13th International Green Energy Conference (IGEC-XIII)

July 15-18, 2021

Virtual Conference

Conference Program

International Association for Green Energy

UNIVERSITY OF WATERLOO

天津大學 Tianjin University

13th International Green Energy Conference (IGEC-XIII)

Agenda Overview

Thursday, July 15, 2021

Preliminary Plan	(All Beijing Time, GMT +8)				
Thursday	**July 15, 2021**				
8:30 am - 8:50 am	**Opening Session** Zoom ID：966 715 2021				
8:50 am - 9:40 am	**Randy MacEwen (President and CEO, Ballard Power Systems Inc.)** **The Future of Zero-Emission Heavy-Duty Mobility** **Session Chair: Xianguo Li** Zoom ID：966 715 2021				
9:40 am - 9:50 am	Break				
Special session S1: **Advances in Redox Flow Batteries** Session Chairs: Qian Xu and Qixing Wu Zoom ID：966 716 2021		**Session S2 Hydrogen and fuel cells 1** Session Chairs: Shuhui Sun and Yan Yin Zoom ID：966 718 2021		**Session S3** Heat and mass transport Session Chairs: Sunny Li and Bingyang Cao Zoom ID：966 717 2021	
9:50 am - 10:10 am	IGEC2021-001 (Invited)	9:50 am - 10:10 am	IGEC2021-158	9:50 am - 10:10 am	IGEC2021-419
10:10 am - 10:30 am	IGEC2021-002 (Invited)	10:10 am - 10:30 am	IGEC2021-452	10:10 am - 10:30 am	IGEC2021-422
10:30 am - 10:50 am	IGEC2021-003 (Invited)	10:30 am - 10:50 am	IGEC2021-155	10:30 am - 10:50 am	IGEC2021-425
10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break
11:00 am - 11:20 am	IGEC2021-004 (Invited)	11:00 am - 11:20 am	IGEC2021-179	11:00 am - 11:20 am	IGEC2021-428
11:20 am - 11:40 am	IGEC2021-005 (Invited)	11:20 am - 11:40 am	IGEC2021-200	11:20 am - 11:40 am	IGEC2021-494
11:40 am - 12:00 pm	IGEC2021-006 (Invited)	11:40 am - 12:00 pm	IGEC2021-302	11:40 am - 12:00 pm	
12:00 pm - 12:20 pm	IGEC2021-007 (Invited)	12:00 pm - 12:20 pm	IGEC2021-482	12:00 pm - 12:20 pm	
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					

7:00 pm - 7:50 pm	**Vladimir Terzija (Skoltech)** **Advanced Monitoring and Control for Sustainable Green Energy Systems** **Session Chair: Qing Du** Zoom ID：966 715 2021
7:50 pm - 8:00 pm	Break

Session S4 Energy systems modelling and optimization 1 Session Chairs: Sadegh Azizi and Haifeng Liu Zoom ID：966 716 2021		**Session S5 Advanced and green materials for energy technologies** Session Chairs: XiaoYu Wu and Zhongyi Jiang Zoom ID：966 717 2021		**Session S6 Hydrogen and fuel cells 2** Session Chairs: Wen-Feng Lin and Zhiguo Qu Zoom ID：966 718 2021	
8:00 pm - 8:20 pm	IGEC2021-284	8:00 pm - 8:20 pm	IGEC2021-149	8:00 pm - 8:20 pm	IGEC2021-113
8:20 pm - 8:40 pm	IGEC2021-344	8:20 pm - 8:40 pm	IGEC2021-152	8:20 pm - 8:40 pm	IGEC2021-239
8:40 pm - 9:00 pm	IGEC2021-254	8:40 pm - 9:00 pm	IGEC2021-224	8:40 pm - 9:00 pm	IGEC2021-290
9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break
9:10 pm - 9:30 pm	IGEC2021-359	9:10 pm - 9:30 pm	IGEC2021-368	9:10 pm - 9:30 pm	IGEC2021-293
9:30 pm - 9:50 pm	IGEC2021-365	9:30 pm - 9:50 pm	IGEC2021-389	9:30 pm - 9:50 pm	IGEC2021-443
9:50 pm - 10:10 pm	IGEC2021-374	9:50 pm - 10:10 pm	IGEC2021-488	9:50 pm - 10:10 pm	IGEC2021-446
10:10 pm - 10:30 pm	IGEC2021-410	10:10 pm - 10:30 pm	IGEC2021-491	10:10 pm - 10:30 pm	IGEC2021-125
Night break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					

Friday, July 16, 2021

Preliminary Plan	(All Beijing Time, GMT +8)
Friday	**July 16, 2021**
8:00 am - 8:50 am	**Paul Parker (University of Waterloo)** **Electrification and Efficiency: Improving Energy and Emission Performance in Offices, Homes and Aircraft** **Session Chair: SeongDae Kim** Zoom ID：966 715 2021
8:50 am - 9:40 am	**Ravi Rajamani (drR2 consulting, University of Connecticut)** **Certification of Electric Aircraft** **Session Chair: Hikmet Karakoc** Zoom ID：966 715 2021
9:40 am - 9:50 am	Break
	Invited Keynote Session
9:50 am - 10:25 am	Dr. Aimy Bazylak (University of Toronto) In operando imaging for carbon dioxide electrolysis Session Chair: Kui Jiao Zoom ID：966 715 2021

10:25 am - 11:00 am	Dr. Yan Yin (Tianjin University) Design of transition metal-nitrogen-carbon catalyst layer for anion exchange membrane fuel cell Session Chair: Meng Ni Zoom ID：966 715 2021				
11:00 am - 11:35 am	Dr. Rui Xiong (Beijing Institute of Technology) AI accelerates the development of a new generation of battery management systems Session Chair: Zhongchao Tan Zoom ID：966 715 2021				
11:35 am - 11:40 am	Break				
11:40 am - 12:30 pm	**Li Zhao (Tianjin University)** **How to Approach Carnot Cycle: Methodology and Application** **Session Chair: Zhibin Yu** Zoom ID：966 715 2021				
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					
7:00 pm - 7:50 pm	**Jianzhong Wu (Cardiff University)** **Energy Network Architectures Enabling a Carbon Neutral Future** **Session Chair: Jing Shi** Zoom ID：966 715 2021				
7:50 pm - 8:00 pm	Break				
Session S7 Renewable and clean energy Session Chairs: Bale Reddy and Rui Xiong Zoom ID：966 716 2021		**Session S8 Advanced energy systems** Session Chairs: Jianzhong Wu and Fei Gao Zoom ID：966 717 2021		**Session S9 Hydrogen and fuel cells 3** Session Chairs: Yimin Wu and Jianbo Zhang Zoom ID：966 718 2021	
8:00 pm - 8:20 pm	IGEC2021-104	8:00 pm - 8:20 pm	IGEC2021-260	8:00 pm - 8:20 pm	IGEC2021-116
8:20 pm - 8:40 pm	IGEC2021-218	8:20 pm - 8:40 pm	IGEC2021-353	8:20 pm - 8:40 pm	IGEC2021-128
8:40 pm - 9:00 pm	IGEC2021-305	8:40 pm - 9:00 pm	IGEC2021-380	8:40 pm - 9:00 pm	IGEC2021-164
9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break
9:10 pm - 9:30 pm	IGEC2021-404	9:10 pm - 9:30 pm	IGEC2021-386	9:10 pm - 9:30 pm	IGEC2021-206
9:30 pm - 9:50 pm	IGEC2021-407	9:30 pm - 9:50 pm	IGEC2021-413	9:30 pm - 9:50 pm	IGEC2021-215
9:50 pm - 10:10 pm	IGEC2021-416	9:50 pm - 10:10 pm	IGEC2021-431	9:50 pm - 10:10 pm	IGEC2021-308
10:10 pm - 10:30 pm	IGEC2021-440	10:10 pm - 10:30 pm	IGEC2021-437	10:10 pm - 10:30 pm	IGEC2021-485
Night break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					

Saturday, July 17, 2021

Preliminary Plan	(All Beijing Time, GMT +8)				
Saturday	**July 17, 2021**				
8:00 am - 8:50 am	**Zhiguo Qu (Xi'an Jiaotong University)** **Nanofluidic Ionic Osmotic Energy Conversion with Thermal Modulation** **Session Chair: Chong Wen Tong** Zoom ID：966 716 2021				
8:50 am - 9:40 am	**Bingyang Cao (Tsinghua University)** **Towards green IC with near-junction thermal managements** **Session Chair: Paul Parker** Zoom ID：966 716 2021				
9:40 am - 9:50 am	Break				
Special Session S10: Water/Vapor Electrolysis Session Chairs: Ronghui Qi and Chuanshuai Dong Zoom ID：966 715 2021		**Session S11 Energy storage techniques** Session Chairs: Xianke Lin and Bin Li Zoom ID：966 717 2021		**Session S12 Hydrogen and fuel cells 4** Session Chairs: Samaneh Shahgaldi and Yanzhou Qin Zoom ID：966 718 2021	
9:50 am - 10:10 am	IGEC2021-011 (Invited)	9:50 am - 10:10 am	IGEC2021-287	9:50 am - 10:10 am	IGEC2021-122
10:10 am - 10:30 am	IGEC2021-012 (Invited)	10:10 am - 10:30 am	IGEC2021-362	10:10 am - 10:30 am	IGEC2021-137
10:30 am - 10:50 am	IGEC2021-013 (Invited)	10:30 am - 10:50 am	IGEC2021-230	10:30 am - 10:50 am	IGEC2021-176
10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break
11:00 am - 11:20 am	IGEC2021-014 (Invited)	11:00 am - 11:20 am	IGEC2021-209	11:00 am - 11:20 am	IGEC2021-248
11:20 am - 11:40 am	IGEC2021-015 (Invited)	11:20 am - 11:40 am	IGEC2021-383	11:20 am - 11:40 am	IGEC2021-263
11:40 am - 12:00 pm	IGEC2021-016 (Invited)	11:40 am - 12:00 pm	IGEC2021-467	11:40 am - 12:00 pm	IGEC2021-473
12:00 pm - 12:20 pm		12:00 pm - 12:20 pm		12:00 pm - 12:20 pm	IGEC2021-497
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					
7:00 pm - 7:50 pm	**Mingfa Yao (Tianjin University)** **Developing Trend of IC Engine Technology for Low-Carbon and Carbon-Neutrality** **Session Chair: Kaushik Saha** Zoom ID：966 717 2021				
7:50 pm - 8:00 pm	Break				

