DOD are implemented as feature vectors (inputs) to predict the heat generation rate of LIB with an accuracy of $R2 > 0.995$. Two different EKF estimation models are developed based on state equations derived from the equivalent circuit model and coulomb counting equation to predict the SOC/DOD. A comparison of heat generation rate and DOD estimates from the coulomb counting method, EKF estimation methods and measured data from the battery test station is presented to evaluate their respective performance. Further potential of this data-based model for thermal management system control and sensor diagnostics is presented. Data-based models for LIB heat generation are successfully developed by adapting novel modelling techniques such as incorporating ANN and EKF, demonstrating the ability to build accurate models relying solely on LIB discharge data for real-time system monitoring, control and diagnostics.



(a) Schematic of the artificial neural network architecture with EKF



(b) LIB thermal EKF - ANN model performance

Keywords: Lithium Ion Battery, Databased Model, Neural Network, Extended Kalman Filter, Heat Generation.

Proceedings of the 14th International Green Energy Conference
IGEC2022-099
July 4-8, 2022

Peculiar Influence of Paddle-wheel Effect on the Ionic Conductivity of Antiperovskite Na_3SO_4F

Yuxiang Li[1], Heng Wang[1], Peng Liu[1], Lulu Ma[1], Ya Tang[1,*], Hongbin Zhao[1,*]
[1]Department of Chemistry, College of Sciences, Shanghai University
[1]99, Shangda Road, Shanghai 200444, PR China
liyx225@shu.edu.cn; chem-wh@shu.edu.cn; 512968907@qq.com; m000324@qq.com; tangya0709@shu.edu.cn; hongbinzhao@shu.edu.cn

ABSTRACT
All-solid-state lithium-ion batteries (ASSLBs) that use solid-state electrolytes (SEs) with intrinsic safety instead of ubiquitous organic electrolytes open up a new situation for energy storage. However, the ionic conductivity of SEs is generally lower than that of liquid electrolytes, thus we need to modify them to improve their ionic conductivity. The paddle-wheel effect can be used to improve the ionic conductivity through the dynamic coupling of polyanion rotation/reorientation with cation migration. Herein, we have prepared the synthetic crystal of kogarkoite, Na_3SO_4F, using the mechanical ball-milling method. Na_3SO_4F has an order-disorder phase transition, the biggest difference between its low and high-temperature phases is that at high temperatures the SO_4 tetrahedra are completely disordered. Through electrochemical impedance testing, we found that as the temperature increases, Na_3SO_4F undergoes a phase change while the ionic conductivity decreases, which is different from other polyanionic crystalline materials with order-disorder phase changes. Therefore, we will next investigate what role the paddle-wheel effect of the polyanion SO_4^{2-} plays in the low- and high-temperature phases of Na_3SO_4F.

Keywords: Solid electrolyte, Paddle-wheel effect, Kogarkoite.

Proceedings of the 14th International Green Energy Conference
IGEC2022-100
July 4-8, 2022

MANGANESE - COBALT SULFIDE NANOWIRE FOR HIGH-PERFORMANCE OXYGEN EVOLUTION REACTION CATALYST

Zijian Huang, Jinkui Chen, Hongyan Duan, Yifan Guo, Jiayang Luo, Zhuoyu Wang, Yanmei Gong, Daixin Ye*, Hongbin Zhao*
[1]Department of Chemistry, College of Sciences, Shanghai University
[1]99 Shangda Road, Shanghai 200444, PR China
daixinye@shu.edu.cn, hongbinzhao@shu.edu.cn

ABSTRACT
Oxygen evolution reaction (OER) is a reaction limiting hydrogen production from electrolytic water, and it is also an important topic for many researchers. The development of high-performance OER cheap catalyst is of great significance for the development of hydrogen energy economy. Double transition metal sulfides have excellent electrochemical properties and very low cost, so they have broad research prospects. In this study, we prepared a novel manganese cobalt sulfide nanowire array by simple hydrothermal method. Through the morphology characterization test of scanning electron microscope(SEM), the clear change of vulcanization can be observed. The electrochemical test shows that the catalyst has excellent OER performance.

Keywords: OER, cobalt sulfide nanowire array,performance

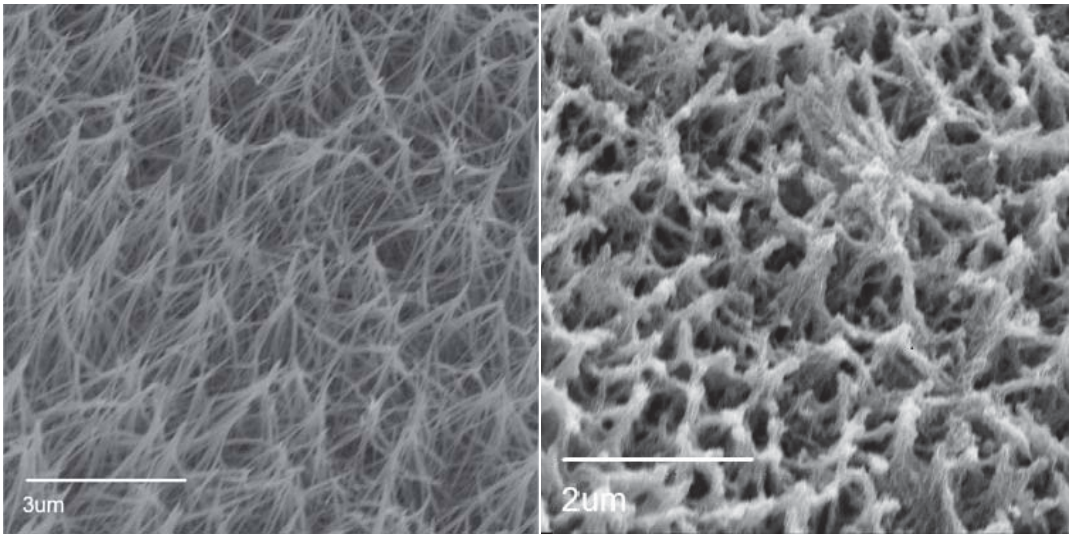


Fig.1 SEM images of manganese cobalt sulfide nanowire before and after vulcanization

ACKNOWLEDGEMENT
We gratefully acknowledge financial support from Key Research & Development projects of Zhejiang Province (2019C01072), National Natural Science Foundation of China (22002086, 51803116), and Key Laboratory of Fuel Cell Technology of Guangdong Province. Dr. Daixin Ye thanks the Program of Special Appointment (Young Dongfang Scholar) of the Shanghai Education Committee.

Proceedings of the 14th International Green Energy Conference
IGEC2022-101
July 4-8, 2022

PREPARATION OF $Ti_3C_2T_X$ IN-SITU COUPLED CoP-NiCoP HETEROJUNCTION AND WATER ELECTROLYSIS PERFORMANCE

Shiyuan Fei, Zhaoming Kang, Yifan Guo, Hongyan Duan, Jinkui Chen, Daixin Ye*, Hongbin Zhao*, Jiujun Zhang
Department of Chemistry, College of Sciences, Shanghai University
99 Shangda Road, Shanghai 200444, PR China
2770107290@shu.edu.cn, kangzm@shu.edu.cn, daixinye@shu.edu.cn, hongbinzhao@shu.edu.cn

ABSTRACT

Oxygen evolution (OER) and hydrogen evolution reaction (HER) are the main reactions of electrolyzing water. Hence, people are committed to developing cheap and efficient catalysts for electrolyzing water to produce clean and sustainable energy. Phosphide as a non-noble metal is considered to have great potential in application as HER catalyst due to its high electrocatalytic activity and large raw material reserves. At the same time, the combination of phosphide and other conductive carrier materials (such as graphene, carbon nanotubes and MXene) to produce synergy can greatly optimize the reaction activity of the catalyst and improve the catalytic reaction rate. In this report, utilizing 2D low-layer $Ti_3C_2T_x$ to load NiCo bimetallic hydroxide precursor, and then through phosphating, we can synthesize ultralong NiCoP nanoneedle heterojunction CoP–NiCoP–Ti_3C_2T (CP–NCP–T) modified by in-situ interface array coupling of $Ti_3C_2T_x$ carrier and CoP nanoparticles. And electrochemical tests show that the prepared CP–NCP–T catalyst has excellent electrocatalytic activity for HER and OER in 1.0 M KOH electrolyte. When the current density of the catalyst reaches 50 mA cm^{-2}, the over potentials required for HER and OER are 112 and 281 mV respectively.

Keywords: $Ti_3C_2T_X$, CoP-NiCoP heterojunction, In-situ, Water electrolysis.

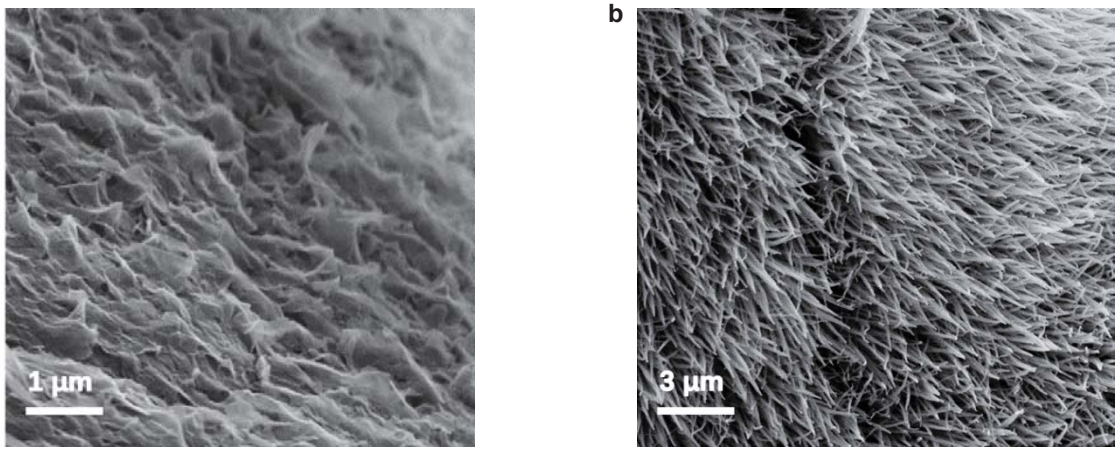


Fig. SEM images of (a) a few layers of Ti_3C_2T coated on nickel mesh and (b)Ti_3C_2T in situ coupled CoP NiCoP heterojunction nanoneedle array.

References

[1] Zhaoming Kang, Daixin Ye*, Hongbin Zhao*, etal. Recent progress of MXenes and MXene-based nanomaterials for the electrocatalytic hydrogen evolution reaction. Journal of Materials Chemistry A, 2021, 9: 6089–6108.

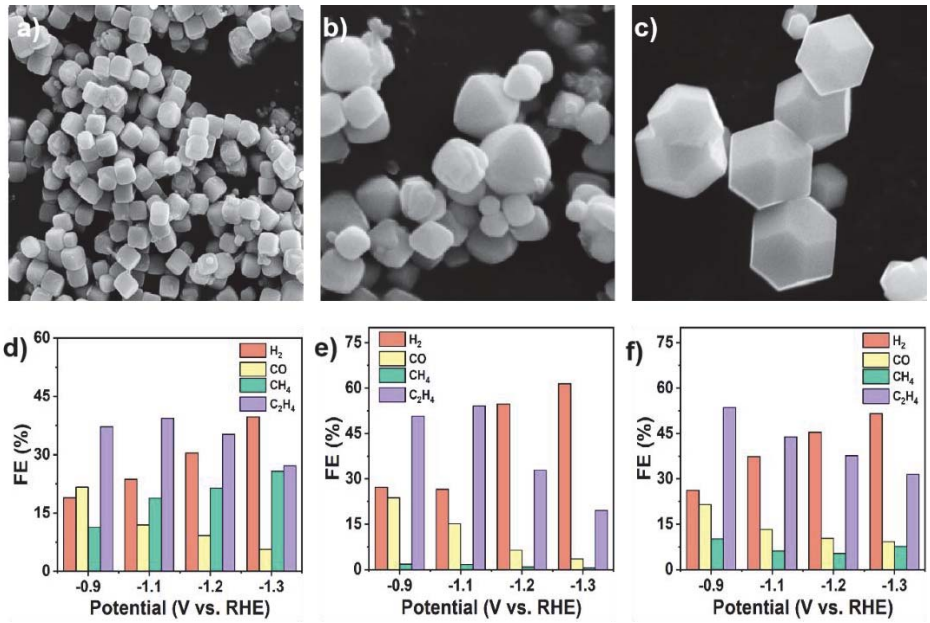
[2] Yanmei Gong, Zhaoming Kang, Daixin Ye*, Hongbin Zhao*, etal. Progress in energy-related graphyne-based materials: advanced synthesis, functional mechanisms and applications. Journal of Materials Chemistry A, 2020,8: 21408–21433.