Session S13 Energy conversion and management Session Chairs: Goni Boulama and Jun Zhao Zoom ID：966 715 2021		**Session S14 Energy systems modelling and optimization 2** Session Chairs: Zhijun Peng and Xili Duan Zoom ID：966 718 2021		**Session S15 Green building and decarbonization** Session Chairs: Fengying Yan and Sining Yun Zoom ID：966 716 2021	
8:00 pm - 8:20 pm	IGEC2021-134	8:00 pm - 8:20 pm	IGEC2021-227	8:00 pm - 8:20 pm	IGEC2021-194
8:20 pm - 8:40 pm	IGEC2021-185	8:20 pm - 8:40 pm	IGEC2021-233	8:20 pm - 8:40 pm	IGEC2021-242
8:40 pm - 9:00 pm	IGEC2021-197	8:40 pm - 9:00 pm	IGEC2021-257	8:40 pm - 9:00 pm	IGEC2021-269
9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break	9:00 pm - 9:10 pm	Break
9:10 pm - 9:30 pm	IGEC2021-212	9:10 pm - 9:30 pm	IGEC2021-335	9:10 pm - 9:30 pm	IGEC2021-275
9:30 pm - 9:50 pm	IGEC2021-377	9:30 pm - 9:50 pm	IGEC2021-338	9:30 pm - 9:50 pm	IGEC2021-326
9:50 pm - 10:10 pm	IGEC2021-449	9:50 pm - 10:10 pm	IGEC2021-341	9:50 pm - 10:10 pm	IGEC2021-371
10:10 pm - 10:30 pm	IGEC2021-245	10:10 pm - 10:30 pm	IGEC2021-434	10:10 pm - 10:30 pm	
Night break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					

Sunday, July 18, 2021

Preliminary Plan	(All Beijing Time, GMT +8)
Sunday	**July 18, 2021**
8:00 am - 8:50 am	**Yimin Wu (University of Waterloo)** **Semiconductor assisted photocatalysis for CO_2 reduction to liquid solar fuels** **Session Chair: Qiuwang Wang** Zoom ID：966 715 2021
8:50 am - 9:40 am	**Qing Du (Tianjin University)** **Development of multi-scale and multi-physics simulation models for proton exchange membrane fuel cell systems** **Session Chair: Yun Wang** Zoom ID：966 715 2021
9:40 am - 9:50 am	Break

Special Session S16: Advances in Fuel Cells Session Chairs: Yunqi Li and Jing Tang Zoom ID：966 717 2021		**Session S17 Energy systems modelling and optimization 3** Session Chairs: Shuichi Torii and Hua Tian Zoom ID：966 716 2021		**Session S18 Hydrogen and fuel cells 5** Session Chairs: Yixiang Shi and Haiqiao Wei Zoom ID：966 718 2021	
9:50 am - 10:20 am	IGEC2021-031 (invited)	9:50 am - 10:10 am	IGEC2021-347	9:50 am - 10:10 am	IGEC2021-119

10:20 am - 10:50 am	IGEC2021-032 (invited)	10:10 am - 10:30 am	IGEC2021-110	10:10 am - 10:30 am	IGEC2021-131
		10:30 am - 10:50 am	IGEC2021-296	10:30 am - 10:50 am	IGEC2021-167
10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break	10:50 am - 11:00 am	Break
11:00 am - 11:20 am	IGEC2021-033 (invited)	11:00 am - 11:20 am	IGEC2021-272	11:00 am - 11:20 am	IGEC2021-182
11:20 am - 11:40 am	IGEC2021-034 (invited)	11:20 am - 11:40 am	IGEC2021-101	11:20 am - 11:40 am	IGEC2021-251
11:40 am - 12:00 pm	IGEC2021-035 (invited)	11:40 am - 12:00 pm	IGEC2021-146	11:40 am - 12:00 pm	IGEC2021-401
12:00 pm - 12:20 pm	IGEC2021-036 (invited)	12:00 pm - 12:20 pm	IGEC2021-221	12:00 pm - 12:20 pm	IGEC2021-500
Day break: organize workshop, panel discussion, poster session, sponsor exhibition or networking events					
7:00 pm - 7:50 pm	**Jianbo Zhang (Tsinghua University)** **Startup of Fuel Cells and Lithium-ion Batteries from Low Temperatures** **Session Chair: Pierre Benard** Zoom ID：966 715 2021				
8:00 pm - 8:30 pm	**Awards ceremony** Zoom ID：966 715 2021				

13th International Green Energy Conference (IGEC-XIII)

Agenda Detailed

13th International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021

Virtual Conference

Thursday, July 15, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

8:30 am - 8:50 am
Opening Session
8:50 am - 9:40 am
Plenary Session: The Future of Zero-Emission Heavy-Duty Mobility Randy MacEwen (President and CEO, Ballard Power Systems Inc.) Session Chair: Xianguo Li

Thursday, July 15, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Special Session S1: Advances in Redox Flow Batteries

Session Chairs: Qian Xu and Qixing Wu
9:50 am - 10:10 am
IGEC2021-001 (Invited): The synergistic effect of additives and outer fields on the performance of non-aqueous redox flow batteries Qian Xu Jiangsu University xuqian@ujs.edu.cn
10:10 am - 10:30 am
IGEC2021-002 (Invited): Development of Electrode Design for High-Power Vanadium Redox Flow Batteries Qixing Wu Shenzhen University qxwu@szu.edu.cn
10:30 am - 10:50 am
IGEC2021-003 (Invited): Recent Advances in Vanadium Flow Battery Design and Manufacture at Institute of Metal Research, Chinese Academy of Sciences Ao Tang Chinese Academy of Sciences a.tang@imr.ac.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-004 (Invited): Optimizing the flow and transport in VRFB for improved performance Weiwei Yang Xi'an Jiaotong University yangww@mail.xjtu.edu.cn
11:20 am - 11:40 am
IGEC2021-005 (Invited): Local Porosity and Microstructure Optimization for Redox Flow Battery Electrode Menglian Zheng Zhejiang University menglian_zheng@zju.edu.cn
11:40 am - 12:00 pm
IGEC2021-006 (Invited): Material designs and testings of organic redox flow batteries based on multi-electron quinone molecule Jackie Puiki Leung Chongqing University leungpuiki@hotmail.com
12:00 pm - 12:20 pm
IGEC2021-007 (Invited): Adapted Thin-film Photovoltaics Coupled to Redox Flow Batteries for Unbiased Solar Energy Storage S. Murcia-López Sant Adrià de Besòs Spain smurcia@irec.cat

Thursday, July 15, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S2: Hydrogen and fuel cells 1

Session Chairs: Shuhui Sun and Yan Yin
9:50 am - 10:10 am
IGEC2021-158 A Component-level Model of Polymer Electrolyte Membrane Electrolysis Cells for Hydrogen Production. **Daniela Ruiz** University of California Irvine druizdia@uci.edu
10:10 am - 10:30 am
IGEC2021-452 Convolutional neural network (CNN) of neutron radiography images for liquid quantification in proton exchange membrane fuel cells **YIHENG PANG** University of California, Irvine YIHENGP@UCI.EDU
10:30 am - 10:50 am
IGEC2021-155 Design of SOFC-GT hybrid systems with membrane reactor for CO2 removal **Yili Shen** Tianjin University yilisen@tju.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-179 Diffusive and Convective Mass Transportations in Proton Exchange Membrane Fuel Cells with Orientational Flow Channels Having Porous Blocks **Hao Chen** Beijing University of Technology chenh@bjut.edu.cn
11:20 am - 11:40 am
IGEC2021-200 TRANSIENT MODEL OF DYNAMIC POWER OUTPUT UNDER PEMFC LOAD CURRENT VARIATIONS **Bin Gao** Hunan University jackgao@hnu.edu.cn
11:40 am - 12:00 pm
IGEC2021-302 EFFECT OF A-SITE NON-STOICHIOMETRY IN PEROVSKITES ONEXSOLUTION OF CATALYTIC NANOPARTICLES AND HYDROGEN OXIDATION REACTION IN SOLID OXIDE FUEL CELLS **Na Yu** Wuhan University Yuuna@whu.edu.cn
12:00 pm - 12:20 pm
IGEC2021-482 INFLUENCE OF DISPERSION SOLVENT ON THE ANODE PERFORMANCE FOR ANION EXCHANGE MEMBRANE FUEL CELL **Di Xiao** Tianjin University 2019201370@tju.edu.cn

Thursday, July 15, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Session S3: Heat and mass transport

Session Chairs: Sunny Li and Bingyang Cao
9:50 am - 10:10 am
IGEC2021-419 MODELLING OF SESSILE WATER DROPLET FREEZING PROCESS ON THE HORIZONTAL COLD PLATE SURFACE **LU Menglong** Beijing Institute of Technology hitlml89757@163.com
10:10 am - 10:30 am
IGEC2021-422 DESIGN TO COMPENSATE THE END LOSS EFFECT OF FIXED LINEAR-FOCUS FRESNEL LENS SOLAR SYSTEM **WANG Hai** Beijing Institute of Technology wanghai_sky@126.com
10:30 am - 10:50 am
IGEC2021-425 A MODELLING STUDY OF SOLID-LIQUID HEAT TRANSFER AREA AND DISTANCE OF SESSILE DROPLETS ON THE HORIZONTAL PLATE SURFACE **DANG Qun** Beijing Institute of Technology 3220200459@bit.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-428 ANALYSIS ON THE DYNAMIC VARIATION OF FROST THICKNESS AND ITS INFLUENCING FACTORS IN THE EARLY FROSTING STAGE **LEI Shangwen** Beijing Institute of Technology 3220200258@bit.edu.cn
11:20 am - 11:40 am
IGEC2021-494 EX-SITU EXPERIMENTAL STUDY ON EXTRACTION OF DROPLET DYNAMIC PARAMETERS BASED ON DROPLET SHAPE IN PEMFC **Mengjie Li** Tianjin University limengjie_565@tju.edu.cn

Thursday, July 15, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

7:00 pm - 7:50 pm
Plenary Session: Advanced Monitoring and Control for Sustainable Green Energy Systems Vladimir Terzija (Skoltech) Session Chair: Qing Du

Thursday, July 15, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Session S4: Energy systems modelling and optimization 1

Session Chairs: Sadegh Azizi and Haifeng Liu
8:00 pm - 8:20 pm
IGEC2021-284 Performance Evaluation and Comparison of Oxy-Fuel Combustion of Biomass Syn-gas Combined Cycle and Steam Turbine Power Plants **Munur Herdem** 1) Adiyaman University, 2) Waterloo Institute for Sustainable Energy (WISE) herdem@adiyaman.edu.tr
8:20 pm - 8:40 pm
IGEC2021-344 A combined renewable energy-based system with high-temperature steam electrolysis for sustainable hydrogen production **Nejat Tükenmez** Isparta University of Applied Sciences nejattukenmez@isparta.edu.tr
8:40 pm - 9:00 pm
IGEC2021-254 NUMERICAL SIMULATION OF THE GEOTHERMAL-SOLAR CHIMNEY POWER PLANTS **Fei Cao** Hohai University fcao@hhu.edu.cn
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-359 SIMULATION AND PARAMETRIC OPTIMIZATION OF A SMALL-SCALE CPV-ORC SYSTEM **Lin Zeng** China University of Petroleum (East China) Z19060003@s.upc.edu.cn
9:30 pm - 9:50 pm
IGEC2021-365 Data-Driven Anode Potential Prediction in Lithium-ion Batteries for Lithium Plating Prevention Based on Gaussian Process Regression **Kavian Khosravinia** University of Ontario Institute of Technology kavian.khosravinia@ontariotechu.net
9:50 pm - 10:10 pm
IGEC2021-374 Thermodynamic analysis of a solar-wind energy based integrated plant with PEM fuel cell stack **Nejat Tukenmez** Isparta University of Applied Sciences nejattukenmez@isparta.edu.tr
10:10 pm - 10:30 pm
IGEC2021-410 Fuzzy Inference Systems-based Temperature Coolant Systems' Control of Ships **Batuhan ATASOY** Piri Reis University batasoy@pirireis.edu.tr