Proceedings of the 14th International Green Energy Conference
IGEC2022-102
July 4-8, 2022

TUNING THE CRYSTAL FACETS OF POLYHEDRAL CUPROUS OXIDE STRUCTURES TO ENHANCE THE SELECTIVITY OF ETHYLENE PRODUCTS FROM ELECTROCATALYTIC REDUCTION OF CO_2

Yu Sun, Jian Cai, Shiyuan Fei, Daixin Ye, Hongbin Zhao*
College of Sciences &Institute for Sustainable Energy, Shanghai University, Shanghai 200444, P. R. China
hongbinzhao@shu.edu.cn

ABSTRACT
It remains challenging to catalyse the formation of these multicarbon compounds with high selectivity via the CO_2 reduction reaction (CO_2RR). Copper-based materials have so far been the most efficient in electrocatalysing the conversion of CO_2 to C2+ hydrocarbons and oxygenates. Studies on Cu_2O NPs have shown that those with different crystal faces exhibit different stability and different catalytic activities. Here, we have successfully prepared cubic Cu_2O (6 {100} crystal facets), octahedral Cu_2O (8 {111} crystal facets), truncated octahedral (6 {100} and 8 {111} crystal facets) Cu_2O by the template method and evaluated their electrocatalytic performance for the reduction of CO_2 to C_2H_4. The selectivity for the C_2H_4 production increases in the order, *c*-Cu_2O < *o*-Cu_2O < *t*-Cu_2O, (with FE_{C2H4} = 42%, 48%, and 53%, respectively). It was shown that the selectivity and activity of C_2H_4 production depends strongly on the exposed crystal facets in Cu_2O NPs. Exposure of {100} facets to Cu_2O NPs contributes to promote C-C coupling to generate C_2H_4 products, and exposure of {111} facets to Cu_2O NPs contributes to the escape of the product C_2H_4 from the crystal surface. This study has guided a new direction for crystal surface engineering to improve the catalytic activity and product selectivity of electrocatalytic CO_2 reduction.



SEM images and FE values of a,d) *c*-Cu_2O NPs, b,e) *o*-Cu_2O NPs, and c,f) *t*-Cu_2O NPs.

Keywords: Cu_2O, crystal facets, CO_2RR, ethylene.

Acknowledgment
We gratefully acknowledge financial support from Key Research & Development projects of Zhejiang Province (2019C01072). National Natural Science Foundation of China (22002086), and Key Laboratory of Fuel Cell Technology of Guangdong Province. Dr. Daixin Ye thanks the Program of Special Appointment (Young Dongfang Scholar) of the Shanghai Education Committee (DQ20180003).

Proceedings of the 14th International Green Energy Conference
IGEC2022-103
July 4-8, 2022

Fe/Co diatom doped with N/P as an active electro catalyst for Zn-air battery

Hongyan Duan, Jinkui Chen, Rida Javed[a*], Yifan Guo, Muhammad Arif Khan[a], Daixin Ye[b], Hongbing Zhao[b*],

a School of Materials Science and Engineering, Shanghai University,

b College of Sciences & Institute for Sustainable Energy, Shanghai University, Shanghai 200444, P. R. China–

(Email: ridajaved617@yahoo.com, hongbinzhao@shu.edu.cn)

In this research, we propose an improved technique for developing an ORR catalyst employing sustainable biomass as a self-supply of carbon, iron, nitrogen, and phosphorus. This process is followed by chemical activation with KOH, intrinsic doping with nitrogen, iron, and phosphorus, and extrinsic doping with cobalt to produce a catalyst with improved ORR catalytic performance. The SEM images revealed 3D hierarchically honey comb like structure having micro and mesoporous. with high surface area. The HADAAF STEM, EDX, mapping and XPS were performed to further investigate the structure confirmation of the Co/ Fe -N-C/P catalyst. The synthesized Co/Fe-N-C/P displays excellent ORR activity with a half wave potential of (0.85 V versus RHE), and limiting current density 5.20 mA cm^{-2} in 0.1 M KOH solution. This research will undoubtedly aid in the design and synthesis of biomass resources as a simple approach to converting renewable bio mass materials into a useful electro catalyst for Zn-air batteries.

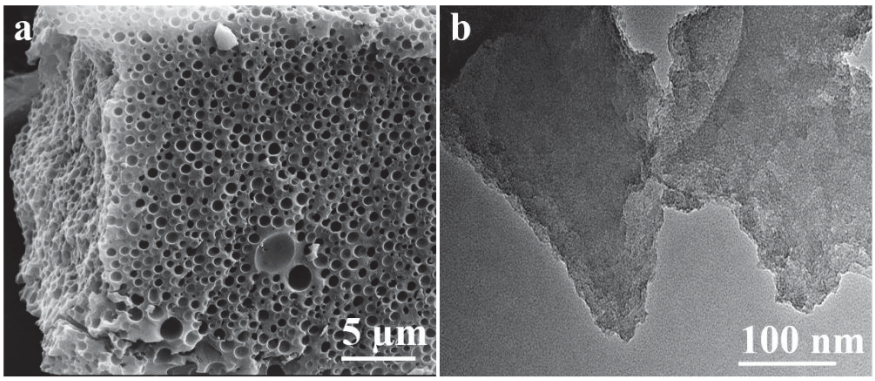


Figure 1. (a) SEM image and (b) TEM image for Co/Fe-N-C/P

Key words: biomass, doping, chemical activation, oxygen reduction reaction and phosphorus.

Acknowledgment
We gratefully acknowledge financial support from Key Research & Development projects of Zhejiang Province, China (2019C01072).

Proceedings of the 14th International Green Energy Conference
IGEC2022-104
July 4-8, 2022

SELECTIVE PRODUCTION OF MONOCYCLIC AROMATIC HYDROCARBON FROM LIGNIN USING NI/ZSM-5 CATALYST

Hongling Pan, [a,b] *Xuan Zhou,* [a,b] *Guotao Li,* [a,b] *Zhicai Du,* [a,b] *Yan Luo,*[a,b*] *Zhengyuan Yang,* [a,b] *Hongxin Wei,* [a,b]
[a] Civil Aircraft Fire Science And Safety Engineering Key Laboratory of Sichuan Province, Civil Aviation Flight University of China, Guanghan 618307, China
[b] College of Civil Aviation Safety Engineering, Civil Aviation Flight University of China, Guanghan 618307, China
* Corresponding author emails: luohaiyanabc@163.com

ABSTRACT

Lignin is a kind of biomass resource with complex structure, abundant yield but low utilization rate, which can be depolymerized into high value-added products by catalytic pyrolysis and has broad application prospects. In order to improve the yield of aromatic hydrocarbons obtained from catalytic pyrolysis of lignin, this study used lignin as the raw material and Ni metal-modified ZSM-5 catalysts were prepared by impregnation method. With the different Si/Al ratio (5:18, 5:50, 5:85, 5:300, 5:470) of zeolite and metal loading amount (5, 10, 15, 20, 25 wt.%) as experimental variables, catalytic fast pyrolysis (CFP) of lignin was performed using pyrolysis-gas chromatography-mass spectrometry (Py-GC/MS) to explore the suitable catalytic performance for aromatic hydrocarbon production. The series of Ni/ZSM-5 catalysts reduced the phenolic component of the pyrolysis products, significantly increased the relative content of the target product aromatics, and the proportion of monocyclic aromatic hydrocarbons in the aromatic products was greatly enhanced. The research results showed that ZSM-5 with the Si/Al ratio of 5:18 had the best catalytic performance for aromatic production, selectively generating 35.22% of the aromatic products. The loading of 15 wt.% Ni (15 wt.% Ni/ZSM-5, Si/Al=5:18) further boosted the catalytic performance for lignin, achieving the best selectivity of 84.95% for aromatic production, of which the selectivity of monocyclic aromatic hydro carbon was 82.23%. This research provides a suitable Ni modified zeolite catalyst for high monocyclic aromatic hydrocarbon production from catalytic pyrolysis of lignin.

Keywords: Fast pyrolysis, Lignin, Aromatics, Ni/ZSM-5.

Proceedings of the 14th International Green Energy Conference
IGEC2022-106
July 4-8, 2022

STUDY ON GRAVITY EFFECT ON FROST CHARACTERISTICS UNDER NATURAL CONVECTION

LEI Shangwen[(a)], SONG Mengjie[(a,*)]
[(a)] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing, 100081, China (3220200258@bit.edu.cn, 3120200459@bit.edu.cn)

ABSTRACT
As a common natural phenomenon, frosting exists widely in engineering fields. To avoid the drawbacks and take advantage of frost, understanding the frost characteristics is meaningful and challengeable. Frosting experiments on cold plates under natural convection are carried out, with the surface temperature at -25 ºC and -15 ºC. To investigate the gravity effect on the frost characteristics, cold plates are installed horizontally, vertically and inversely. The frost characteristics, including frosting stages, frost layer thickness and surface roughness are analyzed and discussed. Results show that the first three frosting stages are within 240 s, with their frost thickness less than 450×10^{-6} m. A higher frost thickness can be obtained when the gravity direction is consistent with the growth direction of the frost layer. Due to the gravity effect, the condensate droplets could converge into large ones, which significantly prolong the subsequent droplet solidification and frosting process, thus influence the frost characteristics in the early frosting stage. Due to the periodic reverse melting and the gravity effect, frost thickness and surface roughness fluctuate in the frosting process. Fluctuation of surface roughness of the inverted cold plate is the largest, with I1 and I2 reaching 56.47×10^{-6} m and 68.68×10^{-6} m, respectively. Contributions of this study are expected to provide a more in-depth understanding of the frosting process and thus provide a reference for frost prediction, suppression and defrosting in engineering applications.

Keywords: Gravity effect, Natural convection, Frosting stage, Frost thickness, Surface roughness

Proceedings of the 14th International Green Energy Conference
IGEC2022-107
July 4-8, 2022

EXPERIMENTAL STUDY ON TRAPPED AIR BUBBLES IN HORIZONTAL ICE SLICE

SHAO Keke, SONG Mengjie*,
Department of Energy and Power Engineering, School of Mechanical Engineering,
Beijing Institute of Technology, Beijing, 100081, China,
3120215288@bit.edu.cn, mengjie.song@bit.edu.cn

ABSTRACT

The ice formed from water containing dissolved air is widely seen in the fields of aerospace, power transmission, and transportation. The trapped bubble is a kind of bubble that appears in the ice along with the freezing process, and has an important influence on the physical properties of the ice. To study the characteristics of distribution and behavior of trapped air bubbles, a series of water freezing experiments in a horizontal Hele-Shaw cell were carried out. Results show that obvious bubbles begin to appear in the ice, when the freezing temperature is less than -10 ^{o}C. Four stages, namely nucleation, development, elongation and close, are defined in the bubble formation process. Two types of bubbles, egg- and needle-shaped bubbles, incorporated in ice are observed, with their longitudinal axis all parallel to the freezing direction. According to the order of appearance of bubbles, three regions, egg-shaped bubbles region, egg- and needle-shaped bubbles region and needle-shaped bubbles region, can be divided. When the freezing rate is less than 3.07 μm/s, no bubbles appear in the ice. The results of this study are meaningful for the optimization of mechanical and thermal deicing technologies.

Keywords: Freezing water films, Hele-Shaw cell, trapped air bubble, bubble distribution.

Proceedings of the 14th International Green Energy Conference
IGEC2022-108
July 4-8, 2022

NUMERICAL STUDY ON FREEZING PROCESS OF WATER DROPLET ON INCLINED SURFACE

DANG Qun, SONG Mengjie*
Department of Energy and Power Engineering, School of Mechanical Engineering,
Beijing Institute of Technology, Beijing, 100081, China
qun.dang@bit.edu.cn, mengjie.song@bit.edu.cn

ABSTRACT

Droplet freezing on inclined surface exists widely in engineering fields. To avoid the drawbacks of it, investigating the freezing process of sessile water droplet on inclined cold surface is necessary. In this study, a theoretical model based on heat-enthalpy method is presented to simulate the freezing process of sessile water droplet on inclined surface under natural convection. After the model experimentally validated by droplet profiles and freezing duration, the freezing characteristics are fully analyzed, including contact area, frozen height and vertex offset, etc. As found, the effect of droplet volume on freezing characteristics is great. When the droplet volume increases from 5 μL to 25 μL on 40^{o} inclined surface, the contact area increases by 232.84% from 7.31 mm^2 to 24.34 mm^2. The initial and frozen heights increase by 49.95% from 1.76 mm to 1.17 mm, and by 55.70% from 1.32 mm to 2.05 mm, respectively. This study is beneficial for understanding freezing process of water droplet on the inclined surface, and thus the optimization of refrigeration and defrosting technologies.

Keywords: Sessile water droplet, inclined surface, wetting behavior, freezing process, modelling study.

Proceedings of the 14th International Green Energy Conference
IGEC2022-109
July 4-8, 2022

Highly Selective Production of Valuable Aromatics/Phenols from Forestry and Agricultural Residues Using Ni/ZSM-5 Catalyst

Xuan Zhou, [a,b] *Hongling Pan,* [a,b] *Guotao Li,* [a,b] *Zhicai Du,* [a,b] *Yan Luo,*[a,b*] *Zhengyuan Yang,* [a,b] *Hongxin Wei* [a,b]
[a] Civil Aircraft Fire Science And Safety Engineering Key Laboratory of Sichuan Province, Civil Aviation Flight University of China, Guanghan 618307, China
[b] College of Civil Aviation Safety Engineering, Civil Aviation Flight University of China, Guanghan 618307, China
* Corresponding author email: luohaiyanabc@163.com

ABSTRACT
The aim of this research is to design and synthesize efficient catalyst to enhance high value-added products such as aromatics and phenols from the catalytic fast pyrolysis (CFP) of different types of forestry and agricultural residues. All three biomasses (RS, WS, and BP) had no aromatic production via thermal pyrolysis alone, however, the aromatic yield and monocyclic aromatic selectivity have been largely enhanced using ZSM-5 with suitable silica-alumina ratios and Ni loadings. Meanwhile, biomass types have significant effects on the pyrolyzed products distribution due to their different components. Cellulose and hemicellulose promoted the production of aromatics, while lignin enhanced the production of phenols. The promotion of phenol by Ni was better and more efficient than that by molecular sieve.