Thursday, July 15, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Session S5: Advanced and green materials for energy technologies

Session Chairs: XiaoYu Wu and Zhongyi Jiang
8:00 pm - 8:20 pm
IGEC2021-149 SCALABLE FABRICATION OF CRYSTALLINE COF MEMBRANE FROM AMORPHOUS POLYMERIC MEMBRANE **Chunyang Fan** Tianjin University wuhong@tju.edu.cn
8:20 pm - 8:40 pm
IGEC2021-152 TIGHT COVALENT ORGANIC FRAMEWORK MEMBRANES FOR EFFICIENT ANION TRANSPORT VIA MOLECULAR PRECURSOR ENGINEERING **Yan Kong** Tianjin University yankong@tju.edu.cn
8:40 pm - 9:00 pm
IGEC2021-224 Zeolitic Imidazolate Framework derived PtCo@NG cathode catalyst for Proton exchange membrane fuel cell **Liancheng Sun** Tianjin University lianchengsun@tju.edu.cn
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-368 Interfacial Charge Transfer Transitions, hol doping and sensitization for visible light response in Trivalent Rare earth ions/TiO2 Nanoparticles Functionalized with Salicylic acid **Chaima Ouled amor** University of Gafsa (Tunisia) amorchaima92@gmail.com
9:30 pm - 9:50 pm
IGEC2021-389 Characterization of optimized activated carbon derived from peach stones **Souha Harabi** National Engineering School of Gabes souhaharrabi20@gmail.com
9:50 pm - 10:10 pm
IGEC2021-488 S Doped Fe/N/C with Hierarchical Porosity for Efficient Oxygen Reduction **Muhammad Arif Khan** Shanghai University mazs65@yahoo.com
10:10 pm - 10:30 pm
IGEC2021-491 Biomass derived M-N-C/P catalyst use as an active electro catalyst for Zn-air battery **Rida Javed** Shanghai University ridajaved617@yahoo.com

Thursday, July 15, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S6: Hydrogen and fuel cells 2

Session Chairs: Wen-Feng Lin and Zhiguo Qu
8:00 pm - 8:20 pm
IGEC2021-113 Two-dimensional modeling of solid oxide fuel cell with thermally induced delamination **Yang Wang** Tianjin University 3012201316@tju.edu.cn
8:20 pm - 8:40 pm
IGEC2021-239 Cost-effective photocatalytic H2 generation from H2S **Maali-Amel Mersel** University of Pannonia sam003miloo@gmail.com
8:40 pm - 9:00 pm
IGEC2021-290 DEVELOPMENT AND APPLICATION OF HIGH TEMPERATURE RESISTANT FLEXIBLE INTEGRATED MICRO SENSOR **Hsiang-Ting Lin** Yuan Ze University xup689420@gmail.com
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-293 FLEXIBLE 4-IN-1 MICROSENSOR FOR IN-SITU MONITORING OF PROTON BATTERY **Yi-Chuan Lin** Yuan Ze University chuan881018@gmail.com
9:30 pm - 9:50 pm
IGEC2021-443 Surface Wettability Tuning on Polymer-Graphite Composite Materials for PEMFC Application **GUANLEI ZHAO** Tsinghua Univversity zgl1989@mail.tsinghua.edu.cn
9:50 pm - 10:10 pm
IGEC2021-446 LASER PERFORATED CATHODE GAS DIFFUSION LAYERS FOR DIRECT METHANOL FUEL CELLS **Abdullah Alrashidi** University of Miami a.alrashidi1@miami.edu
10:10 pm - 10:30 pm
IGEC2021-125 Experimental investigation on the performance and electrochemical characteristics of PEM fuel cell with the three-dimensional dot matrix flow field **Xiangyang Chen** Tianjin University chenxy1103@tju.edu.cn

Friday, July 16, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Plenary and Keynote Sessions

8:00 am - 8:50 am
Plenary Session: Electrification and Efficiency: Improving Energy and Emission Performance in Offices, Homes and Aircraft Paul Parker (University of Waterloo) Session Chair: SeongDae Kim
8:50 am - 9:40 am
Plenary Session: Certification of Electric Aircraft Ravi Rajamani (drR2 consulting, University of Connecticut) Session Chair: Hikmet Karakoc
8:50 am - 9:40 am: Break
9:50 am - 10:25 am
Keynote Session: In operando imaging for carbon dioxide electrolysis Dr. Aimy Bazylak (University of Toronto) Session Chair: Kui Jiao
10:25 am - 11:00 am
Keynote Session: Design of transition metal-nitrogen-carbon catalyst layer for anion exchange membrane fuel cell Dr. Yan Yin (Tianjin University) Session Chair: Meng Ni
11:00 am - 11:35 am
Keynote Session: AI accelerates the development of a new generation of battery management systems Dr. Rui Xiong (Beijing Institute of Technology) Session Chair: Zhongchao Tan
11:35 am - 11:40 am: Break
11:40 am - 12:30 pm
Plenary Session: How to Approach Carnot cycle: Methodology and Application Li Zhao (Tianjin University) Session Chair: Zhibin Yu

Friday, July 16, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Plenary Session

7:00 pm - 7:50 pm
Plenary Session: Energy Network Architectures Enabling a Carbon Neutral Future Jianzhong Wu (Cardiff University) Session Chair: Jing Shi

Friday, July 16, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Session S7: Renewable and clean energy

Session Chairs: Xili Duan and Rui Xiong
8:00 pm - 8:20 pm
IGEC2021-104 Effects of different main injection timings and injection pressures on combustion and emissions of diesel-THF-ethanol blended fuel **Yangyi Wu** Tianjin University yangyiwu@tju.edu.cn
8:20 pm - 8:40 pm
IGEC2021-218 COMPARISON OF DEVELOPING GREEN ENERGY TECHNOLOGIES WITHIN THE FRAMEWORK OF SUSTAINABILITY **Murat AYAR** Eskisehir Technical University muratayar@eskisehir.edu.tr
8:40 pm - 9:00 pm
IGEC2021-305 The Conceptual Design and Flow Investigation of the Novel Land-Based Dual-Axis Augmentation Wind Turbine **Wen Tong Chong** University of Malaya chong_wentong@um.edu.my
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-404 Flow Characteristics Investigation of a Novel Power-Augmented Water Kinetic Turbine for Affordable Energy Capturing from River **Keen Kuan Kong** University of Malaya keenkuan88@um.edu.my
9:30 pm - 9:50 pm
IGEC2021-407 EXHAUST EMISSION EFFECTS OF DIESEL-ETHANOL FUEL BLEND IN COMPRESSION IGNITION ENGINE **Mersin Hürpekli** Kocaeli University mhurpekli@gmail.com
9:50 pm - 10:10 pm
IGEC2021-416 GEOTHERMAL PLANT COMBINED WITH ABSORPTION AND RANKINE CYCLES FOR TRIGENERATION **Ali Ismael** Ontario Tech University Ali.Ismael@ontariotechu.ca
10:10 pm - 10:30 pm
IGEC2021-440 TECHNO-ECONOMIC ANALYSIS OF PLASMA CATALYSIS POWER TO AMMONIA (PCP2A) PROCESS **Rithu Muthalathu** University of Waterloo rmuthala@uwaterloo.ca

Friday, July 16, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Session S8: Advanced energy systems

Session Chairs: Jianzhong Wu and Fei Gao
8:00 pm - 8:20 pm
IGEC2021-260 A study on the effects of electronic expansion valve on novel hot-gas bypass defrosting performance for an air source heat pump unit **Long Zhang** Beijing Institute of Technology yilizl@126.com
8:20 pm - 8:40 pm
IGEC2021-353 ANALYSIS AND ASSESSMENT OF SOLAR ENERGY DRIVEN INTEGRATED GASIFICATION SYSTEM WITH WASTE MANAGEMENT OPTION **B. Gungor** Ontario Tech. University bogachan.gungor@ontariotechu.net
8:40 pm - 9:00 pm
IGEC2021-380 DESIGN OF A MOBILE FLOATING NUCLEAR POWER PLANT INTEGRATED WITH A SOLAR BASED HYDROGEN ENERGY SYSTEM **Mert Temiz** Ontario Tech. University mert.temiz@ontariotechu.ca
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-386 Energy and exergy analyses of a solar combined plant for producing power, hydrogen, oxygen, heating and cooling **Mehmet ALTINKAYNAK** Isparta University of Applied Sciences mehmetaltinkaynak@isparta.edu.tr
9:30 pm - 9:50 pm
IGEC2021-413 AIRCRAFT FUEL EFFICIENCY BASED ON AIRLINE OPERATIONS **ILKAY ORHAN** Eskisehir Technical University, iorhan@eskisehir.edu.tr
9:50 pm - 10:10 pm
IGEC2021-431 EXPERIMENTAL VISUALIZATION OF TWO-PHASE FLOW INSIDE A REAL-SIZE PISTON OF A CROSSHEAD-TYPE MARINE ENGINE **B. Liang** Harbin Engineering University mingpj@mail.sysu.edu.cn
10:10 pm - 10:30 pm
IGEC2021-437 An integrated system based on ammonia alkaline fuel cell with heat recovery **Khaled Al-Hamed** Ontario Tech University khaled.alhamed@ontariotechu.net

Friday, July 16, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S9: Hydrogen and fuel cells 3

Session Chairs: Yimin Wu and Jianbo Zhang
8:00 pm - 8:20 pm
IGEC2021-116 Analysis of novel flow field characteristics based on a 3-D proton exchange membrane fuel cell model **Zhiming BAO** Tianjin University zmbao@tju.edu.cn
8:20 pm - 8:40 pm
IGEC2021-128 Experimental study on a dead-ended anode and cathode recirculation H2-O2 PEM fuel cell under different operating conditions **Ben Hou** Tianjin University 17864303351@163.com
8:40 pm - 9:00 pm
IGEC2021-164 THREE-DIMENSIONAL NUMERICAL STUDY OF A CATHODE GAS DIFFUSION LAYER WITH A THROUGH/IN PLANE SYNERGETIC GRADIENT POROSITY DISTRIBUTION FOR PEM FUEL CELLS **yulin wang** Tianjin university of commerce wangylfcs@yeah.net
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-206 Dynamic wettability model development for liquid water transport in PEMFC gas flow channel **Qiaoyu Guo** Tianjin University gqy1201_@tju.edu.cn
9:30 pm - 9:50 pm
IGEC2021-215 Investigation on Transient Operation Swtiching with Different Cathode Flow Fields in a Single Proton Exchange Membrane Fuel Cell **Zhifeng Xia** Tongji University xzf1994@tongji.edu.cn
9:50 pm - 10:10 pm
IGEC2021-308 Optimization of electrode assembly technology for proton exchange membrane (PEM) dehumidification system **Lijuan Huang** South China University of Technology m15901188726@163.com
10:10 pm - 10:30 pm
IGEC2021-485 CROSSLINKED QUATERNARY AMMONIUM POLY(N-METHYL-PIPERIDINE-CO-P-TERPHENYL) FOR ANION EXCHANGE MEMBRANES **Zixi Nie** Tianjin University 2019201297@tju.edu.cn

Saturday, July 17, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Plenary Session

8:00 am - 8:50 am
Plenary Session: Nanofluidic Ionic Osmotic Energy Conversion with Thermal Modulation Zhiguo Qu (Xi'an Jiaotong University) Session Chair: Chong Wen Tong
8:50 am - 9:40 am
Plenary Session: Towards green IC with near-junction thermal managements Bingyang Cao (Tsinghua University) Session Chair: Paul Parker

Saturday, July 17, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Special Session S10: Water/Vapor Electrolysis

Session Chairs: Ronghui QI and Chuanshuai Dong
9:50 am - 10:10 am
IGEC2021-011 (Invited): Multi-scale modelling and material manipulations on PEM-based electrolyte dehumidifier **Ronghui QI** South China University of Technology qirh@scut.edu.cn
10:10 am - 10:30 am
IGEC2021-012 (Invited): Modulating molecular and microscopic structures of polymeric carbon nitride for boosting photocatalytic hydrogen and oxygen evolution **Xiaoming Fang** South China University of Technology cexmfang@scut.edu.cn
10:30 am - 10:50 am
IGEC2021-013 (Invited): Hot carriers in metal-semiconductor photoelectrode for solar water splitting **Lixia Sang** Beijing University of Technology sanglixia@bjut.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-014 (Invited): A new liquid desiccant regeneration method for air dehumidification coupled with hydrogen production **Qing CHENG** Nanjing Tech University chengqingny@njtech.edu.cn
11:20 am - 11:40 am
IGEC2021-015 (Invited): Study of solid-state hydrogen storage based on metal hydride and its application in fuel cell power system **Zhen WU** Xi'an Jiaotong University wuz2015@mail.xjtu.edu.cn
11:40 am - 12:00 pm
IGEC2021-016 (Invited): Experimental Study of Two-phase Flow in PEM Electrolytic Cells **Hao CHEN** Beijing University of Technology chenh@bjut.edu.cn

Saturday, July 17, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Session S11: Energy storage techniques

Session Chairs: Xianke Lin and Bin Li
9:50 am - 10:10 am
IGEC2021-287 machine learning based li-ion battery pack state of health prediction for multistage charging **Jonathan Couture** Ontario Tech University jonathan.couture@ontariotechu.net
10:10 am - 10:30 am
IGEC2021-362 Fault Diagnosis of a Single Battery Cell Via Transfer Learning **Chukwuemeka Nwauche** University of Ontario Institute of Technology chukwuemeka.nwauche@ontariotechu.net
10:30 am - 10:50 am
IGEC2021-230 THE BLENDING AND TRANSMISSION OF HYDROGEN AND NATURAL GAS IN TRANSMISSION AND DISTRIBUTION PIPELINES **Arash Khabbazi** University of British Columbia arashjkh@student.ubc.ca
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-209 Numerical simulation of hydrogen filling process in novel high-pressure microtube storage device **Guokun Liu** Tianjin University liugk@tju.edu.cn
11:20 am - 11:40 am
IGEC2021-383 FLEXIBLE FOUR-IN-ONE MICROSENSOR PACKAGE AND APPLICATION **Chung-Yu Chien** Yuan Ze University s1073819@mail.yzu.edu.tw
11:40 am - 12:00 pm
IGEC2021-467 Intercalation conversion cathode based on mo6s8 for lithium sulfur battery **Jili Xu** Shanghai University xjl99@shu.edu.cn

Saturday, July 17, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S12: Hydrogen and fuel cells 4

Session Chairs: Samaneh Shahgaldi and Yanzhou Qin
9:50 am - 10:10 am
IGEC2021-122 Experimental evaluation on the performance of cathode parallel staggered baffle flow field for proton exchange membrane fuel cell **Zhengguo Qin** Tianjin University qzgshandong@tju.edu.cn
10:10 am - 10:30 am
IGEC2021-137 Research on electrochemical reaction and mass transfer in two-phase modular microfluidic fuel cell stack **Peiyao Zhi** Tianjin University Zhi_peiyao@163.com
10:30 am - 10:50 am
IGEC2021-176 Analysis of Proton Exchange Membrane Fuel Cell under Transient Gas Supply and Load Change **Jing LIU** Tongji University jingliu@tongji.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-248 FLEXIBLE INTEGRATED MICROSENSOR FOR PROTON EXCHANGE MEMBRANE WATER ELECTROLYZER INTERIOR MONITORING **Shan-Yu Chen** Yuan Ze University france091578@gmail.com
11:20 am - 11:40 am
IGEC2021-263 RESEARCH AND DEVELOPMENT OF HIGH-DURABILITY ANODE CATALYST FOR PEM WATER ELECTROLYZER MEA TECHNOLOGY **Jyun-Wei Yu** Yuan Ze University s1048703@g.yzu.edu.tw
11:40 am - 12:00 pm
IGEC2021-473 Reasonable structure design of ZIF-derived ORR catalyst with dual-metal active site for fuel cell **Weikang Zhu** Tianjin University lovsunny77@tju.edu.cn
12:00 pm - 12:20 pm
IGEC2021-497 EFFECT OF LIQUID WATER PRESENCE ON GAS DIFFUSION LAYER EFFECTIVE THERMAL CONDUCTIVITY **Shibo Cao** Tianjin University shibocao@tju.edu.cn

Saturday, July 17, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Plenary Session

7:00 pm - 7:50 pm
Plenary Session: Developing Trend of IC Engine Technology for Low-Carbon and Carbon-Neutrality Mingfa Yao (Tianjin University) Session Chair: Kaushik Saha

Saturday, July 17, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Session S13: Energy conversion and management

Session Chairs: Goni Boulama and Jun Zhao
8:00 pm - 8:20 pm
IGEC2021-134 Simulation study on the effects of water injection strategies on Oxy-Fuel Combustion (OFC) in a Gasoline Direct Injection (GDI) engine at economical oxygen-fuel ratios **Xiang Li** University of Bedfordshire, Luton, UK xiang.li@beds.ac.uk
8:20 pm - 8:40 pm
IGEC2021-185 MULTI-PHYSICAL TRANSPORT PHENOMENON IN CAPACITIVE DEIONIZATION: A DEMENSIONLESS ANALYSIS **Meng Yang** Xi'an Jiaotong University yangmeng123@stu.xjtu.edu.cn
8:40 pm - 9:00 pm
IGEC2021-197 NANOFLUIDIC OSMOTIC ENERGY CONVERSION MODULATION WITH THERMAL AND PH VALUE GOVERNED INTERFACIAL REACTIONS **Xu Zhang** Xi'an Jiaotong University 13556435897@163.com
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-212 Determining the Effect of Intake Air Pressure on Combustion Characteristics of a Diesel Engine Using Ethanol-Diesel Fuel Blends **Mustafa Vargün** Marmara Universtiy mustafavargun@gmail.com
9:30 pm - 9:50 pm
IGEC2021-377 AN EXPERIMENTAL AND NUMERICAL STUDY ON UNSTEADY CHARACTERISTICS OF FLOW BOILING IN STRAIGHT MICROCHANNEL UNDER SUDDEN HEAT FLUX INCREASE **Jiaojiao Zhuang** China University of Petroleum (East China) zhuangjiaojiao98@163.com
9:50 pm - 10:10 pm
IGEC2021-449 EFFECT OF LEADING-EDGE DIMPLE ON THE PRE-STALL AERODYNAMIC PERFORMANCE OF A WIND TURBINE AIRFOIL **Biplab Das** National Institute of Technology Silchar biplab.2kmech@gmail.com
10:10 pm - 10:30 pm
IGEC2021-245 Renewable Energy Innovation by Recycling Waste Heat Energy by using Graphene-coated Thermoelectric Generator (GTEG) **KAH HOU TENG** UCSI University tengkh@ucsiuniversity.edu.my

Saturday, July 17, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S14: Energy systems modelling and optimization 2

Session Chairs: Zhijun Peng and Xili Duan
8:00 pm - 8:20 pm
IGEC2021-227 Thermodynamic Analysis Of Geothermal Energy Based Multigeneration Plant For Useful Outputs **Yunus Emre Yuksel** Afyon Kocatepe University yeyuksel@aku.edu.tr
8:20 pm - 8:40 pm
IGEC2021-233 EVALUATION OF A MULTIGENERATIONAL PLANT WITH THE PARABOLIC TROUGH COLLECTOR FIELD FOR PRODUCING ELECTRICITY, HYDROGEN, COOLING-HEATING AND FRESH WATER **Murat Koc** Isparta University of Applied Sciences muratkoc@isparta.edu.tr
8:40 pm - 9:00 pm
IGEC2021-257 TRANSIENT MODEL OF A SOLAR AIDED THERMAL ENERGY STORAGE UNIT INTEGRATED HEAT PUMP SYSTEM **Nezir Yağız ÇAM** Yaşar University nezir.cam@yasar.edu.tr
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-335 DESIGN AND MODELING OF THE GEOTHERMAL ENERGY DRIVEN INTEGRATED SYSTEM FOR USEFUL PRODUCTS **Fatih YILMAZ** Isparta University of Applied Sciences fatihyilmaz@isparta.edu.tr
9:30 pm - 9:50 pm
IGEC2021-338 A novel renewable energy based integrated plant with thermal energy storage and hydrogen generation **Fatih YILMAZ** Isparta University of Applied Sciences fatihyilmaz@isparta.edu.tr
9:50 pm - 10:10 pm
IGEC2021-341 DEMAND MANAGEMENT AND SUSTAINABLITIY OF ENERGY EFFICIENCY FOR COOLING PROCESSES IN INDUSTRIAL APPLICATIONS **M.Ziya Sogut** Piri Reis University mzsogut@gmail.com
10:10 pm - 10:30 pm
IGEC2021-434 AIRCRAFT BATTERIES FOR HYBRID ELECTRIC PROPULSION CERTIFICATION AND RELATED ISSUES **Melih YILDIZ** Girne University melih.yildiz@kyrenia.edu.tr

Saturday, July 17, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Session S15: Green building and decarbonization

Session Chairs: Fengying Yan and Sining Yun
8:00 pm - 8:20 pm
IGEC2021-194 ANALYSIS OF INFLUENCING FACTORS AND PREDICTION OF COUNTY-LEVEL CARBON EMISSION FROM ENERGY CONSUMPTION BASED ON STIRPAT MODEL **Hongjiang Liu** Tianjin University hongjiang@tju.edu.cn
8:20 pm - 8:40 pm
IGEC2021-242 DEEP ENERGY EFFICIENCY RETROFITS VERSUS DIRECT ELECTRIFICATION FOR URGENT EMISSIONS REDUCTION: A CASE STUDY USING 33,780 RESIDENTIAL ENERGY PROFILES IN WATERLOO, CANADA **Heather McDiarmid** University of Waterloo heatheratp2@gmail.com
8:40 pm - 9:00 pm
IGEC2021-269 An Assessment of Green Airport Concept in Turkey **Betul Kacar** Eskisehir Technical University betulkacar@eskisehir.edu.tr
9:00 pm - 9:10 pm
Break
9:10 pm - 9:30 pm
IGEC2021-275 Optimization of energy and daylighting metrics for algae integrated facade systems **Yonca Yaman** Dokuz Eylül University yonca.yaman@ogr.deu.edu.tr
9:30 pm - 9:50 pm
IGEC2021-326 A Regional and Recruitment-based analysis of Canadian Household Carbon Footprints **Nicholas Palaschuk** University of Waterloo npwpalaschuk@uwaterloo.ca
9:50 pm - 10:10 pm
IGEC2021-371 Experimental Design Analysis of Murexide Dye Removal by activated Carbon Adsorption **Rimene Dhahri** Faculty of sciences of Gafsa, University of Gafsa, Tunisia dhahririmene@gmail.com