Keywords: Catalytic fast pyrolysis; Forestry and agricultural residues; Ni/ZSM-5; Aromatics; Phenols; Py-GC/MS

Proceedings of the 14th International Green Energy Conference
IGEC2022-110
July 4-8, 2022

MATHEMATICAL MODEL STUDY ON FLOW BOILING IN MICROCHANNEL HEAT EXCHANGER

JIANG Zhengyong, SONG Mengjie*
Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing, 100081, China
mengjie.song@gmail.com

ABSTRACT
To solve the heat dissipation problem of high heat flux devices, flow boiling heat transfer in microchannels is widely used and investigated. The rectangular radial microchannel heat exchangers with grooves, was experimentally studied and reported by us. To further improve it heat transfer performances by optimizing their structural parameters, a mathematical model is developed, with heat transfer coefficient (*HTC*) used as validation parameter. As analyzed, the average deviation of the rectangular radial microchannel heat exchangers with grooves is 7.03%. For the microchannel heat exchangers with grooves, the influence of adjusting structure parameters on the *HTC* is obvious. Under a heating load of 400 W and a volume flow rate of 8 L/h, the *HTC* of the heat exchanger with grooves could be improved to 102.56 kW/m^2K, which is 58.69% higher than the experimental data. The results of this study are expected to provide references for the structural design optimization of the microchannel heat exchanger.

Keywords: Microchannel heat exchanger, Mathematical modeling, Flow boiling, Heat transfer coefficient

Proceedings of the 14th International Green Energy Conference
IGEC2022-115
July 4-8, 2022

SUSTAINABILITY ASSESSMENT OF ETHYLENE PRODUCTION FROM WASTE SEWAGE SLUDGE

Ankit Singh
Department of Hydro and Renewable Energy
Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India
a_singh@hre.iitr.ac.in

Xiao Yu Wu
Department of Mechanical and Mechatronics
University of Waterloo, Waterloo, Canada
xiaoyu.wu@uwaterloo.ca

Sonal K. Thengane
Department of Hydro and Renewable Energy
Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India
sonalt@hre.iitr.ac.in

ABSTRACT
Ethylene is one of the majorly produced chemical worldwide. The annual global ethylene market during 2019 was USD 162.5 billion, and in terms of volume was 0.16 billion tonnes, owing to its extensive range of applications as intermediate in various industries and as feedstock for many downstream products. Almost all ethylene is currently made from petrochemical feedstock and is responsible for high greenhouse gases (GHG) emissions. With the increase in urbanization and manufacturing, there is a lot of waste generation, and efficient disposal or management of the waste is a challenge. This paper assesses the sustainability of ethylene production from waste sewage sludge, addressing the issue of high GHG emissions, fossil fuel depletion, and waste management. OpenLCA was used to conduct gate-to-gate life cycle analysis (LCA). Drying of sewage sludge accounts for the highest energy consumption in the entire process and drastically affects the environment as well as the economic performance of this waste-to-ethylene production route. Replacing the natural gas consumption during drying with sun drying can reduce GHG emissions by 68%. Techno-economic analysis (TEA) unveils that the price of ethylene from a plant with a capacity of 10 metric tonnes/day in the current scenario is not competitive with the current ethylene market price i.e., USD 1.03/kg. The primary factor hindering the economic viability of the process is the high cost of peptone and cellulase used during fermentation and hydrolysis, respectively. Cutting the cost of peptone and cellulase by 50% by integrating plant with enzyme production can bring down the breakeven price of ethylene to USD 1.18/kg from USD 1.47/kg (base case) making it competitive with the present market price.

Keywords: Bioethylene, Sewage sludge, Life cycle analysis, Techno-economic analysis.

Proceedings of the 14th International Green Energy Conference
IGEC2022-116
July 4-8, 2022

Effect of nHeptane/Isopropanol/Butanol/Diesel Blends on Exhaust Emissions in a Common Rail Diesel Engine

Mustafa Vargün [1,], Ahmet Yapmaz [2], İlker Turgut Yılmaz[3], and Cenk Sayın[4]*

[1]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: mustafa.vargun@marmara.edu.tr

[2] Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: ahmetyapmaz@gmail.com

[3]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: ilker.yilmaz@marmara.edu.tr

[4]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34854, Istanbul, Turkey, e-mail: csayin@marmara.edu.tr

[*]Corresponding author: e-mail: mustafa.vargun@marmara.edu.tr

ABSTRACT
Due to the limited availability of fossil fuels in the world, researchers have focused on research on alcohol-fossil diesel fuel mixtures in recent years. In this study, the effects of HIB15 (5% nHeptane, 5% isopropanol, 5% Butanol) and HIB30 (10% nHeptane, 10% isopropanol, 10% Butanol) fuel mixtures on the exhaust emissions of a 4-cylinder 8-valve diesel engine were investigated. The experiments were carried out at engine loads of 40 Nm, 60 Nm and 80 Nm and at a constant engine speed of 1900 rpm. More than 20% reduction in CO_2 emissions has been observed with the use of HIB fuels. With the increase in engine load, a significant decrease was observed in O_2 emissions in all fuel types, while an increase in NO emission emissions was observed. Compared to FBDF fuel, a reduction in HC emissions was observed with the use of HIB fuels in general.

Keywords: Butanol, Diesel Engine, Fuel Blends, Exhaust Emissions, isopropanol, nHeptane.

Proceedings of the 14th International Green Energy Conference
IGEC2022-117
July 4-8, 2022

REALIZING NET-POSITIVE ENERGY POTENTIAL – A MIXED METHODOLOGY PERFORMANCE ASSESSMENT OF A NET-ZERO ENERGY BUILDING

Monika Mikhail[1], David Mather[2], Paul Parker[1]
[1]School of Environment, Enterprise and Development (SEED), University of Waterloo
[2] Mechanical and Mechatronics Engineering, University of Waterloo
200 University Avenue W. Waterloo, ON, N2L 3G1
monika.mikhail@uwaterloo.ca

Net-positive energy building designs promise a building that produces more energy than it consumes over a year and typically distributes the excess clean energy to the surrounding grid (1). Net-zero energy buildings are designed to be self-sufficient and produce as much energy as they consume, however during peak sunny months, net-positive energy performance can be achieved with photovoltaic generation (2). This presents a unique opportunity for the built sector to offer improved energy efficiency and expand the sources of affordable and clean energy. In this way, building design and operational decisions can contribute to sustainable cities and climate action if performance meets the design goals.

Canada's first net-zero energy multi-tenant case study office building achieved net-positive performance over several periods. Its innovative design features such as solar air heaters, solar photovoltaic panels and geothermal pumps enable it to have an energy use intensity that is one-third of the average commercial building in Canada (2). Globally, measured energy use can be 2.5 times higher than predicted energy use and this presents a roadblock to the realization of desired energy conservation and climate action (4). The performance gap, or difference between predicted and measured energy use (5), can contribute to increased operating costs and emissions (4–6).

In this mixed method study, quantitative and qualitative performance data were analyzed. Three years of measured operational energy meter data were compared with the design model to identify areas of achieved and potential operational improvement. Interviews with building management were conducted to understand operational changes from the original design intent. This presentation will identify the design features and operational decisions that enable a net-positive energy performance.

Keywords: Net-positive energy performance, performance gap, mixed methodology.

References:

1. Kolokotsa D, Rovas D, Kosmatopoulos E, Kalaitzakis K. A roadmap towards intelligent net zero- and positive-energy buildings. Sol Energy. 2011 Dec 1;85(12):3067–84.

2. Cole RJ, Fedoruk L. Shifting from net-zero to net-positive energy buildings. Building Research & Information. 2015;43(1):111–20.

3. Kawabata T. The Integration of Social Influence Theory and the Energy Cultures Framework. Univ Waterloo. 2021;235.

4. Zou PXW, Xu X, Sanjayan J, Wang J. Review of 10 years research on building energy performance gap: Life-cycle and stakeholder perspectives. Energy Build. 2018;178:165–81.

5. Jain N, Burman E, Stamp S, Mumovic D, Davies M. Cross-sectoral assessment of the performance gap using calibrated building energy performance simulation. Energy Build. 2020;224:110271.

6. de Wilde P. The gap between predicted and measured energy performance of buildings: A framework for investigation. Autom Constr. 2014 May 1;41:40–9.

Proceedings of the 14th International Green Energy Conference
IGEC2022-118
July 4-8, 2022

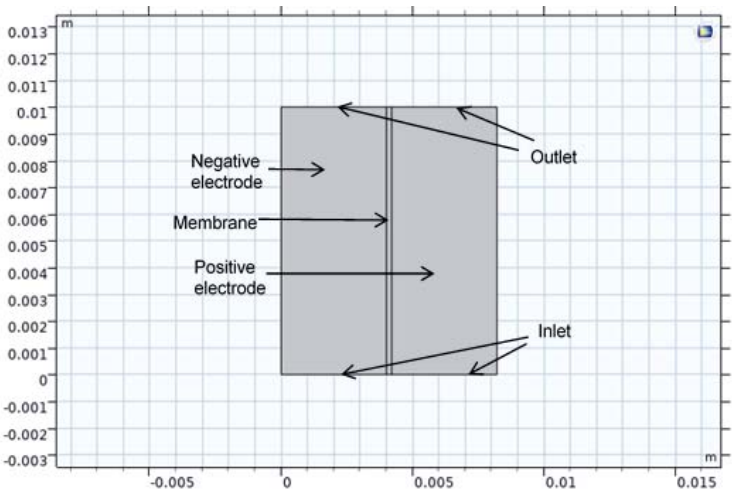
A DEEP EUTECTIC SOLVENT FLOW BATTERY MODEL BASED ON KEY PARAMETERS OBTAINED BY ELECTROCHEMICAL TEST

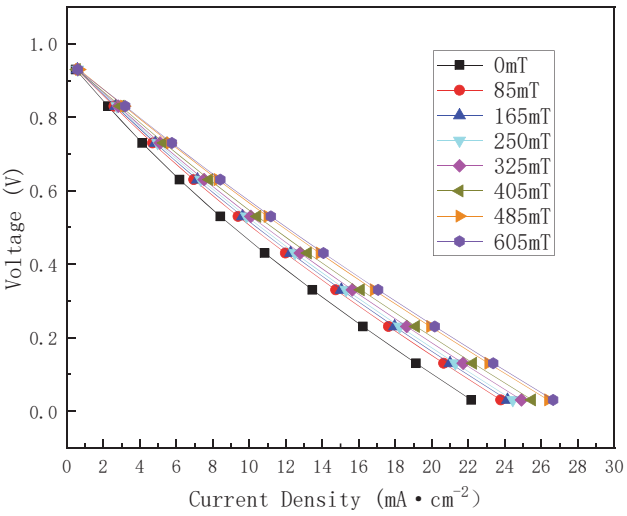
Haotian Zhou, Ruiping Zhang, Qian Xu*
Institute for Energy Reasearch, Jiangsu University,
301 Xuefu Road, Zhenjiang, Jiangsu Province, China
E-mail: xuqian@ujs.edu.cn

ABSTRACT

Flow battery is an ideal energy storage system for full use of renewable energy [1], but its cell voltage is limited by the electrochemical window of water [2]. Flow battery using deep eutectic solvent (DES) as electrolyte can provide a wider electrochemical window, but it faces the problems of high viscosity and slow mass transfer speed [3]. The application of magnetic field has been proved to be an effective way to improve the mass transfer capacity in eutectic solvents [4]. In this paper, a two-dimensional numerical model of flow battery under the effect of the magnetic field is established to optimize the key parameters of the flow battery. We mixed choline chloride (98 %) and ethylene glycol (99 %) in a molar ratio of 1:2 as DES electrolyte, and then parameters of the electrolyte were tested. Based on the experiment data under different magnetic field intensity, the change of polarization curve is simulated. The result of the simulation has the same trend with experimental data, but there is a gap in values between simulation and experimental results. Through further analysis, we found that the increase of diffusion coefficient is the main reason why magnetic field can provide positive effect on DES electrolyte. This model will show the way to make best use of magnetic field in DES flow battery.

Keywords: Flow battery, Deep eutectic solvent, Magnetic field.





References:

[1] Wei W , Luo Q , Li B , et al. Recent Progress in Redox Flow Battery Research and Development[J]. Advanced Functional Materials, 2013, 23(8), 970-986.

[2] Yan H , Shuang G , Yan Y , et al. Nonaqueous redox-flow batteries: Features, challenges, and prospects[J]. Current Opinion in Chemical Engineering, 2015, 8:105-113.

[3] Xu Q , Qin L Y , Ji Y N , et al. A deep eutectic solvent (DES) electrolyte-based vanadium-iron redox flow battery enabling higher specific capacity and improved thermal stability[J]. Electrochimica Acta, 2018.

[4] Rong C, Peizhuo S, Huaneng S, Qian X, Effect of exerted magnetic field on the performance of non-aqueous iron-vanadium redox flow battery with deep eutectic solvent (DES) electrolyte, Electrochimica Acta, Volume 399, 2021.

Proceedings of the 14th International Green Energy Conference
IGEC2022-119
July 4-8, 2022

Solar Redox Flow Battery Based on Metal Ion Doped TiO_2 Electrode

Zihan Zhang, Ping Lu, Tong Zhao, Qian Xu*
Institute for Energy Research, Jiangsu University
Zhenjiang 212013 , China
E-mail: xuqian@ujs.edu.cn

ABSTRACT

Solar redox flow battery is an integrated device with electrolyte as the “medium”, which combines power generation and energy storage technology to effectively reduce energy transmission losses, while preserving the advantages of flow batteries that can independently design energy capacity and power density, etc. The technology has great prospects in frequency regulation and peak regulation of the power grid. However, the current performance of the photoelectrode in solar flow batteries is still limited by the utilization of the solar spectrum. Recently, based on the point defect mechanism formed by the surface low-coordination oxygen atoms easily leaving the lattice position, we modified the photoanode by using metal chloride as a doping agent to dope Cu^{2+} and Cr^{3+} onto the TiO_2 film. As can be seen from the instantaneous current plot, under the condition of applied bias of 0.5 V, in both Fe^{2+} solution and Fe^{2+}-Cr^{3+} mixed solution, the current of the photoelectrode doped with Cu^{2+} and Cr^{3+} is higher than that of the conventional TiO2 electrode. Among them, in the Fe^{2+}-Cr^{3+} mixed solution, the average current of doped Cr^{3+}(8.93 mA) is about 43.8% higher than that of TiO_2 electrodes (6.21 mA). In addition, the Mott-Schottky curve shows that the photoelectrode doped with Cr^{3+} has the largest carrier concentration ($1.5x10^{21}$·cm^{-2}) and flat band voltage (-0.257 V) in the Fe^{2+}-Cr^{3+} mixed solution. After the synthesis of TiO_2 materials, the low coordination oxygen atoms on the surface are easy to leave the lattice position and form point defects. After adding Cu^{2+}, doped ions will replace lattice ions, so as to enhance the stability of lattice and improve the crystallinity of samples These results provide more feasible ways to improve the performance of solar flow batteries.

Keywords: Solar Redox Flow Battery, Doping, TiO_2 photoelectrode.

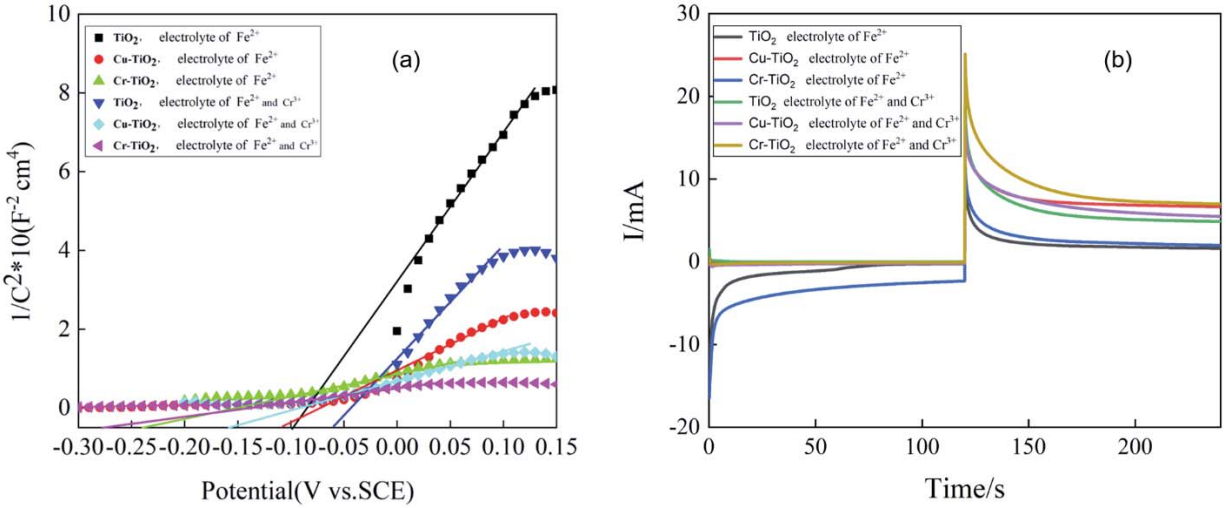


Fig1. The Mott-Schottky curve (a) and instantaneous current plot (b) of metal ion doped TiO_2 electrode in different electrolytes

References:

[1] Li W, Jin S. Design Principles and Developments of Integrated Solar Flow Batteries. Accounts of Chemical Research. 2020;53(11):2611-21.

[2] Sánchez-Díez E, Ventosa E, Guarnieri M, Trovò A, Flox C, Marcilla R, et al. Redox flow batteries: Status and perspective towards sustainable stationary energy storage. Journal of Power Sources. 2021;481:228804.

[3] Bae D, Faasse GM, Smith WA. Hidden figures of photo-charging: a thermo-electrochemical approach for a solar-rechargeable redox flow cell system. Sustainable Energy & Fuels. 2020;4(6):2650-5.

[4] Zhang W, Lin YY, Chen R, Zhu X, Ye DD, Yang Y, et al. Self-doped TiO2 nanotube array photoanode for microfluidic all-vanadium photoelectrochemical flow battery. Journal of Electroanalytical Chemistry. 2021;897.

Proceedings of the 14th International Green Energy Conference
IGEC2022-121
July 4-8, 2022

PERFORMANCE OF A PIEZOELECTRIC RAINWATER ENERGY HARVESTER USING ARDUINO UNO MICROCONTROLLER IN ACTUAL RAIN.

Ahmad Rusydan Zaabah and Azfarizal Mukhtar
College of Engineering, Universiti Tenaga Nasional (UNITEN), Putrajaya Campus, Jalan IKRAM-UNITEN, 43000 Kajang, Selangor Darul Ehsan, Malaysia
azfarizal.mukhtar@gmail.com

ABSTRACT

The development of microelectronics has led to smaller appliances. These appliances can now be fed from energy recovered by an energy harvester. The piezoelectric harvester can be utilized to convert vibrations into electricity. Thus, when raindrops have an impact on the surface of a piezoelectric beam, the stress energy generated by the penetrating raindrop will be converted into harvestable electrical energy. Most of the studies were performed by simulating rain droplets using laboratory devices that are not completely accurate with respect to the actual rain situation. The novelty of this study is to examine the energy produced in the actual rain where the intensity of the rain is contemplated. This study examined the power collection performance of rainwater using a piezoelectric sensor in Jerteh, Terengganu. The voltages generated by the raindrops were measured using an Arduino UNO microcontroller, and an ad-hoc circuit was constructed to improve the result obtained from the raindrops. The study analysed three different timelines at the peak and at the end of the rainfall event in May 2021. The result showed that the maximum voltages of 2.68V, 3.96V and 3.35V were produced by raindrops over the three timelines. Hence, the accumulated energy could be reported at 0.12 μJ, 1.9 μJ, and 0.22 μJ, respectively. The results of this study show that the amount of energy produced by actual rain is very low using this method. However, it is still favorable to be used in low-consumption applications such as RFID tags.

Keywords: Rain energy harvester, Piezoelectric, Arduino, Raindrops.

Proceedings of the 14th International Green Energy Conference
IGEC2022-122
July 4-8, 2022

Numerical simulation of DC-SOECs with metal foam supporting carbon chamber

Yu Han

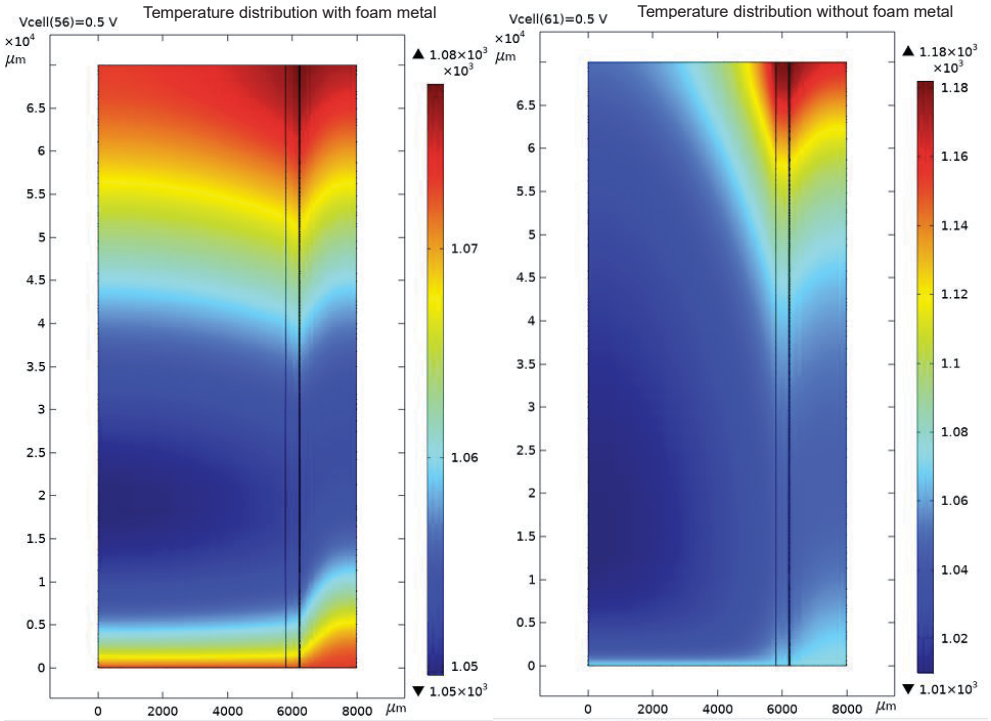
State Key Laboratory of Clean Energy Utilization, Zhejiang University

38 Zheda Road, Hangzhou, 310027, China

hanyu0219@zju.edu.cn

Abstract

The direct utilization of solid carbon in SOECs has received rising interest with a lower operational cost and higher volumetric energy density. However, the significant temperature variation caused by in situ gasification reduces the cell lifetime. In this paper, a 2D tubular model for direct carbon solid oxide electrolysis cells (DC-SOECs) with the adoption of metal foam as a carbon chamber at anode are developed. The results show that enhanced heat transfer with foam metal significantly improves the temperature distribution of DC-SOEC. The maximum temperature is decreased, while the minimum temperature is increased. The mechanical properties of the DC-SOEC can be effectively improved by decreasing the temperature gradient and limiting maximum temperature. It is also found that hydrogen and carbon monoxide productions increase with similar input power after adding foam metal support, which indicates metal foam carbon chamber is beneficial for the DC-SOEC performance improvement. Moreover, the influence of inlet gas flow rate, inlet gas temperature and the distance between carbon chamber and anode are further analyzed. The results of this study form a solid foundation to optimize the structure of tubular H2O-assisted DC-SOECs.



Keywords: SOEC, carbon gasification, foam metal.

Proceedings of the 14th International Green Energy Conference
IGEC2022-123
July 4-8, 2022

CALCULATION AND ANALYSIS OF SOLAR IRRADIANCE FOR A SMALL FRESNEL FIXED LINEAR-FOCUS SOLAR COLLECTOR

Hai Wang [a,b], *Mengjie Song* [a*]

a Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China; wanghai_sky@126.com (H.W.) mengjie.song@bit.edu.cn (M.S.)
b Department of Mechanics Engineering, School of Mechanics and Automotive Engineering, Zhaoqing University, Zhaoqing, 526061, China
* Corresponding author: mengjie.song@bit.edu.cn (M.S.)

ABSTRACT
The polar tracking system coupling straight slip rails of a small Fresnel fixed linear-focus solar collector (FFLSC) is introduced, and the calculation model of the solar radiation received by the FFLSC is established. The influence of geographical factors on the performance of FFLSC is analyzed. The results show that the maximum adjustment interval of the solar collector is 48 days and the minimum interval is 20 days. The total amount of accumulated solar radiation absorbed throughout the day basically presents a bimodal distribution with the increase of the day number of a year. The high altitude factor can make up for the negative impact of the high geographical latitude factor on the accumulated solar radiation absorbed of FFLSC.

Keywords: solar collectors, solar irradiance, polar tracking, geographic factors

Proceedings of the 14th International Green Energy Conference
IGEC2022-124
July 4-8, 2022

A COMPARATIVE INVESTIGATION INTO THE IMPACT OF NOVEL AND TRADITIONAL MECHANOCHEMICAL SYNTHESIS TECHNIQUES ON THE HYDROGEN ENERGY STORAGE OF METAL HYDRIDES

Babak O' Shahreza[1,2,3 *], Julia Ivanisenko[4], Fjodor Sergejev[1], Francisco Javier Perez[3], Amol Kamble[5], Jacques Huot[2]
1 Department of Mechanical and Industrial Engineering, Tallinn University of Technology (TalTech), 19086 Tallinn, Estonia
2 Hydrogen Research Institute, University of Québec in Trois-Rivières (UQTR), 3351 des Forges, Trois-Rivières G9A 5H7, Canada
3 Department of Chemical and Materials Engineering, Complutense University of Madrid (UCM), Av. Complutense, 28040 Madrid, Spain
4 Institute of Nanotechnology (INT), Karlsruhe Institute of Technology (KIT), 76021 Karlsruhe, Germany
5 Amity School of Engineering & Technology, Amity University Mumbai, Mumbai, Maharashtra, 410206, India
* Corresponding author: omranpour@uqtr.ca

ABSTRACT
Hydrogen energy is recyclable and environmentally friendly, and when used in fuel cells, it will produce zero carbon emission, hence, it is named as the future resource of energy. However, the storage of hydrogen is one of the main challenges in the development of this energy resource. Solid-state hydrogen storage such as metal hydride is rather a new approach in the storage of hydrogen offering the advantages of higher volumetric density of storage and lower risks of detonation and combustion, but with the main limitation of the long activation time to absorb hydrogen. Earlier studies showed that mechanochemical synthesis of metal hydrides can enhance the activation time by means of imposing microstrains and dislocation densities and thereby, facilitating the diffusion of hydrogen atoms into the crystal structure of metals.
This work conducted an analysis to compare three methods of mechanochemical synthesis techniques for the enhancement of the kinetics of hydrogenation. High Pressure Torsion Extrusion (HPTE) as a new technique, has been recently developed for the synthesis of metals and alloys. Cold rolling (CR) and ball milling, the other conventional methods have been also widely used to synthesize the materials for different purposes, and they were implemented here to compare the effectiveness of the new technique. As-received samples of niobium were synthesized by CR for 1, and 10 passes, another group was synthesized by ball milling for 30 minutes, 1 hour, and 3 hours, and finally the other group was extruded through the HPTE die for one pass. Thereafter, the samples were exposed to hydrogen for one day in a Sievert apparatus. Except for ball-milled samples, the other two groups of samples were in bulk shapes in the form of small chunks. Results of XRD analysis showed that all techniques imposed large amounts of microstrains and dislocation densities on the materials. Results of hydrogenation revealed that all ball-milled samples could absorb the hydrogen very fast only within the first 300 sec of exposure to the hydrogen gas although they could not reach the full capacity of hydrogen absorption. On the other side, the HPTE and cold-rolled samples reached the full capacity of hydrogen sorption but within a longer time of activation. The HPTE sample required ~6 hours to reach the full capacity and the CR sample after 10 passes of rolling needed 17 hours to reach the capacity; the CR sample after 1 pass was not able to reach its full capacity within one day though partially activated. The reason for the drastic change between the activation time of ball-milled samples and the other two techniques was related to the fact that ball-milled samples were turned to powders after the synthesis and thereby, having a much higher ratio of surface to volume as compared to the other two groups of samples. As a result, the diffusion of hydrogen atoms to the powder was much faster. Nonetheless, the reduction of the capacity in ball-milled samples was due to the fact that the ball milling process was performed in the atmosphere and therefore, the surface was oxidized and thereby, limiting the capacity of the material for the hydrogen uptak, whereas the HPTE and CR processing allowed the samples to reach the full theoretical capacity. In the final analysis, ball milling and cold rolling both have limitations in the activation of metal hydrides. The former technique limits the capacity of the material due to surface oxidation and requires an inert atmosphere and special equipment to avoid this issue, and the latter one requires several passes of rolling in order to impose enough microstrains on the material and to enhance the activation time. HPTE, on the other hand, was able to impose large amounts of strains and dislocation densities on the material just in one pass of extrusion, and hence, facilitated the absorption of hydrogen without limiting the capacity. This comparison can confirm the efficiency of the new technique and its productivity for the synthesis of bulk metal hydrides to be used in mobile and stationary applications in reversible hydrogen storage systems, namely indoor vehicles such as forklift trucks or Nickel-metal hydride ($Ni\text{-}MH_x$) batteries.