Sunday, July 18, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Plenary Session

8:00 am - 8:50 am
Plenary Session: Semiconductor assisted photocatalysis for CO2 reduction to liquid solar fuels Yimin Wu (University of Waterloo) Session Chair: Qiuwang Wang
8:50 am - 9:40 am
Plenary Session: Development of multi-scale and multi-physics simulation models for proton exchange membrane fuel cell systems Qing Du (Tianjin University) Session Chair: Yun Wang

Sunday, July 18, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 717 2021

Special Session S16: Advances in Fuel Cells

Session Chair: Yunqi Li and Jing Tang
9:50 am - 10:20 am
IGEC2021-031 (invited) Materials Space-Tectonics: A Conceptual Paradigm for Creating Second-Generation Porous Materials **Yusuke Yamauchi** The University of Queensland y.yamauchi@uq.edu.au
10:20 am - 10:50 am
IGEC2021-032 (invited) Application of Carbon-Metal Hybrid Electrocatalyst in Hydrogen Evolution **Zhong-Li Wang** Tianjin University wang.zhongli@tju.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-033 (invited) Electrosynthesis promoted hydrogen evolution/hydrogenation reaction **Lisong Chen** East China Normal University lschen@chem.ecnu.edu.cn
11:20 am - 11:40 am
IGEC2021-034 (invited) Transient Performance Loss of Pt/C Fuel Cell Catalyst Hindering High Efficiency Operation **Yung-Tin Pan** National Tsing Hua University ytpan@mx.nthu.edu.tw
11:40 am - 12:00 pm
IGEC2021-035 (invited) Lifetime Evaluation Methods for Vehicle Fuel Cells and Analysis of Key Influencing Factors **Huicui Chen** Tongji University chenhuicui@tongji.edu.cn
12:00 pm - 12:20 pm
IGEC2021-036 (invited) Graphene Nanomesh as An Effect Electrocatalysts for Oxygen Reduction in Acid Media **Wei Xia** East China Normal University wxia@chem.ecnu.edu.cn

Sunday, July 18, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 716 2021

Session S17: Energy systems modelling and optimization 3

Session Chairs: Shuichi Torii and Hua Tian
9:50 am - 10:10 am
IGEC2021-347 Study Residential Energy Consumption Using a Bottom-up Monte Carlo Markov Chain Stochastic Model **Ryan Quan** University of Waterloo r4quan@uwaterloo.ca
10:10 am - 10:30 am
IGEC2021-110 Pilot-ignited high-pressure direct injection natural gas engines **Weifan Luo** Tianjin University 2019201351@tju.edu.cn
10:30 am - 10:50 am
IGEC2021-296 Analysis and Optimization of Performance and Emissions of Water-injected Intake Port Gasoline Engine under Knocking **Zuowen Liu** Chongqing University liuzuowen3@163.com
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-272 Simulation Study Between PVDF Piezoelectric Bridge and Cantilever Transducers for Raindrop Energy Harvesting **Cheong Yenn Jou** UCSI University delsolboy3@hotmail.com /1001643277@ucsiuniversity.edu.my
11:20 am - 11:40 am
IGEC2021-101 Modeling the spray characteristics of blended fuels for gasoline direct injection applications **Kaushik Saha** Indian Institute of Technology Delhi kaushiksaha@ces.iitd.ac.in
11:40 am - 12:00 pm
IGEC2021-146 Numerical study of coupled internal nozzle flow and spray formation of Diesel injection (Spray A - ECN) system **Kaushik Saha** Indian Institute of Technology Delhi kaushiksaha@ces.iitd.ac.in
12:00 pm - 12:20 pm
IGEC2021-221 Modeling and Optimization of Small-Scale Spiral Blade Vertical Axis Wind Turbine (VAWT) **Laveet Kumar** Mehran University of Engineering and Technology laveet.kumar@faculty.muet.edu.pk

Sunday, July 18, 2021-Morning

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 718 2021

Session S18: Hydrogen and fuel cells 5

Session Chairs: Yixiang Shi and Haiqiao Wei
9:50 am - 10:10 am
IGEC2021-119 A COMPREHENSIVE THREE-DIMENSIONAL MODEL OF PEM ELECTROLYZER CONSIDERING DETAILED CHANNEL TWO-PHASE FLOW **Yifan Xu** Tianjin University xyf@tju.edu.cn
10:10 am - 10:30 am
IGEC2021-131 Two-dimensional simulation of purge processes for dead-end H2/O2 proton exchange membrane fuel cell with different hydrogen flow arrangements **Hengyang Tao** Tianjin University 93667514@qq.com
10:30 am - 10:50 am
IGEC2021-167 Transport of reactant gas in PEM fuel cells with metal foam flow fields **Mengshan Suo** Tianjin University suomengshan@tju.edu.cn
10:50 am - 11:00 am
Break
11:00 am - 11:20 am
IGEC2021-182 Cell Voltage and Two-phase Flow in a Unitized Regenerative Fuel Cell Operating in Alternate Fuel Cell and Electrolytic Cell Mode **Rui Jiao Yu** Beijing University of Technology hangguo@bjut.edu.cn
11:20 am - 11:40 am
IGEC2021-251 Anti-corrosion microporous layer of PEM electrolysis anode for long-lasting operation **Jyun-Wei Yu** Yuan Ze University s1048703@g.yzu.edu.tw
11:40 am - 12:00 pm
IGEC2021-401 Durability enhancement of proton exchange membrane fuel cells by ferrocyanide or ferricyanide additives **Xin Liu** Tianjin University pdxinliu@tju.edu.cn
12:00 pm - 12:20 pm
IGEC2021-500 EFFECTS OF CLAMPING FORCE AND MEMBRANE SWELLING ON STRUCTURAL DEFORMATION AND PERFORMANCE OF PROTON EXCHANGE MEMBRANE FUEL CELL **Yuwen Liu** Tianjin University liuyuwen@tju.edu.cn

Sunday, July 18, 2021-Afternoon

(Time Zone: Beijing Time, GMT +8)

Zoom ID：966 715 2021

Plenary Session

7:00 pm - 7:50 pm
Startup of Fuel Cells and Lithium-ion Batteries from Low Temperatures Jianbo Zhang (Tsinghua University) Session Chair: Pierre Benard
8:00 pm - 8:30 pm
Awards ceremony

Abstracts of Plenary Sessions

Biographies of Plenary Speakers

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Bingyang Cao
Affiliation	School of Aerospace Engineering, Tsinghua University, Beijing 100084, China

Invited Plenary Lecture

Presentation Title	**Towards green IC with near-junction thermal managements**
Abstract (Approximately 200 words)	Heat transport and thermal management are becoming a bottleneck problem in electronic systems. Approaching green IC necessitates an in-depth understanding of heat transport and efficient thermal management strategies to ensure the electronic devices' reliability, lifetime, power output and energy costs. The talk will cover the following topics. (1) Heat transport in nanostructures: At micro/nanoscale, however, the system size becomes comparable to the mean free path or the wave length of phonons in semiconductors, where heat transports in a non-diffusive way and the Fourier's law breaks down. Non-Fourier effects result in the size-, geometry-, interface- and heating condition-dependence of effective thermal conductivity of nanostructures. (2) Heat generation and thermal spreading: In the near-junction regions of electronic devices, heat generation is dominated by non-equilibrium scattering among electrons and phonons, and the heat transfer process is dominated by thermal spreading resistance. The density of material interfaces is dramatically increasing, which makes interfacial thermal transport become a dominant factor for the overall thermal performance. (3) Embedded liquid cooling: Embedded microchannel liquid cooling is demonstrated to be one of the most promising thermal management technologies. The optimization design of microchannels is a typical multi-objective issue involving in lowering the flow drag, enhancing the heat transfer coefficient, and increasing the temperature uniformity etc.
Biographical Sketch (Approximately 200 words)	Bingyang Cao is full professor and head in the School of Aerospace Engineering, Tsinghua University, China. He was awarded MOE New Century Talented Scientists Program (2011), Excellent Youth Funding of NSFC (2013), Wu Zhonghua Outstanding Young Scholar Award from China Engineering Thermophysics Society (2014), Outstanding Young Scientists Funding of NSFC (2018), First Prize of Natural Science of MOE (2019), and IAAA Medal & Fellow of International Association of Advanced Materials (2020). He currently serves as chair of the Young Scientist Committee of the Heat and Mass Transfer Society of China, vice-chair of the Thermally Conductive Composite Committee of the Composite Society of China, executive committee member of the Asian Union of Thermal Science and Engineering, member of the Heat and Mass Transfer Society of China etc. His research mainly covers micro/nanoscale heat transfer, thermal functional materials, and advanced thermal management technologies. He has published more than 150 SCI-indexed journal papers. He is currently serving as Editor-in-Chief of ES Energy & Environment, editorial member of 6 international journals, including Journal of Physics: Condensed Matter (SCI), Scientific Reports (SCI), Materials (SCI) etc.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Qing Du
Affiliation	Tianjin University

Invited Plenary Lecture

Presentation Title	**Development of multi-scale and multi-physics simulation models for proton exchange membrane fuel cell systems**
Abstract (Approximately 200 words)	Cost, performance and durability are the main technical challenges before the large-scale commercialization of proton exchange membrane fuel cell (PEMFC). For the aspect of performance and durability, water, heat, and energy management are commonly considered as important factors. The management becomes even more complicated when it comes to PEMFC systems since various auxiliary subsystems need to be monitored simultaneously. Therefore, it is of great importance to comprehensively understand the interaction inside the complicated energy system. To investigate the coupled heat and mass transfer processes, a comprehensive dynamic system model is developed, including a stack sub-model and various auxiliary sub-models such as membrane humidifier, hydrogen pump, air compressor, and radiator. All sub-models have been rigorously validated against experimental data to guarantee the system model reliability. The mutual effects among stack and associated subsystems are investigated, focusing on the overall water utilization and thermal management. To further study transient responses and corresponding energy management for hybrid power systems, electrochemical thermally coupled Li-ion battery sub-model, DC/DC converter sub-model, and vehicle dynamics sub-model are integrated with the system model. Rule-based energy management strategies under China standard operating conditions for light vehicles are studied.
Biographical Sketch (Approximately 200 words)	Dr. Qing Du is now a professor, as well as the leader of Electrochemical Thermophysics Laboratory of State Key Laboratory of Engines, Tianjin University (SKLE). He obtained his B.S, MS and Ph.D. degree from Tianjin University in 1990, 1993 and 1999 respectively. Beginning in 2000, he carried out a 2-year post-doctoral study, then joined SKLE as an associate professor in 2002 and became a full professor in 2006. His research interests mainly focuses on fuel cells and engines, especially the simulation and experiments of water and heat management of fuel cells, liquid fuel breakup and combustion process of IC engines. He has published over 90 peer-reviewed journal papers and obtained about 15 patents and software copyrights. He now also act as the director of HR Department of Tianjin University.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	**Randy MacEwen**
Affiliation	**President and CEO, Ballard Power Systems Inc.**