Keywords: Solid-state hydrogen storage, mechanochemistry, microstructure.

Acknowledgement: Estonian research council grant (PUTJD1010), and MSCA-COFUND-UNA4CAREER (Grant No. 847635)

Proceedings of the 14th International Green Energy Conference
IGEC2022-125
July 4-8, 2022

ELECTRODEPOSITION OF PLATINUM ON CARBON PAPER AS AN EFFICIENT AND DURABLE SELF-SUPPORTING ELECTRODE FOR METHANOL AND AMMONIA OXIDATION REACTIONS

Xingchen Wang, Meihui Tan, Huaneng Su, Qian Xu, Weiqi Zhang*
Institute for Energy Research, Jiangsu University,
Zhenjiang 212013, China
E-mail: zwq1586@ujs.edu.cn

ABSTRACT

Platinum nanoparticles (Pt NPs) supported on carbon (Pt/C) are commonly used as the electrocatalyst for oxidation of a variety of important molecules including methanol and ammonia. For practical applications of Pt/C in direct methanol fuel cell and direct ammonia fuel cell, Pt/C is mixed with polymer binder and deposited on a conductive carbon paper (CP) as the anode/cathode by a traditional spray method. It results in a waste of Pt electrocatalyst during deposition process and a reduced electrochemically surface area (ECSA) due to the coverage of polymer binder on a part of Pt active sites. Additionally, the introduction of insulating polymer binder will increase the interfacial resistance and hinder the fast electron transport required for electrocatalysis. Furthermore, the degradation of Pt NPs such as detachment, migration and agglomeration is prone to occur because of the weak interaction between Pt NPs and carbon support. In order to solve the problems, square-wave potential (SWP) electrodeposition method was employed in this study for electrode preparation. Compare with traditional preparation method, SWP electrodeposition enables direct growth of Pt NPs on CP without any binder, and it is possible to prepare self-supporting electrodes (SSEs) with controllable Pt morphology by optimizing multiple parameters, such as upper potential (E_U), lower potential (E_L), time, frequency, and so on. The electrocatalytic activity and durability of prepared SSEs toward methanol oxidation reaction (MOR) and ammonia oxidation reaction (AOR) were investigated.

SWP electrodeposition and all electrochemical measurements were carried out in a typical three-electrode electrochemical cell, including a Pt foil as counter electrode, a saturated calomel electrode (SCE) as reference electrode and CP or CP with electrodeposited Pt as working electrode. SWP electrodeposition was conducted as follows: A Pt precursor (250 mM H_2PtCl_6 + 0.5 M H_2SO_4) was rapidly reduced at the nucleation potential of −1.3 V for 0.2 s and formed crystal nucleus on the surface of CP; The potential jumped between E_L and E_U (0.75 V) repeatedly at a frequency of 10 Hz for 10 min.

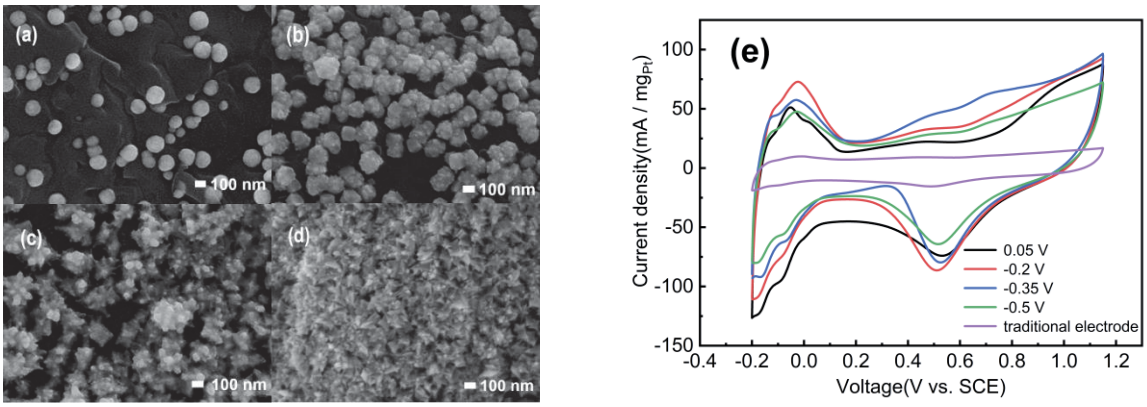


Fig.1.SEM images of SSEs prepared at different E_L (a) 0.05 V, (b) -0.2 V, (c) -0.35 V and (d) -0.5 V. (e) CVs of SSEs and traditional electrode with Pt black recorded in N_2-saturated 0.5 mol L^{-1} H_2SO_4 solution at a scan rate of 50 mV s^{-1}.

Fig. 1 shows that when E_L was negatively shifted from 0.05 V to -0.5 V, the shape of Pt NPs changed from smooth sphere to sharp thorn. The cyclic voltammetry (CV) tests were carried out for comparing the ECSAs of prepared SSEs and traditional electrode. Notably, all ECSAs of prepared SSEs are much higher than that of traditional electrode, indicating the increased efficiency of Pt utilization. Especially, ECSA of SSE with the E_L of -0.2 V gained 83.3 m^2 g_{Pt}^{-1}, almost four times of the ECSA of traditional electrode (22.3 m^2 g_{Pt}^{-1}). Subsequently, MOR and AOR measurements were conducted and the results demonstrates that both of electrocatalytic activity and durability of SSE with the E_L of -0.2 V are much superior than traditional electrode. This work proposes new strategy for developing highly efficient and durable Pt electrocatalysts and it is promisingly used in the practical fuel cells.

Keywords: Pt electrocatalysts, durability, self-supporting electrode, square-wave potential electrodeposition, methanol and ammonia oxidation reactions.

Proceedings of the 14th International Green Energy Conference
IGEC2022-126
July 4-8, 2022

Performance analysis of a reversible solid oxide cell system using steam as the sweeping gas in electrolysis and pure O2 as oxidant in fuel cell mode.

Nan Zheng
Zhejiang University
22127070@zju.edu.cn

ABSTRACT

Reversible solid oxide cell (rSOC) can flexibly switch between the electrolysis mode and fuel cell mode for electricity energy storage and power generation. To further increase its efficiency and cost-effectiveness, herein, we develop a multi-physics rSOC model by using steam as the sweeping gas in electrolysis and pure O2 as the oxidant in fuel cell mode. The specific working process of the system is shown in Figure 1. With the supplement of fluctuating photovoltaic power, rSOC can electrolyze H_2O from 6:45 a.m. to 5:45 p.m. and generate electricity in the night. During the period with identical operating voltages, the proposed system can utilize 79% more electricity power due to a smaller oxygen evolution resistance. Moreover, the electrolysis efficiency and the H2 production rate are increased by 4.2% and 120%, respectively. In addition, the power density is increased by 60% in fuel cell mode, total power generation capacity is increased by 5.9 times. This study can provide guidance for the optimization of hydrogen production, pure oxygen production and power generation performance of reversible solid oxide cell system.

Keywords: reversible solid oxide cell; fluctuating photovoltaic power; hydrogen production.

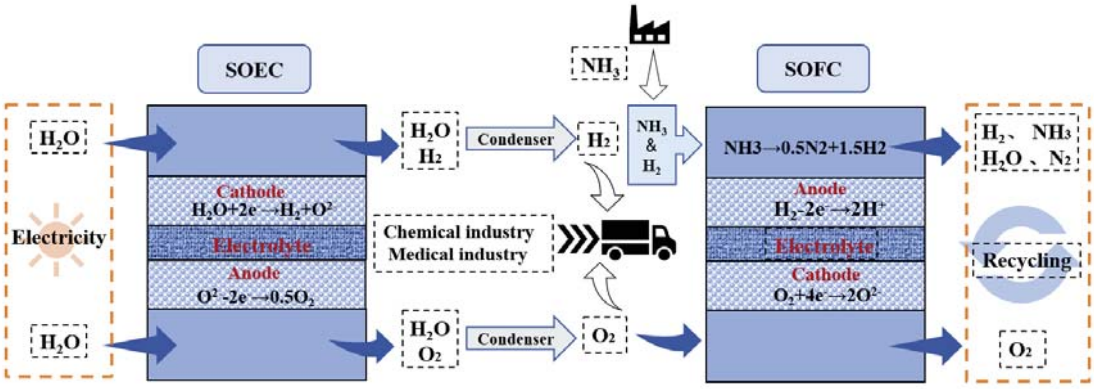


Figure.1

Proceedings of the 14th International Green Energy Conference
IGEC2022-127
July 4-8, 2022

ESTIMATION OF INCREASING THE SOLAR-BASED HYDROGEN PRODUCTION IN TROIS-RIVIÈRES

Ashkan Makhsoos[1], Mohsen Kandidayeni[2], Loïc Boulon[1], Bruno G. Pollet[1,3]*
1-Institute for Hydrogen Research Université du Québec à Trois-Rivières Trois-Rivières, Canada
2- Department of Electrical and Computer Engineering, University of Sherbrooke
3- GreenH2Lab, Institute for Hydrogen Research, Department of Chemistry, Biochemistry and Physics
*Ashkan.Makhsoos@uqtr.ca

ABSTRACT

The proton exchange membrane water electrolyzer (PEMWE) is the most viable hydrogen production method from renewable energy sources (RESs). However, the efficiency of PEMWE widely varies, encountering different amounts of input currents. In addition to efficiency, intermittent input affects the durability of PEMWE and causes its cell to erode. In this direction, hybrid energy sources with energy management are becoming more popular in hydrogen production. Hybrid energy sources include two or more supplements of electrolyzers, such as the battery, wind, and solar combined. This research evaluates efficient green hydrogen production from clean, accessible, and unlimited solar energy and anticipates the possible amount of solar power by employing machine learning techniques. The PEMWE feeding configuration is analyzed to determine the most profitable feeding configuration. First, available energy is experimentally collected by a photovoltaic (PV) panel. Then an empirical PEMWE model is nominated, and the hydrogen output in the standard scenario is calculated. Afterward, the PEMWE feeding pattern is equipped with a battery, and its current is controlled. Finally, the results of different configurations are compared, and the continuous feeding seems to be more compelling.

Keywords: PEMWE, Solar Energy, Photovoltaic, Energy Efficiency.

Proceedings of the 14th International Green Energy Conference
IGEC2022-128
July 4-8, 2022

COMPUTATIONAL DESIGN AND EXPERIMENTAL REALIZATION OF ZN-DOPED $LaNi_{0.6}Fe_{0.4}O_{3-\delta}$ SOLID OXIDE FUEL CELL AIR ELECTRODE TO ENHANCE PERFORMANCE AND LONG-TERM DURABILITY UNDER CR-POISONING CONDITIONS

Sanaullah Qamar[a,b,1], Saeed Ur Rehman[a,1], Hye-Sung Kim[a], Hafiz Ahmad Ishfaq[a,b], Rak-Hyun Song[a,b], Tak-Hyoung Lim[a,b], Seok-Joo Park[a,b], Dong-Woo Joh[a], Kyunghan Ahn[c*], Seung-Bok Lee[a,b*]

[a] *High Temperature Energy Conversion Laboratory, Korea Institute of Energy Research, 152 Gajeong-ro, Yuseong-gu, Daejeon 34129, Republic of Korea*

[b] *Department of Advanced Energy and Technology, University of Science and Technology, 217 Gajeong-ro, Yuseong-gu, Daejeon 34113, Republic of Korea*

[c] *School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon 16419, Republic of Korea*

sanaullahqamar002@hotmail.com

ABSTRACT:
Chromium poisoning rapidly deteriorates the performance of solid oxide fuel cell (SOFC) cathode materials such as $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ and $La_{0.6}Sr_{0.4}CoO_3$ that otherwise show superior oxygen reduction kinetics. Previously, $LaNi_{0.6}Fe_{0.4}O_3$ (LNF) has exhibited excellent stability towards chromium-poisoning. However, it demonstrates relatively low electrocatalytic activity. Here we address this problem by advising a substitution strategy via *ab initio* first-principles calculations to boost the electrochemical performance of LNF by promoting oxygen-vacancy generation. The density functional theory (DFT) outcomes have suggested that the charged oxygen-vacancy defect formation energies of Zn-doped LNF (2.07 eV for $La_8Ni_5Fe_2Zn_1O_{24}$ and 1.83 eV for $La_8Ni_4Fe_3Zn_1O_{24}$) are lower than those of undoped LNF (2.92 eV for $La_8Ni_5Fe_3O_{24}$). To consolidate the DFT results various Zn-doped LNF materials are synthesized where $LNFZ_3$ (3mol% Zn-doped LNF) has demonstrated the highest kinetics for oxygen reduction. $LNFZ_3$ shows a 25.4% decrement in polarization resistance and a 52.3% increment in the maximum power density of an anode-supported SOFC compared to LNF when operated at 700 °C. Moreover, $LNFZ_3$ shows minimum degradation during a 300 h intense chromium-poisoning stability test conducted at 700 °C. The synergy of high performance and good stability makes the newly developed $LNFZ_3$ cathode a promising candidate for scale-up and further commercial validation studies.