Invited Plenary Lecture

Presentation Title	**The Future of Zero-Emission Heavy-Duty Mobility**
Abstract (Approximately 200 words)	Hydrogen fuel cells offer a unique value proposition to decarbonize heavy-duty mobility, including bus, truck, train and marine applications. The 2020s will be the Hydrogen Decade as strong policy support, along with cost reductions for fuel cells and green hydrogen, will drive volume adoption in key geographies and disrupt hard-to-abate use cases in heavy-duty mobility.
Biographical Sketch (Approximately 200 words)	Randy MacEwen has served as CEO and a member of the Board of Directors of Ballard Power Systems since 2014. He has held executive roles in clean energy companies for 20 years, including in hydrogen, fuel cells and solar. In his earlier career, he was a lawyer specializing in M&A and corporate finance. Mr. MacEwen represents Ballard as a supporting member of the Hydrogen Council. Mr. MacEwen holds a Bachelor of Arts degree and a Bachelor of Law degree.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Prof. Paul Parker
Affiliation	University of Waterloo, Faculty of Environment

Invited Plenary Lecture

Presentation Title	**Electrification and Efficiency: Improving Energy and Emission Performance in Offices, Homes and Aircraft**
Abstract (Approximately 200 words)	Green energy comes in many forms and the avoided energy demand created by increased efficiency is one of the best. Electrical energy systems have improved their efficiency in many applications and the increasing use of low carbon electricity sources enables these technologies to also reduce greenhouse gas (GHG) emissions when they replace fossil fuel use. This paper will highlight the benefits of both reduced demand for energy and reduced emissions. Technologies are available to improve the efficiency of our commercial and residential buildings (e.g. heat pumps, LED lighting, energy recovery ventilation), as well as our transportation (electric motors instead of internal combustion engines). Despite the identified benefits of many of these technologies, the adoption rates are often low. Further studies are needed into the barriers to adoption and the best means to overcome these barriers. Heat pumps are an excellent example in the building industry. In transportation, electric aviation faces many of the challenges of electric vehicles. The need to introduce policies to address the information, financial, regulatory, risk and trust barriers is highlighted. The result can be improved societal performance with reduced energy demand and a transition to a low carbon future.
Biographical Sketch (Approximately 200 words)	Paul Parker is a professor and former Associate Dean in the Faculty of Environment at the University of Waterloo. His research focuses on building sustainable communities by creating win-win opportunities for the environment and economy. He is particularly concerned with how local economic development strategies can achieve a sustainable future. Sustainable energy systems are an essential starting point, so he looks first at conservation and improving energy efficiency, then at renewable energy sources and smart grid networks as integral parts of community energy plans. Paul's research interests include sustainable energy policy, sustainable community development, the green economy, zero carbon buildings, residential retrofits, electric aviation and low-carbon futures.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	**Zhiguo Qu**
Affiliation	**Xi'an Jiaotong University**

Invited Plenary Lecture

Presentation Title	**Nanofluidic Ionic Osmotic Energy Conversion with Thermal Modulation**
Abstract (Approximately 200 words)	Ions are significant energy carriers for energy conversion and storage. Nanofluidic ionic osmotic energy conversion could directly convert salinity-gradient energy and solar energy into electricity, and its physical essence is nanofluidic based ion selective diode transport process. However, the coupled ion transport and heat transfer inside nanofluidic channel is lack of unified physical cognition, and the corresponding osmotic power density is still relatively low which limits its practical applications. Following the approach of "Understanding microscopic physical process-Clarifying mesoscopic coupled heat and mass transfer-Optimizing macroscopic performance", the anisotropic ion diffusion behavior on the solid-liquid interface of nanoporous membranes has been investigated via first principle simulation. In addition, a dimensionless analysis is carried out with respect to the coupled Poisson-Nernst-Planck equation and Navier-Stokes equation. Under this circumstance, the dimensional multi-physical ion transport in nanofluidic channel and osmotic energy conversion is unified by a reduced number of dimensionless governing parameters, contributing to the alleviation of future experimental burden. Facing the challenge of low osmotic power density, we proposed the route of "solar photothermal enhanced ionic osmotic energy conversion under salinity-gradient". Due to the thermal modulation induced by solar energy, the ion selective transport capability is highly consolidated. Consequently, the ionic osmotic power density breakthrough 10 W/m^2 under 1 sun and sea/river water salinity-gradient, promoting the osmotic energy conversion into potential applications.
Biographical Sketch (Approximately 200 words)	Zhiguo Qu is Professor at Xi'an Jiaotong University, China. He received his PhD degree in Power Engineering and Engineering Thermophysics in 2005 from Xi'an Jiaotong University. He has worked in the Advanced Heat Transfer Company and the Pennsylvania State University as a visiting scholar. In 2020, He was supported by the National Natural Science Foundation for Distinguished Young Scholars. His research mainly focuses on Efficient Heat and Mass Transfer, Micro and Nano Energy Conversion, and Hydrogen & Fuel Cell Technologies. He published 282 papers, including 175 SCI Journal Paper (First/Corresponding Author 132) with an H index of 41 from Google Scholar. He also has 3 chapters for English book and 54 authorized invention patents. Besides, he involves in formulating a national standard, and he has been invited 28 times for presentation in conferences. He received the First Prize of Shaanxi Province Science Award (in 2020, ranked No.1), the Second Prize of National Scientific and Technological Progress Award (in 2015, ranked No.2), the Second Prize of National Technical Invention Award (in 2009, ranked No.3), and the First Prize of National Scientific and Technological Progress Award (Innovation Team, in 2017, ranked No.6).

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Ravi Rajamani	
Affiliation	drR2 consulting	
Invited Plenary Lecture		
Presentation Title	**Certification of Electric Aircraft**	
Abstract (Approximately 200 words)	Electric aircraft promise to usher in a new, more sustainable, aviation ecosystem. However, before they can do that, they need to certified. Many conventional standards for certification do not apply to the new technologies engendered by electric propulsion. In this talk, Dr. Ravi Rajamani will discuss some of the challenges inherent in the certification process and place it in the context of what standards development organizations are doing. This is based on a new research report published in March, 2021 called, “Unsettled Issues Regarding the Certification of Electric Aircraft,” coauthored with Anna Dietrich.	
Biographical Sketch (Approximately 200 words)	Ravi Rajamani is an independent consultant working on applying model-based and data analytics techniques to aerospace and other complex systems, especially in the areas of controls, PHM and all forms of propulsion. He has published six books including Electric Flight Technology: The Unfolding of a New Future. In addition, Dr. Rajamani is the author of many book chapters, journal papers, conference proceedings, and patents. Prior to his current job, Ravi worked at Meggitt, UTC and GE. He has a PhD from University of Minnesota, an MBA from University of Connecticut, an MSc from IISc, Bangalore, and a BTech from IIT, Delhi. He is active within various SAE technical committees and serves as the chair of the IVHM steering group. He currently serves as the Editor in Chief of the SAE International Journal of Aerospace and is part of the editorial board of two other journals. He has visiting research positions at the University of Connecticut and at Cranfield University, and has been elected a fellow of SAE and of IMechE.	

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Prof Vladimir Terzija, IEEE Fellow
Affiliation	Skoltech, Moscow, Russia

Invited Plenary Lecture

Presentation Title	**Advanced Monitoring and Control for Sustainable Green Energy Systems**
Abstract (Approximately 200 words)	As a result of high penetration of Converter Interfaced Generation (CIG), also called nonsynchronous generation, converter connected demand and mixed ac-dc transmission and even distribution networks, the nature of operation of modern electrical power systems became a challenge. The nature of the entire system became more complex, expressed in quite a new dynamics, but also a new way how to monitor, protect and control such a new system, the system playing one of the most critical role in progressing modern societies, the system enabling functioning of other critical infrastructures in all countries. On the other hand, availability of modern sensor and ICT technology opened new paradigms for coping with previously described challenges. The presentation is aiming of addressing new approaches of monitoring, protecting and controlling future electrical power systems. In this context, some of typical PMU-based Wide Area Monitoring, Protection and Control applications, also model-free and data driven, will be discussed and presented. Experience gathered from 3 flagship multi-million projects funded by Ofgem (UK) Network Innovation Competition, VISOR, EFCC and FITNESS projects, will be summarized and also discussed from the perspective of their extension to another level: integration of different energy systems and approaches for their operation, fostering flexibility and resilience of particular energy systems. The presentation will also attempt to demonstrate some of results achieved through hardware in the loop testing using Real-time Digital Simulator (RTDS).
Biographical Sketch (Approximately 200 words)	Vladimir Terzija was born in Donji Baraci (former Yugoslavia). He received the Dipl-Ing., MSc, and PhD degrees in electrical engineering from the University of Belgrade, Belgrade, Serbia, in 1988, 1993, and 1997, respectively. He is a Full Professor at Skoltech, Moscow, Russia. He is also a Distinguished Professor at the Shandong University, Jinan, China, where he has been since 2013. From 1997 to 1999, he was an Assistant Professor at the University of Belgrade, Belgrade, Serbia. From 2000 to 2006, he was a senior specialist for switchgear and distribution automation with ABB, Ratingen, Germany. From 2006 to 2020 he was the Engineering and Physical Science Research Council (EPSRC) Chair Professor in Power System Engineering with the School of Electrical and Electronic Engineering, The University of Manchester, Manchester, U.K. His current research interests include smart grid applications; wide-area monitoring, protection, and control; multi-energy systems; switchgear and transient processes; ICT, data analytics and digital signal processing applications in power systems. Prof. Terzija is Editor in Chief of the International Journal of Electrical Power and Energy Systems, Alexander von Humboldt Fellow, as well as a DAAD and Taishan Scholar. He is the recipient of the National Friendship Award, China (2019).