Keywords: Solid oxide fuel cells, Perovskite, Cathode, Cr-poisoning, $LaNi_{0.6}Fe_{0.4}O_3$, Oxygen reduction reaction.

Proceedings of the 14th International Green Energy Conference
IGEC2022-129
July 4-8, 2022

ANALYSIS OF MODIFIED CO_2 BASED COMBINED POWER AND EJECTOR-EXPANSION REFRIGERATION CYCLE WITH DUAL EVAPORATORS ACTIVATED BY ENGINE EXHAUST HEAT

Yan zhu[1, 2 *], Mingzhang Pan[2, 3 *], Zongrun Wang[2], Youcai Liang[1, #]
1 School of Electric Power Engineering, South China University of Technology, Guangzhou 510640, China
2 Guangxi Key Laboratory of Manufacturing System & Advanced Manufacturing Technology, School of Mechanical Engineering, Guangxi University, Nanning 530004, China
3 Guangxi Key Laboratory of Petrochemical Resource Processing and Process Intensification Technology, Guangxi University, Nanning 530004, China
* These authors contributed equally to this work and should be considered co-first authors.
# Corresponding author: E-mail address: liangyoucai@scut.edu.cn

ABSTRACT

Considering the outstanding physical properties, CO_2 based combined power and refrigeration cycle has been widely investigated for waste heat recovery recently. With the rapid development of cold chain logistics, the requirement for transporting fresh and frozen goods in the same batch increasingly grows. In this research, a combined system consisting of a supercritical CO_2 Brayton cycle (sCO_2 cycle) and an ejector-expansion refrigeration cycle with dual evaporators is presented with the aim to harness the engine exhaust heat effectively. The throttling loss that occurs in expansion valves can be recovered more thoroughly by using two ejectors. For combined power, refrigeration, and freezing mode (mode 1) and combined refrigeration and freezing mode (mode 2), a comparative analysis is performed between the original cycle (Pan et al., 2021) and the proposed cycle under the basic operating condition to investigate the improvement in thermodynamic and economic performance of the proposed cycle. Afterwards, the influences of several key parameters on system performance under mode 2 with maximum cooling output are revealed. Furthermore, multi-objective optimization is carried out under different cases with different lengths of the freezing zone. The results show that the exergy efficiency under mode 1 and mode 2 of the proposed system are improved by 0.57% and 10.22%, respectively, at the expense of an increase of 1726 $ in investment. And the sum unit cost of product and dynamic payback period are reduced by 7.72% and 11.38%, respectively. Besides, the system with longer length of the freezing zone performs better in exergy efficiency and sum unit cost of product under mode 2, but the dynamic payback period shows a reverse trend for lower total cooling output. In the optimized condition, the system can provide 18.791 kW for the refrigerated zone and 33.804 kW for the freezing zone when the length of the freezing zone is 4.8 m, whose exergy efficiency and sum unit cost of product are 16.954% and 108.64 $/GJ, respectively. And the corresponding dynamic payback period is about 4.994 years.

Keywords: waste heat recovery, supercritical carbon dioxide, power and refrigeration cycle, refrigerated truck applications.

Proceedings of the 14th International Green Energy Conference
IGEC2022-131
July 4-8, 2022

OPTIMIZATION OF SYNTHESIS OF ACTIVATED CARBON DERIVED FROM PREACH STONES

Souha Harabi, Sami Guiza, Mohamed Bagane
University of Gabes, National School of Engineers of Gabes, Laboratory of Applied Thermodynamic LR18ES33, 6029, Gabes, Tunisia;
souhaharrabi20@gmail.com

ABSTRACT

This study aims to synthesize activated carbon (chemical activation with phosphoric acid, 50%) from a lignocellulosic precursor (peach stones). Indeed, the central composite design (CCD) of response surface methodology (RSM) was developed to minimize the number of experiences and determine the effect of four factors on the yield. The main operating parameters that have been undertaken for the present analysis are respectively; an impregnation time ranging between 3h30 to 4h30, impregnation rate [5;6], and the carbonization temperature interval starting from 400 °C to reaching 600°C for a duration of 3h30 to 4h30.
The ANOVA analysis results reveal a good agreement between the quadratic model predictions and the experimental values, with an R2 of 0.9901. For a carbonization temperature of 400 °C, a carbonization time of 4 h30, an impregnation time of 6 h, and an impregnation rate of 3.5, the best point was determined with a yield of 69.52 %.

Keywords: activated carbon, peach stones, CCD, optimization.

Proceedings of the 14th International Green Energy Conference
IGEC2022-132
July 4-8, 2022

PARAMETRIC STUDY AND THERMODYNAMIC EVALUATION OF A SOLAR LITHUIM BROMIDE WATER ABSORPTION COOLING SYSTEM DESIGNED FOR THE BUILDING SECTOR

Abdelmajid Saoud [1], Yasmina Boukhchana [1], and Ali Fellah[2]
[1] University of Gabes, National School of Engineers of Gabes, Laboratory of Applied Thermodynamic LR18ES33, 6029, Gabes, Tunisia;
[2] University of Gabes, Higher Institute of Applied Sciences and Technology of Gabes, Laboratory of Applied Thermodynamic LR18ES33, 6029, Gabes, Tunisia
Abdelmajidsaoud17@gmail.com; boukhchana.yasmina@gmail.com; al.fellah@gmail.com

ABSTRACT
The building sector is one of the most energy-intensive. It accounts for around 40% of the worldwide energy consumption. Meanwhile, heating and cooling loads appear to be the primary drivers. In this regard, solar cooling is an intriguing alternative that could address this erratic amount of consumption because the peaks in cold and heat demand typically coincide with an abundance of solar radiation.
An assessment of an energy-based single-effect lithium bromide water absorption chiller (SE ACH) for cooling and heating is presented in this paper. Energy, enthalpy, temperature, mass flow rate, and heat rate are all evaluated in each component of the chiller. This cycle simulation is based on a condensation temperature range of 30 to 40 °C and five evaporation temperatures ranging from 4.5°C to 12.5°C with a temperature step of 2°C. The temperature range of the generator will be modified to be within acceptable limits. Another significant parameter being explored is (the solution heat exchanger, and the solution concentration).
The major findings of this study show that the heat rate in both the generator and the absorber is larger than in the condenser and evaporator, which may be explained by the presence of heat mixing in the solution, which is not the case for pure fluids. Furthermore, the overall performance (COP) of the chiller is found to rise with evaporator temperature. Despite this, COP decreases when the condenser and absorber temperatures fall.
The system is evaluated, numerically, under steady-state conditions using Engineering Equation Solver (EES) software.

Keywords: Energy analysis, LiBR-H2O, solar cooling, absorption chiller, COP, EES

Proceedings of the 14th International Green Energy Conference
IGEC2022-133
July 4-8, 2022

HEAT PUMP INTEGRATED THERMAL MANAGEMENT SYSTEM IN FUTURE ZERO-EMISSION VEHICLES

Nan Zhang, Yiji Lu *, Zahra Hajabdollahi Ouderji, Andrew McKeown, Zhibin Yu *
James Watt School of Engineering, University of Glasgow, Glasgow G12 8QQ, UK
Email address: yiji.lu@glasgow.ac.uk,zhibin.yu@glasgow.ac.uk,

ABSTRACT
The regulations aiming to reduce greenhouse gas emissions by 2030 to keep global warming below 1.5℃ require the world to speed up the phase-out of fossil-fuels-based vehicles. The transportation sector will turn dramatically to full electric (battery or fuel cell) under the current planned strategy. However, the thermal management problem of electric vehicles in a cold and hot climate can largely limit their driving range such as HVAC driven cabin thermal management issues and battery thermal management problems. In this paper, a review of advanced electric vehicle thermal management systems is introduced. First, the latest battery thermal management systems in terms of different operating conditions are provided. Afterwards, the heat pump assisted integrated thermal management system including cabin and battery thermal management is reviewed with regard to performance and intelligent control logic. This review aims to identify the importance of heat pump technology in EVs and to bridge the research gap between integrated vehicle thermal management and separate thermal management system.
Keywords: Heat pump, Integrated electric vehicle thermal management system, Extreme fast charging and discharging

Proceedings of the 14th International Green Energy Conference
IGEC2022-135
July 4-8, 2022

HOW TO PROMOTE ENERGY ENTERPRISES IN DIFFERENT REGIONS TO PARTICIPATE IN CHINA'S CARBON TRADING MARKET：AN EVOLUTIONARY GAME MODEL

*Dongxu Chen[a], Ran Wu[b], Tao Ma[c]**
School of Management, Harbin Institute of Technology
92 xidazhi street, Nangang District, Harbin, Heilongjiang, China
a: 18b910049@stu.hit.edu.cn
b: raynawu@163.com
c*: (Corresponding author), matao@hit.edu.cn

ABSTRACT
At present, China is at a critical moment of transition from a regional carbon emission trading market (CETM) to a national market. In the process of participating in the national CETM, due to the difference of regional characteristics, the trade-off between carbon emission reduction and regional economic growth makes the policy choices of regional governments show the characteristics of differentiation. Therefore, it is of great significance to analyze the strategic choices of different local governments and energy enterprises in participating in the national CETM and its influence mechanism for the construction of the national CETM. This paper constructs an evolutionary game model between local governments and energy enterprises in the national CETM. The Kaya identity is extended and embedded into the game model to decompose the impact of regional characteristics. According to the actual situation of China's regional economic development and the operation of the national CETM, through numerical simulation, this paper analyzes the strategic choice of different local governments and energy enterprises participating in the national CETM, and demonstrates the impact of regional characteristics on the strategic choice. The results show that the industrial structure, energy consumption intensity and energy structure in a region have a negative impact on the willingness of local governments to issue support policies. The free carbon quota allocated to energy enterprises and the benefits from policies have a positive impact on energy enterprises' participation in the national CETM. And the carbon emissions of energy enterprises have a negative impact on energy enterprises' participation in the national CETM. According to the research results, this paper puts forward suggestions for more regions and energy enterprises to participate in the national CETM. The formulation of carbon emission reduction policies by local governments should take full account of regional characteristics. local governments can give corresponding tax incentives and subsidies to energy enterprises that join the national CETM, At the initial stage of the development of the national carbon trading market, local governments can appropriately increase the carbon quota allocated free of charge.

Keywords: Carbon emissions trading market, Energy enterprises, Local government, Evolutionary game model.

Proceedings of the 14th International Green Energy Conference
IGEC2022-136
July 4-8, 2022

N-DOPED BLOCK COPOLYMER-DERIVED CARBON SUPPORT SYNTHESIZED BY AMMONIA ASSISTED FOR OXYGEN REDUCTION REACTION IN POLYMER ELECTROLYTE MEMBRANE FUEL CELLS

Yi Yang[1,2], Chenglin Zhao[1,3], Zhida Wang*[,1], Changfeng Yan*[,1,2,3]

[1] Hydrogen Production and Utilization Group, CAS Key Lab of Renewable Energy, Guangdong Key Lab of New and Renewable Energy Research and Development, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou, China, 510640.
[2] University of Chinese Academy of Sciences, Beijing, China, 100039.
[3] Nano Science and Technology Institute, University of Science and Technology of China, Suzhou China, 215123.

E-mails: wangzd@ms.giec.ac.cn, yancf@ms.giec.ac.cn

ABSTRACT
Block copolymer is a kind of promising precursor to design ordered mesoporous carbon (OMC) material due to its accessibility and controllability. But since introducing heteroatoms will influence the self-assembly process, its application has been limited. Herein, we develop an ammonia assisted pyrolysis method to deposit N atoms and build C-N bonds during the block copolymer degradation stage. The resulting N-OMC exhibits a well-ordered mesoporous structure and excellent thermal stability. N-doping leads to rich defect structure and the N content is up to 6.93 at.% with 21.91 at.% pyridinic N and 58.02 at.% graphitic N. Therefore, after loading PtCo nanoparticles, N-OMC represents high oxygen reduction reaction activity with a notable half-wave potential and Tafel slope of 0.875 V_{RHE} and 24.15 $mV \cdot dec^{-1}$, respectively, which is also confirmed by theory calculation. After the accelerated degradation test the $E_{1/2}$ and ECSA decayed only by 1.58% and 14.86%, respectively, showing great stability. The confinement of the N-doped mesoporous structure can avoid particle aggregation, while defects can enhance the electrocatalysis ability. This work gives a new strategy to introducing N into block copolymer-derived carbon and demonstrates that N-OMC is ideal support in the fuel cell application.

Keywords: N-doped, Block copolymer-derived carbon, Ordered mesoporous carbon, Ammonia assisted pyrolysis, Oxygen reduction reaction.

Proceedings of the 14th International Green Energy Conference
IGEC2022-137
July 4-8, 2022

LITHIUM-ION BATTERY MULTI-FAULT DIAGNOSIS VIA TRANSFER LEARNING-BASED LONG SHORT-TERM MEMORY AND CONVOLUTIONAL NEURAL NETWORKS

Chukwuemeka Nelson Nwauche, Xianke Lin*
Department of Automotive and Mechatronics Engineering, Ontario Tech University, Oshawa, Ontario L1G 0C5, Canada
xianke.lin@IEEE.org (Xianke Lin)

ABSTRACT
Fault detection in lithium-ion batteries (LIBs) is paramount to ensuring the long life and proper functioning of the batteries. To that end, this paper proposes a combined LSTM(Long Short Term Memory)-CNN(Convolutional Neural Network) fault diagnosis framework that leverages voltage fault residuals to accurately detect multiple faults within a LIB during partial and full charging regimes. This framework removes the need for expert knowledge and parameter tuning, which in turn allows for widespread adoption. The framework is also adaptable to varying battery chemistries and performs well with a small amount of available data. The framework leverages voltage residuals generated via a randomly initialized or pre-trained LSTM model. Experimental results show its ability to accurately detect the different types of faults utilizing full voltage charging curve residuals with an accuracy of 95%. The framework can also detect faults utilizing partial voltage charging curve residuals & a pre-trained LSTM model with an accuracy of 94%.

Proceedings of the 14th International Green Energy Conference
IGEC2022-138
July 4-8, 2022

LI-ION BATTERY ANODE POTENTIAL MONITORING AND CHARGING OPTIMIZATION USING BATTERY CASING AS REFERENCE ELECTRODE

*Md Ashikur Rahman, Xianke Lin**
Department of Automotive and Mechatronics Engineering, Ontario Tech University
Oshawa, ON L1G 0C5, Canada
* Corresponding author: xiankelin@ieee.org

ABSTRACT
Lithium-ion battery (LIB) internal state such as state of charge (SOC), electrode capacity, and available lithium-ion monitoring is helpful for effective battery degradation monitoring. Monitoring these internal parameters is challenging due to the weak observability of the electrode parameters, such as the electrode potential. A reference electrode can be helpful to measure the electrode potential, which can provide information about the battery's internal states. Therefore, monitoring and optimizing the electrode potential through charging optimization is crucial. This paper presents a novel three-electrode battery setup approach using battery casing for anode potential monitoring and optimization. First, a novel reference electrode setup is discussed using the battery casing as the third electrode. Second, a curve matching algorithm is presented to extract anode potential data by comparing it to the standard graphite potential. Finally, a method is presented to monitor the anode potential change and optimize it through battery charging optimization for a stable electrode potential throughout the charging duration. The proposed reference electrode setup has way less impact on cell degradation than the existing reference electrode setup methods. In contrast, the proposed method is practically feasible when it comes to real-time electrode potential monitoring and optimization.

Keywords: Lithium-ion battery, three-electrode cell, electrode potential, reference electrode setup.

Proceedings of the 14th International Green Energy Conference
IGEC2022-139
July 4-8, 2022

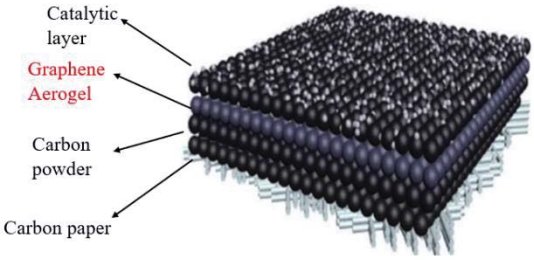
EFFECT OF GRAPHENE AEROGEL DOUBLE MICROPOROUS LAYER ANODE ON DIRECT METHANOL FUEL CELL

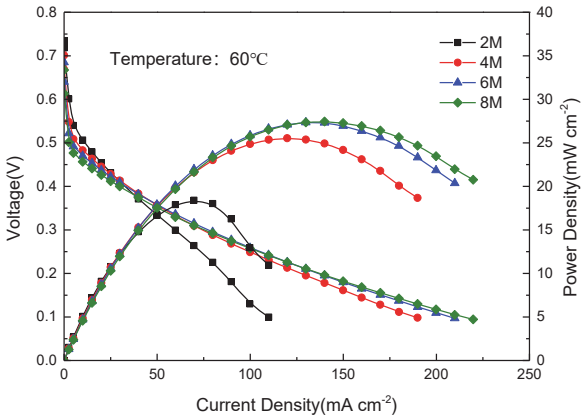
Li Guan, Weibin Yu, Huiyuan Liu, Qian Xu*
Institute for Energy Research, Jiangsu University,
Zhenjiang 212013, China
E-mail: xuqian@ujs.edu.cn:

ABSTRACT

Direct methanol fuel cells (DMFCs) utilize methanol instead of hydrogen as fuel supply, and have been considered anpromising candidate for the power source of portable electronic devices due to the simple structure, high energy density and easy fuel storage. However, performance decay of DMFCs at high concentrations of methanol remains a problem. In this work, we used graphene aerogel to prepare double microporous layer anode. The outer layer is, the inner layer is graphene aerogel. The performance of the double microporous layer electrode under different methanol concentrations was tested. It can be seen from the polarization curve that the performance at 8M methanol concentration achieved 27.45 $mW \cdot cm^{-2}$, with large improvement compared with traditional electrodes. After the introduction of graphene aerogel, the tortuosity of the microporous layer is increased, which increases the methanol transport resistance and reduces the concentration reaching the catalytic layer. The viability of graphene aerogel electrodes for energy storage applications is highlighted.

Keywords: DMFC, graphene aerogel, methanol crossover





Proceedings of the 14th International Green Energy Conference
IGEC2022-141
July 4-8, 2022

A techno-economic survey on waste heat recovery options for UK glass sector

Narges H. Mokarram, Zhibin Yu, Muhammd Imran

Devision of systems, power and energy, University of Glasgow, Glasgow, UK.

School of Engineering and Technology, Aston University, Birmingham, UK.

Abstract:

Three heat recovery cycles studied to recover the waste heat from the exhaust gases outlet of a glass melting furnace. The exhaust gas as the heat source provides the thermal energy to run the combined cycle. Thermodynamic and techno-economic parameters are investigated based on the considered working conditions. A parametric study reveals the effects of some key parameters. Three thermodynamic parameters (Power production, energy and exergy efficiency), as well as five techno-economic parameters (LCOE, NPV, PP, IRR, MOIC). The results showed that ORC is the best possible option or low temperature waste exhaust gases as it is not as expensive as other ones, while super-critical CO_2 has the highest power production to produce power from high temperature waste heat sources.

Keywords: economic; efficiency; Glass sector; Waste heat recovery.

Proceedings of the 14th International reen Energy Conference
IGEC2022-143
July 4-8, 2022

EXPERIMENTAL STUDY ON LOW PLATINUM LOADING HYDROPHILIC-HYDROPHOBIC DUAL CATALYST LAYER AT THE CATHODE OF PEMFC

Jiao Han, Zixuan Wang, Chasen Tongsh, Bowen Wang , Linhao Fan*, Fuqiang Bai*, Kui Jiao
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin, China, 300350
*Corresponding author emails:lhfan@tju.edu.cn (L. Fan);bbfq@163.com (F. Bai)

ABSTRACT

To facilitate the commercialization of fuel cells, using low-Platinum loading membrane electrode assembly (MEA) is an effective solution for cost reduction. The effect of I/C ratio on cell performance in a single catalyst layer is investigated and a new type of hydrophilic and hydrophobic dual catalyst layer is proposed and tested. The hydrophilic inner layer consists of catalyst and Nafion while the hydrophobic outer layer consists of polytetrafluoroethylene (PTFE), catalyst and Nafion. The results show that the single catalyst layer prepared with an I/C ratio of 0.67 has the highest peak power density. Compared with the conventional catalyst layer, the output power density of the hydrogen/air proton exchange membrane fuel cell with a novel catalyst layer is as high as 687 mW cm^{-2}, with a maximum power density improvement of about 8.3%, under the condition that the inner and outer Pt distribution is 7:3 and PTFE content of the hydrophobic outer layer is 10 wt.%. The results also reveal that the mass transfer performance of the novel MEA can be effectively improved.

Keywords: Proton exchange membrane fuel cell; Dual catalyst layer; Low platinum loading; PTFE; Transfer impedance

Proceedings of the 14th International Green Energy Conference
IGEC2022-144
July 4-8, 2022

POTENTIAL OF THERMALLY DRIVEN REFRIGERATOR USING SINGLE ROTOR EXPANDER-COMPRESSOR DEVICE

Saif Alshammari, Sambhaji T. Kadam, Zhibin Yu
James Watt School of Engineering, University of Glasgow
James Watt South Building, University of Glasgow, Glasgow G12 8QQ
S.Alshammari.1@research.gla.ac.uk, Sambhaji.Kadam@glasgow.ac.uk, Zhibn.Yu@glasgow.ac.uk

ABSTRACT
In this paper, a heat driven cooling system that essentially integrated an organic Rankine cycle power plant with a vapour compression refrigerator (ORC-VCR) utilizing the new single rotor expander-compressor was investigated. The aim is to study the potential of the combined cycles using this new device using numerical simulation. The ORC utilized thermal energy from hot water at 95 °C to produce power to drive the VCR. Feasibility of the device in the ORC-VCR and comparison on the system performance are presented based on the heat to cooling and overall exergy efficiencies. At 1000 rpm shaft speed, the system can produce cooling effects up to 1.9 kW and the highest Heat to cooling and overall exergy efficiencies were 63% and 10%, respectively.

Keywords: ORC, ORC-VCC, refrigeration.

Proceedings of the 14th International Green Energy Conference
IGEC2022-145
July 4-8, 2022

COMPARATIVE ANALYSIS OF THE ENERGY SOURCES FOR SUPPLYING THE HOUSES

Dr. Daniel Rohacs
Department of Aeronautics and Naval Architecture, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics
H-1111 Budapest, Hungary
Correspondence: rohacs.daniel@kjk.bme.hu

ABSTRACT

Recently, the major and ambitious objective of the policymakers, make the world cleaner and carbon neutral. The economy accepts, and society agrees with these goals. However, several dilemmas are appearing in the realization of such programs. One of the critical problems is to evaluate and select the best energy source and supplying energy mix. Such a problem is known by householders, too.
The lecture provides a methodology based on the life cycle cost and environmental impact analysis as well as a total sustainable performance index for evaluation of the different energy sources such as electric grids, solar energy, wind energy, using the geothermal energy, and energy generation by implementing the fuel or hydrogen cells, etc. including the co- and three-generation, and energy mix generation. The possible energy storage and energy-saving energy management include isolation, energy recovery, aeration, and shielding.
The proposed total sustainable performance index is the total (all the contributed and associated) cost or environmental impact (as equivalent greenhouse gas emission) related to a year (of operation). In this approach, an essential input element is the availability of the given energy source and the house's location.
The methodology has been applied in comparative analysis of the named energy sources supplying the houses depending on estimated energy demand. The major results show that

i. the realized effective mix of energy sources may include 2 or 3 types of energy sources, available at the location of the house, not more;
ii. the individual house energy supply system should have a special energy management system controlling the energy mix generation and energy saving depending on sensing / measuring the real and actual energy demand,
iii. the house energy supply system should be connected with the energy supply chains of (neighbor) houses and/or with the energy grid.

The result of this research may support the designer in selecting and optimizing the possible energy sources available on the given land around the houses. The results might be upsized to larger buildings, and the methodology can be applied to large buildings and districts.

Keywords: house energy demand, energy supply, energy mix, life cycle cost/impact analysis,

Proceedings of the 14th International Green Energy Conference
IGEC2022-146
July 4-8, 2022

A BATTERY STATES MONITORING METHOD BY APPLYING BATTERY EQUIVALENT MODEL, DEEP LEARNING AND TRANSFER LEARNING

Shaosen Su[a], Akhil Garg[a,*], Wei Li[b], Jianhui Mou[c], Liang Gao[a]
[a] State Key Lab of Digital Manufacturing Equipment & Technology, School of Mechanical Science and Engineering, Huazhong University of Science and Technology, Wuhan, 430000, China
[b] College of Mechanical and Vehicle Engineering, Chongqing University, Chongqing, 400040, China
[c] School of Mechanical, Electrical and Automotive Engineering, Yantai University, Yantai, 264005, China
* Corresponding author's e-mail address: akhil.nitrkl2010@gmail.com

ABSTRACT

Lithium-ion batteries are the main energy storage units of electric devices. The accurate estimation of their state of health (SoH) is significant to improving the reliability and safety of batteries in operation, which has become a hot point in battery management research. However, many existing studies are conducted on the premise of sizeable labeled training data acquisition without considering the time cost and experimental materials consumed by collecting such data set in actual application. Therefore, this work proposes a capacity prediction method based on the battery equivalent circuit model, deep learning, and transfer learning, which applies the simulation data for unsupervised learning of the actual capacity. Firstly, the high-fidelity battery equivalent model consisting of a second-order RC equivalent circuit and two-state thermal model is established, which needs a parameter identification experiment consuming less time and experimental materials. A charge-discharge simulation experiment including constant current constant voltage charging and constant current discharge is carried out based on the generated battery model to obtain the virtual data. Secondly, an actual experiment is conducted to obtain the actual data of the corresponding charge and discharge process. Then, the performances of the feature extraction networks selected from the existing research are compared via NASA data, previous work data and the obtained actual data. The network with the ideal feature extracting performance is selected as the deep feature extractor used in the formation of the capacity estimation model. Finally, the transfer methods based on maximum mean discrepancy (MMD), correlation alignment (CORAL), generative adversarial network (GAN) and dynamic adversarial adaptation networks (DAAN) are selected to calculate the feature alignment metric between the virtual data and actual data, and form four capacity estimation models with the previously selected feature extractor and regressor, respectively. Performance comparison of these four models is conducted for the final selection of the capacity estimation models. The obtained virtual data is selected as the training datasets, and take the last 10%, 20% and 30% of the real data as the test data, respectively. Moreover, to show the necessity of the transfer learning method, a model built by using virtual data without transfer learning method is also established and used for performance comparison with the four models mentioned above. Results show that directly using virtual data to establish a model to predict the actual capacity of the battery will lead to significant estimation errors. The use of transfer learning method can significantly improve the performance of models. Compared with other calculation methods, the GAN-based transfer learning method can use the discriminator to compute the global feature alignment metric between the virtual data and the real data more efficiently. The capacity prediction model established using virtual data and the GAN-based transfer learning method has ideal prediction performance. It is an optional scheme for using the presented method for the unsupervised learning of battery capacity and the reduction of the experimental resource consumption and time cost.