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Jianzhong Wu
Affiliation	School of Engineering, Cardiff University, UK

Invited Plenary Lecture

Presentation Title	**Energy Network Architectures Enabling a Carbon Neutral Future**
Abstract (Approximately 200 words)	Climate change is considered one of the major challenges currently facing the world. Many countries have set up their carbon neutrality targets to contribute to stopping global warming, the architectures of our energy networks will play a crucial enabling role for a green carbon neutral future. Energy networks exist primarily to exploit and facilitate temporal and spatial diversity in energy production and use and to exploit economies of scale where they exist. The energy trilemma (energy security, environmental impact and social cost) presents many complex interconnected challenges which have huge relevance internationally. These challenges vary considerably from region to region due to historical, geographic, political, economic and cultural reasons. As technology and society changes so do these challenges, and therefore the planning, design and operation of energy networks needs to be revisited and optimized in order to integrate more green energy technologies and support the transition to carbon neutrality. This talk will use a whole systems approach to analyze the interconnected and interdependent nature of energy network infrastructure, and introduce latest progress on research and development on energy network architectures. Three major types of energy network architectures will be introduced: regional and service-based energy networks with a focus on Peer to Peer energy systems; bulk transnational energy transmission networks; and differentiated and blended architectures of energy provision focusing on integrated multi-energy systems.
Biographical Sketch (Approximately 200 words)	Dr. Jianzhong Wu is Professor of Multi-Vector Energy Systems and Head of School of Engineering at Cardiff University. His research focus on Smart Grid and Multi-Vector Energy Systems. He has contributed to more than 50 EC, EPSRC and industry funded projects as a Principal Investigator (PI) or a Co-PI. He has published over 260 peer-reviewed papers and is a co-author of books "Smart Grid: Technology and Applications" (2012, Wiley), "Smart Electricity Distribution Networks" (2017, CRC) and "The Future of Gas Networks" (2019, Springer). He is a Co-Chair of INCOSE UK Energy Systems Interest Group, Co-Director of £18m UK Energy Research Centre, an Associate-Director of £5m EPSRC Supergen Energy Networks Hub, and a co-PI of £24.5m WEFO funded FLEXIS project for future integrated energy systems. He is also a co-PI of a £5m EPSRC project on Multi-Scale Infrastructure Systems Analytics, £36m Active Building Centre, and £12m Energy Revolution Consortium. He is a member of Wales Smart Energy System Group, Northern Power Grid Technical Panel of ED2 Business plan, and the Scottish Power Energy Networks Strategic Stakeholder Panel for England and Wales. He is President of the UK Branch of China Electrotechnical Society, an Associate Editor of Applied Energy (Impact Factor: 8.848@2020), Deputy Editor-in-Chief of IET Energy Systems Integration, and the Director of International UNiLAB on Synergies between Energy Networks. He is a Fellow of Energy Institute.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Yimin Wu
Affiliation	University of Waterloo

Invited Plenary Lecture

Presentation Title	**Semiconductor assisted photocatalysis for CO_2 reduction to liquid solar fuels**
Abstract (Approximately 200 words)	Development of sustainable and clean sources of energy, and mitigation of greenhouse gas emissions such as CO_2, is among the greatest challenges facing our planet. Recently, electroreduction has attracted considerable interest for removal of gaseous CO_2. However, it is inherently energy inefficient. Solar energy is the largest primary energy source available. Photocatalytic reduction of CO_2 using solar energy offers an efficient way to convert and store solar energy in the form of chemical fuels, particularly liquid fuels such as methanol. This invited talk will focus on CO_2 reduction in a metal oxide system, namely Cu_2O as inexpensive photocatalysts with good mutlielectron transfer properties due to its loosely bonded d electrons. Cu_2O shows intrinsic p type conductivity due to the presence of negative charged Cu vacancies with one of the lowest electron affinities, identifying Cu_2O as an optimal candidate for reduction of CO_2. Atomic level understanding of active sites in Cu_2O will be presented, that leads to the discovery of the facet specific adsorption and subsequent light induction of CO_2 exclusively into liquid fuel-methanol. The activity of these active sites will be unraveled, in operando, on a single particle level, nanoparticles are designed with high active facet selective active sites and particles activity.
Biographical Sketch (Approximately 200 words)	Dr. Yimin Wu is an assistant Professor in the Department of Mechanical and Mechatronics Engineering and Waterloo Institute of Nanotechnology (WIN), Director of Materials Interfaces Foundry, at the University of Waterloo. Dr. Wu received his DPhil degree in Materials from the University of Oxford in 2013; then worked as a SinBeRise Postdoctoral Fellow at the University of California, Berkeley, and Lawrence Berkeley National Laboratory. Prior to joining Waterloo in 2019, he was focusing on the advanced catalysts and battery research at Argonne National Laboratory and worked as a research assistant professor at University of Illinois. He has published more than 40 high-quality journal papers in prestigious journals such as Nature, Nature Energy, and Nature communications. He is also listed as a primary inventor on 1 US/international patent. His research has been highlighted by mainstream media including Canadian Press, CBC news, BNN Bloomberg, and French Science Magazine. He has won many awards including WIN research leaders award (2020), MIT Technical Review Innovators Under 35 Award Finalist (2020), SinBeRise Postdoctoral Fellowship at the University of California, Berkeley (2013), UK EPRSC Doctoral Prize (2012), Chinese Government Award for Outstanding Students Abroad (2012). His research has been funded by both federal and provincial government agencies.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Mingfa Yao	
Affiliation	State Key Laboratory of Engines (SKLE), Tianjin University	

Invited Plenary Lecture

Presentation Title	Developing Trend of IC Engine Technology for Low-Carbon and Carbon-Neutrality
Abstract (Approximately 200 words)	Despite the rapid development of new energy technologies, especially the renewables, still uncertainties exist in the deployment of these technologies, and technology replacement is a slow and long process. Therefore, internal combustion (IC) engine is still the most widely used power device for a considerable period in the future. Reducing carbon emissions and achieving carbon neutrality are major challenges for IC engine. IC engine and its power train still have great potential for energy saving. Improving thermal efficiency is the most economical and practical technical way to achieve low-carbon IC engines. Advanced IC engine energy-saving technology, hybrid technology, and the use of low-carbon fuels (such as natural gas) are the development trend of low-carbon IC engine technology in the near and mid-term. Further, achieving carbon neutrality of IC engines is a long-term trend of IC engines. By burning biomass fuels, "green" hydrogen and renewable synthetic fuels, IC engines can be used to achieve carbon neutrality. IC engine will also play an important role in the future renewable energy storage system. Therefore, the advanced combustion technology and emission control technology for biomass fuel, hydrogen and synthetic fuel are the key technologies for IC engine to realize carbon neutrality.
Biographical Sketch (Approximately 200 words)	Professor Mingfa Yao received his PhD degree from Tianjin University in 1999. He is a chair professor in Tianjin University and head of the Innovation Research Group supported by the National Natural Science Foundation of China. From March 2009 to March 2021, he served as the director of the State Key Laboratory of Internal Combustion Engines (Tianjin University). In 2011, he was awarded the National Outstanding Young Scholarship supported by the National Natural Science Foundation of China. Professor Yao has been engaged in the research of engine combustion reaction kinetics, combustion theory and combustion technology, and alternative fuel combustion of IC engines. He has chaired more than 50 key cooperation projects supported by the government and industry, and is the head of the national key R&D planning project. His outstanding technical contributions and leadership are in advanced engine combustion. His significant achievements have benefited both the automotive industries and educational institutes. He won the second prize of National Science and Technology Progress Award (2017), the first prize of Tianjin Technology Invention Award (2016), the first prize of Tianjin Natural Science (2020) and the first Award of Technology Invention by the Machinery Industry Federation (2020). He published 150 papers in international journals and was cited more than 6000 times. He was awarded the "Distinguished Visiting Fellow Award" by the Royal Engineering Society and was selected as a fellow of SAE International and a fellow of Combustion Institute in 2020. In 2018, he was selected as one of the world's highly cited scholars in Clarivate Analytics, he was also selected as one of Elsevier's 2019 and 2020 China Highly Cited Scholars.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Jianbo Zhang
Affiliation	Tsinghua University

Invited Plenary Lecture

Presentation Title	Startup of Fuel Cells and Lithium-ion Batteries from Low Temperatures
Abstract (Approximately 200 words)	Vehicle electrification is gaining momentum for its contribution to the city air quality and its potential to promote the use of green energy. However, the diffusion of pure electric vehicle, i.e. battery electric vehicle (BEV) and fuel cell electric vehicle (FCEV), in the high-altitude area, is hindered by the limited performance and exacerbated degradation of lithium-ion batteries (LIB) and fuel cells (FC) at low temperatures. In this lecture, various materials and operation strategies to alleviate such cold startup problem will be first reviewed. After that, our work based on the idea of internal heating using alternating current will be presented. It is shown that such methods can achieve quick startup with negligible degradation and minimal energy consumption. The issues and theory for the extension of the methods to battery and stack are discussed and validated with experiment. Finally, further research directions will be highlighted.
Biographical Sketch (Approximately 200 words)	Dr. Jianbo Zhang received his PhD degree in Aerodynamics from the University of Tokyo, Japan. He worked in Nissan Research Center on the R&D of fuel cell and LIB during 2000~2011. He was offered the professorship in the Department of Automotive Engineering, Tsinghua University, China, and set up the Lab of Electrochemical Power Sources in 2011. His research interests center around the diagnosis and design of electrochemical devices such as fuel cell, lithium-ion cell, and electrolyzer. He co-authored the book The Theory and Application of the Structure Design for Lithium-Ion Batteries (in Chinese). He is a member of the Scientific Committee of International Symposium of Electrochemical Impedance Spectroscopy, a member of the Scientific Committee of European Fuel Cell Forum, and an editor for the journals Battery, Automotive Innovation, eTransportation, etc.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Li Zhao
Affiliation	Tianjin University

Invited Plenary Lecture

Presentation Title	**How to Approach Carnot cycle：Methodology and Application**
Abstract (Approximately 200 words)	Significant interests in thermodynamic cycles arise in recent years, such as Organic Rankine Cycle (ORC), Kalina cycle, et al. The ultimate aim of such researches, which could be traced back to more than one century ago, has not changed with a tireless pursuing to the Carnot cycle. In existing researches, a working fluid, as a medium for energy conversion, plays an important role in the thermodynamic cycle: (1) relative to ideal cycle, most of actual power cycles in the engineering field cannot operate without working fluid; (2) energy efficiency, considering the analysis of second-law efficiency, of actual cycle has a significant decrease due to the introduction of a working fluid. Thus, working fluid is a hot spot in the research of thermodynamic cycle in recent years. Zeotropic mixture has flexibility in thermo-physical properties with a potential for cycle performance enhancement. The effect of thermo-physical properties of zeotropic mixture should be considered when determining the cycle structure and the design of components. This talk will introduce a novel 3D construction method for thermodynamic cycles based on the zeotropic mixture. The principle of 3D construction method will be introduced and several application cases based on this method will also be introduced.
Biographical Sketch (Approximately 200 words)	Professor Zhao Li commits to solve key problems in the efficient utilization of medium and low temperature heat energy. He has carried out in-depth research on the construction of advanced thermodynamic cycles, distributed multi-system based on ORCs, utilization of zeotropic working fluids, and reduction of entropy increase in thermal processes. He has published nearly 100 papers, with over 3,000 citations, and 20 patents in China and abroad. His research is supported by National Natural Science Foundation of China, national key research and development program and national 863 program. In the past five years, he has received a “WSSET Innovation Awards 2017” for his technological innovation on power generation, a Tianjin Science and Technology Award, a Tianjin Natural Science Award, and an Energy Innovation Award of China Energy Research Association.