Keywords: SoH estimation, Battery equivalent model, Deep learning, Transfer learning.

Proceedings of the 14th International Green Energy Conference
IGEC2022-147
July 4-8, 2022

EFFECT OF THE BURNER CAP GEOMETRY ON THE PERFORMANCE OF A DOMESTİC GAS STOVE: AN EXPERİMENTAL STUDY

Ben Atia Warda', Boutar Zouhaier', Halloumi Anouar' and Ennetta Ridha'
Mechanical Modeling, Energy and Material (M2EM), National School of Engineers of Gabes, University of Gabes, Zrig, Gabes, 6029, Tunisia.
e-mails: warda.benatia@enig.u-gabes.tn

ABSTRACT
Cooking is an important domestic activity that needs energy. Traditionally, solid fuels such as firewood and charcoal have been used. However, the combustion of solid fuels inside households causes internal pollution and harms the health of users and other occupants. Nowadays, gaseous fuels like natural gas (CNG) and liquefied petroleum gas (LPG) are the most used for domestic cooking. Considering the limitation of fossil fuels resources, energy conservation issues, environmental problems and the increase in demand for gaseous fuels, it is necessary to explore ways to improve the thermal efficiency and emission characteristics of existing cooking systems.
Although the use of gaseous fuels reduces domestic air pollution, the earliest domestic gas burnershave low heat performance with an efficiency value of approximately 40%.cContinuous research and developmenctin stove design and analysis has led to a significant improvementcin the thermal performance of commercial gas burners with efficiencies exceeding 60%.
This study main objective is to improve an LPG domestic stove through the modification of the cap burner geometry. The effects of various inclination angles (between the top and the lateral cap faces) ranging from 0° to 90°, have been experimentally investigated. Results demonstrated that the thermal efficiency of the burner increases with increasing inclination angle. The highest efficiency was obtained at an angle of 75° and beyond this value, the efficiency dropped. Unfortunately, at this angle value, CO emissions were the highest.

Keywords: Domestic gas stove, Burner cap, LPG, Efficiency, Pollutants emissions.

Proceedings of the 14th International Green Energy Conference
IGEC2022-150
July 4-8, 2022

PREPARATION AND OPTIMIZATION OF CARBON PAPER FOR PROTON EXCHANGE MEMBRANE FUEL CELL BASED ON NOVEL DISPERSANT

Yongqian Chen, Jinqiao Liang,Tongsh Cha, Kui Jiao, Qing Du, Bingfeng Zu, Zhi Liu*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin 300350, China
*Corresponding author emails: liuzhi16@tju.edu.cn

ABSTRACT
Proton exchange membrane fuel cell is considered as the preferred clean and efficient power generation technology in the 21st century because of its high energy conversion efficiency and no pollution. The gas diffusion layer is an important component of fuel cell, which acts as a support for catalyst layer and bipolar plate, a mass transfer channel for reaction gas and water generation, and an electric energy transmission bridge. High-performance carbon fiber paper is the most widespread substrate material for gas diffusion layer currently. The key problem in preparing carbon paper is to find suitable dispersant to optimize the carbon fiber from cluster to disperse. In the present paper, carbon paper precursors are prepared by wet forming technology, the influence of new dispersants on the dispersion effect of chopped carbon fibers in water is studied, and the carbon paper is prepared by impregnation-molding - graphitization method. Explore to join the amount of carbon fiber, carbon fiber length, carbon paper hot pressing pressure on carbon paper physical parameters and the output of the fuel cell performance and electrochemical impedance spectroscopy (EIS). It is found that the more carbon fiber content added, the lower the surface resistivity, which may be caused by the increase of conductive pathways. The porosity will decrease, and the output performance of the fuel cell will increase slightly, while the ohmic loss has insignificant influence. The increase of pressure during hot pressing will reduce the surface resistivity and porosity. The performance of fuel cells has been greatly improved. But the decrease of porosity will lead to water flooding at high current density stage, and the fuel cell output performance luctuates greatly. The shorter the length of the carbon fiber, the denser the network structure will form inside the carbon paper. The thickness and porosity of carbon paper decrease but the surface resistivity increases, and fuel cell output performance does not differ much. However, under low humidity conditions, carbon paper with shorter carbon fiber length has better fuel cell output performance. Changing the length of carbon fiber, the amount of carbon fiber and the pressure during hot pressing have no great influence on the hydrophilicity and hydrophobicity of carbon paper.

Keywords: Proton exchange membrane fuel cell; carbon paper preparation; Dispersant; optimization.

Proceedings of the 14th International Green Energy Conference
IGEC2022-151
July 4-8, 2022

Synthesis of Fine Nano-Pt supported on Carbon Nanotubes for Hydrogen Oxidation under Alkaline Condition

Runfei Yue, Yabiao Pei, Weikang Zhu, Haotian Liu, Na Xie, Junfeng Zhang* and Yan Yin*
State Key Laboratory of Engines, School of Mechanical Engineering,
Tianjin University, Tianjin, 300072, People's Republic of China.
geosign@tju.edu.cn; yanyin@tju.edu.cn

ABSTRACT

Anion exchange membrane fuel cell (AEMFC) is catching more attention for hydrogen utilization due to the ability to employ non-precious metal catalysts. However, the kinetics of hydrogen oxidation reaction (HOR) at the anode side is insufficient. Thus, it is important to develop a highly efficient and robust (HOR) catalyst for hydrogen oxidation. Herein, Pt nanoparticles supported on multi-wall carbon nanotubes (MWCNTs) are synthesized by a thermal reduction for HOR. The influence of temperature (150~350 ºC) on the Pt/CNTs catalyst was investigated to control the nano-Pt size. The catalyst fabricated under 250 ºC (CNT-250) has excellent activity (53.7 mA mg^{-1}_{Pt} @η=50 mV, 2.71 times of commercial Pt/C), resulting from the high dispersity of ultrafine Pt nanoparticles on MWCNTs. This work may guide the developing MWCNTs supported catalysts for improving alkaline HOR activity.

Keywords: Hydrogen oxidation reaction; Pt nanoparticles; Multi-wall carbon nanotubes; Anion exchange membrane fuel cell

Proceedings of the 14th International Green Energy Conference
IGEC2022-152
July 4-8, 2022

CATALYTIC STEAM REFORMING OF MODEL TAR COMPOUND (TOLUENE AND NAPHTHALENE) BY A CHAR SUPPORTED NICKEL BASED PEROVSKITE CATALYST TO GENERATE HYDROGEN

M. Mukamwi1*, T. Somorin, J. Li, F. R. García-García
Department of Chemical and Process Engineering, University of Strathclyde, Glasgow G1 1XQ, United Kingdom
m.mukamwi@strath.ac.uk, tosin.somorin@strath.ac.uk, jun.li@strath.ac.uk, francisco.garcia-garcia@ed.ac.uk

ABSTRACT

Hydrogen derived from biomass gasification is key clean energy alternative for the carbon emissions reduction and achieving the UK's net zero goals. However, hydrogen produced from biomass gasification will be in a syngas mixture which contains H_2, CO, CO_2, CH_4 and tar. Tar is a mixture of mostly aromatic hydrocarbons, and condenses at low temperatures, thus blocking equipment and causing process inefficiencies. Removal of the tar from the syngas can be done through wet scrubbing, thermal reforming, or catalytic reforming. Scrubbing produces contaminated wastewater, an environmental hazard. Thermal cracking requires high temperatures in excess of 900°C. This leaves catalytic cracking being the preferred method, as it solves the tar problem while increasing the hydrogen yield. During the reforming process, the catalyst function is key. The catalyst must be highly active in the tar conversion and have high hydrogen yield and be thermally stable. Many catalyst types have been reported for the tar steam reforming: noble metal catalysts, nickel based catalysts, minerals, zeolites, perovskites and biochar. Nickel-based catalysts in the transition metal group are preferred due to the high activity of nickel and its low cost. However, these catalysts suffer from deactivation caused by deposition of carbon (coking) from the polyaromatic hydrocarbons (PAHs) in tar. Carbon deposition is both direct and also caused by the sulphur present in biomass. There is therefore a research need to develop tar and syngas reforming catalysts which are resistant to sulphur and carbon deactivation. This research developed, synthesized, characterized and tested a novel biochar-supported catalyst $La_{0.9}Ce_{0.1}Ni_{0.5}Co_{0.5}O_3$ which is expected to be tolerant to sulphur and carbon present in syngas. The carbon and sulphur tolerance of the catalyst emanates from the labile oxygen present in the perovskite crystal lattice. During catalytic reforming, when S or C adsorb onto the catalyst surface, the labile oxygen reacts with the adsorbates, forming COx and SOx which in turn desorb into the bulk gas. The catalyst was synthesized using the amorphous citrate and wetness impregnation methods. Calcination volatilized the C, H, O and N from the citrate process, leaving a perovskite metal oxide crystal catalyst (confirmed by XRD) supported on biomass char. Preparation of biochar support was through carbonisation of wheat straw pellets. Catalyst BET surface area was high at 377-384 m^2/g, with pore size 6.37-6.63 nm. The catalyst is thermally stable in the catalytic reforming range of 600-850°C. Figure 1 below shows the catalyst test results in steam reforming a model tar compound (68% C_7H_8 and 32% $C_{10}H_8$ by moles). High H_2 yield was achieved, with H_2 yield in the range of 43-66vol%, and this is comparable with results in literature. Purely thermal reforming (without catalyst) showed minimal H_2 generation (⩽10vol%), thus confirming the effectiveness of the catalyst. The catalytic reforming test was done in presence of sulphur content of 17-30ppm. Catalyst performance was generally steady for the duration of the test

Keywords: novel catalyst, perovskite, tar, deactivation, catalytic steam reforming, hydrogen

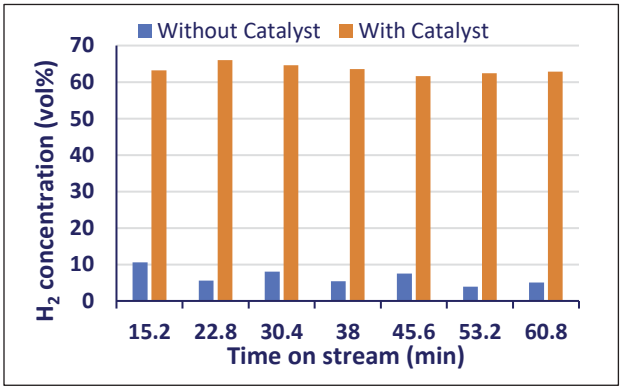


Figure 2: Syngas product composition (N_2 – free), with and without catalyst at 800°C reforming temperature

Website: http://www.iage-net.org/igec2022.

IGEC2022 Secretariat: (jian.zhao@uwaterloo.ca).

Proceedings of the 14th International Green Energy Conference
IGEC2022-153
July 4-8, 2022

USE OF OCTANOL AND WASTE ENGINE OIL BLENDS IN DIESEL ENGINE

Halil Cagatay Basaran [1,], Ilker Turgut Yılmaz[2], and Mehmet Akcay[3]*

[1]Department of Mechanical Engineering, Faculty of Technology, Marmara University, 34854, Istanbul, Turkey, e-mail: cagataybasaran@marun.edu.tr

[2] Department of Mechanical Engineering, Faculty of Technology, Marmara University, 34854, Istanbul, Turkey, e-mail: ilker.yilmaz@marmara.edu.tr

[3] Department of Mechanical Engineering, Faculty of Engineering and Architecture, Mus Alparslan University, 49250, Mus, Turkey,

e-mail: m.akcay@alparslan.edu.tr

[*]Corresponding author: cagataybasaran@marun.edu.tr

ABSTRACT
The decrease in fossil fuels in the world, increasing energy need and increasing fuel prices have pushed researchers to seek alternative fuels. In addition, recently, researchers have focused on obtaining energy from waste by recycling waste materials. In this study, the effects of fuel mixture of waste engine oil and octanol with diesel fuel on the exhaust emissions and the engine efficiency of a 4-cylinder diesel engine were investigated. Waste engine oil was refined with acid-clay process to be used in diesel engines at first. The experiments were performed with accelerator pedal position at 20%, 30%, 40%, 50% with a constant engine speed of 2000 rpm. A significant reduction was observed in exhaust gas temperature, brake specific fuel consumption and NOx emission of fuel mixture tests compared to diesel fuel tests. On the other hand, higher HC and CO_2 emissions were observed in fuel mixture tests. In addition, higher thermal efficiency was observed for fuel mixture tests in lower pedal positions, but it was decreased with increasing pedal position. Similar trends could be seen in O_2 emissions.

Keywords: Waste Engine Oil, Octanol, Diesel Engine, Exhaust Emissions