Abstracts of Keynote Sessions

Biographies of Keynote Speakers

CONFERENCE WEBSITE

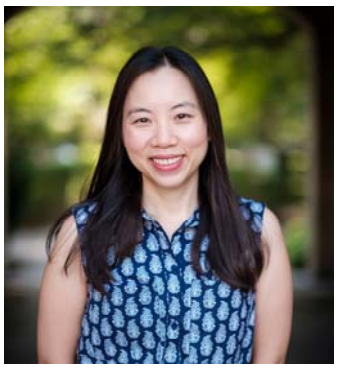
https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Prof. Aimy Bazylak
Affiliation	University of Toronto



Invited Keynote Lecture

Presentation Title	**In operando imaging for carbon dioxide electrolysis**
Abstract (Approximately 200 words)	A sustainable future requires that we harness renewable but intermittent sources of energy and transmit or store it to address real world patterns of use. Renewable energy can be used to sequester CO_2 into a variety of products, such as carbon-neutral fuels and chemical feedstocks, thereby reducing atmospheric CO_2. Reducing atmospheric CO_2 levels requires the substitution of clean power for carbon-intensive fuels as well as CO_2 conversion processes that transform emissions into useful chemical products. This talk will discuss our latest work on performing in operando imaging of carbon dioxide electrolyzers to understand the role of mass transport losses on overall performance.
Biographical Sketch (Approximately 200 words)	Prof. Aimy Bazylak is the Canada Research Chair in Thermofluidics for Clean Energy and Professor in the Department of Mechanical and Industrial Engineering at the U of T. In 2011, she was awarded the I.W. Smith Award from the Canadian Society for Mechanical Engineering, and she received the Ontario Early Researcher Award in 2012. From 2015-2018, she served as the Director of the U of T Institute for Sustainable Energy. In 2015 she was named an Alexander Von Humboldt Fellow (Germany), and in 2019 she was named a Fellow of the American Society of Mechanical Engineers. In 2020, she was named a Helmholtz International Fellow (Germany), was awarded the U of T McLean Award, and was elected to the Royal Society of Canada College of New Scholars, Artists and Scientists.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Rui Xiong
Affiliation	Beijing Institute of Technology

Invited Keynote Lecture

Presentation Title	**AI accelerates the development of a new generation of battery management systems**
Abstract (Approximately 200 words)	Effective management of lithium-ion batteries is a key enabler for a low carbon future, with applications including electric vehicles and grid scale energy storage. The lifetime of these devices depends greatly on the materials used, the system design and the operating conditions. This complexity has therefore made real-world control of battery systems challenging. This invited talk will focus on: (1) Analysis of new energy vehicle safety accidents and summary of causes in the past 10 years, (2) Analysis of the aging mechanism of lithium-ion batteries and battery performance degradation characteristics, (3) Multi-dimensional parameter characterization system of power battery aging and its observation, expression and modeling methods, (4) The application of artificial intelligence in the life prediction of battery system, (5) the challenge of rapid prediction and evaluation of the remaining life of battery, and emerging techniques and perspective comments provided towards more intelligent and interconnected battery management in the future.
Biographical Sketch (Approximately 200 words)	Rui Xiong received his M.Sc. degree in vehicle engineering and Ph.D. degree in mechanical engineering from Beijing Institute of Technology, Beijing, China, in 2010 and 2014, respectively. He is a Professor at the Beijing Institute of Technology, Beijing, China. From 2019 to 2020, he was a Visiting Professor at the Massachusetts Institute of Technology, Cambridge, MA, USA. He has authored more than 100 journal papers, 4 monographs and holds more than 30 patents. His research interests include Intelligent electrified vehicles, energy storage, batteries, digital twin, and machine learning. Dr. Xiong is an IET Fellow. He has been continuously selected as the HIGHLY CITED RESEARCHER from Clarivate Analytics from 2018 to 2020. He was a recipient of the First Prize of Natural Science Award of the Ministry of Education of China in 2018. He serves as the Chairman of the Battery System Subcommittee at IEEE PES Electric Vehicle Satellite Committee-China. He serves as Associate Editors for the IEEE Transactions on Intelligent Transportation System, IET Power Electronics, IET Intelligent Transport Systems, and on the Editorial Board for the Applied Energy and Electrical Engineering. He is also the Chairman of five international conferences in the field of electric vehicles.

CONFERENCE WEBSITE

https://www.iage-net.org/igec2021

2021 International Green Energy Conference

(IGEC-XIII)

July 15-18, 2021 | Tianjin, China

Name	Yan Yin
Affiliation	Tianjin University

Invited Keynote Lecture

Presentation Title	**Design of transition metal-nitrogen-carbon catalyst layer for anion exchange membrane fuel cell**
Abstract (Approximately 200 words)	Pt/C is the mainstream catalyst for fuel cells and is commercially used due to its highly electrocatalytic activity for the oxygen reduction reaction (ORR). However, the high cost and scarcity of Pt remain great challenges for large-scale commercial applications of fuel cell. Developing highly efficient non-noble catalysts for oxygen reduction reaction (ORR) is an urgent requirement for reducing fuel cell cost. As a hot spot material, zeolitic imidazolate frameworks (ZIFs) are being extensively studied as the precursors for synthesizing highly reactive catalysts, due to the diversity of metal-nitrogen-carbon as well as controllability of porous structure. Great progress has been achieved on the oxygen reduction activity in alkaline environment, with much effort having been devoted to the design of active chemical structures and the increase in active site density. When these catalysts are applied to the anion exchange membrane fuel cell (AEMFC), beside their high reactivity, the mass transfer property within the catalyst layer (CL) is also of high significance for AEMFC performance, especially at high current density operation. Here, we report the recent work in State Key Laboratory of Engines (SKLE) of China focusing on the non-noble catalysts layer to improve the AEMFC performance, including the design of nano-structured transition metal-nitrogen-carbon catalyst as well as controllable construction of high-performance CLs.
Biographical Sketch (Approximately 200 words)	Dr. Yan Yin is working at State Key Laboratory of Engines (SKLE) at Tianjin University, China. She received her Ph.D. in 2003 from Yamaguchi University, Japan, in the field of Symbiotic Environmental Systems Engineering. Dr. Yin's research interests include fuel cells; advanced membrane materials; renewable energy; gas separation; hydrogen economy, etc. She holds 10+ international patents and has published about 100 papers including articles in Nature Materials, Nature Communications, Energy & Environmental Science, etc., with nearly 3000 citations and an H-index of 33. She has been one of the Chinese Most Cited Researchers 2019 by Elsevier (2020).

Special Sessions

Special Session: **Advances in Redox Flow Batteries**

Session Description:

The demand for renewable energy such as solar and wind is increasing with the exacerbated consumption of fossil energy and environmental pollution. While renewable energy has the intermittent and discontinuous nature, the redox flow battery (RFB) is considered to be the most promising technology for large-scale energy storage due to the advantages of separated and adjustable power and capacity as well as high energy efficiency. This special session will be devoted to the latest development and R&D achievements for redox flow batteries, ranging from nanomaterials to systems, and from modeling, simulations and analyses to experimental investigations.

Session Organizers:

Qian Xu (Jiangsu University)

Qixing Wu (Shenzhen University)

Session Contents:

Topic 1: The synergistic effect of additives and outer fields on the performance of non-aqueous redox flow batteries

Topic 2: Development of Electrode Design for High-Power Vanadium Redox Flow Batteries

Topic 3: Recent Advances in Vanadium Flow Battery Design and Manufacture at Institute of Metal Research, Chinese Academy of Sciences

Topic 4: Optimizing the flow and transport in VRFB for improved performance

Topic 5: Local Porosity and Microstructure Optimization for Redox Flow Battery Electrode

Topic 6: Material designs and testings of organic redox flow batteries based on multi-electron quinone molecule

Topic 7: Adapted Thin-film Photovoltaics Coupled to Redox Flow Batteries for Unbiased Solar Energy Storage

Topic 1: The synergistic effect of additives and outer fields on the performance of non-aqueous redox flow batteries

Peizhuo Sun, Rong Chen, Qian Xu*
Institute for Energy Research of Jiangsu University, Jiangsu University, Zhengjiang 212013, China
xuqian@ujs.edu.cn

Abstract

The non-aqueous redox flow battery (NARFB) has been studied intensively due to its unique advantages. However, its low performance still hinders the wide application of NARFB. Adding additives to the electrolyte or applying outer fields are possible solutions. In our works, we found that adding low-cost, high catalytic activity additives to the electrolyte can enhance the electrochemical reaction kinetics of the redox pair. The outer fields can also accelerate the movement of ions.

When the additive and the outer field act together, the synergistic effect of them improves the battery performance to a greater extent. The effect of the outer field makes the additive in the electrolyte mixed more evenly, and increases the contact area between the additive and the reactive ions, which makes it easier to overcome the activation energy and speed up the electrochemical reaction. Meanwhile, the charge transfer resistance decreases, and the electrochemical polarization is also improved. The effect of the synergistic effect of additives and outer fields on the electrochemical characteristics and mass transfer of the battery was studied in order to provide prospect for the future development of advanced non-aqueous flow batteries.

Keywords: flow battery; non-aqueous; additives; outer fields

Dr. **Qian Xu** received his Ph.D. degree in Mechanical Engineering from the Hong Kong University of Science and Technology in 2013, and worked as a postdoctoral researcher at the same university until August 2014. In 2017, he worked at University of Waterloo, Canada as a visiting scholar. Currently he is a Professor at Institute for Energy Research, Jiangsu University, China. He has received more than 10 research funds from National Natural Science Foundation of China, China Postdoctoral Foundation and Jiangsu Provincial Foundation etc., and made contributions in the areas of fuel cells, redox flow batteries, multi-scale multiphase heat and mass transport with electrochemical reactions, and computational modeling. He has published over 70 peer-reviewed journal papers (4 of them are ESI hot papers) and 2 academic books with more than 2400 citations (Google Scholar, H-Index 24), and applied 17 patents with 4 issued. He serves as the Member of Editorial Board of Progress in Energy & Fuels, as well as the reviewer for more than 20 international academic journals. He received the “Six Talent Peaks” award of Jiangsu Province in 2016.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-002 (invited)

Topic 2: Development of Electrode Design for High-Power Vanadium Redox Flow Batteries

Qixing Wu
Shenzhen Key Laboratory of New Lithium-ion Batteries and Mesoporous Materials, College of Chemistry and Environmental Engineering, Shenzhen University, Shenzhen 518060, China
qxwu@szu.edu.cn

Abstract

Among various energy storage methods, all vanadium redox flow batteries (VRFB) have received tremendous attentions due to the remarkable design flexibility, excellent energy and power scalability, and potentially low cost. However, the component cost of a VRFB stack is still high to achieve the target set by the U.S. department of energy. Improving the power density of a VRFB can be an effective way to reduce the stack size for cutting down the cost of the whole system. In this talk, recent development of electrode designs in our group will be briefly summarized. Firstly, a multiscale-pore-network carbon felt electrode is developed by the carbothermic reduction method to facilitate the transport and electrochemical reaction of active ions. To further improve the performance of a VRFB, Bismuth nanosphere and nanoleaf coated carbon felts are introduced for VRFB electrode. It has been demonstrated that with the nanoleaf decorated electrode electrodes, the VRFB can yield a superior power density of 3.05 W/cm2 at room temperature. In addition, the newly developed VRFB can stably charge/discharge at a remarkably high current density of 800 mA/cm2 for over 10,000 cycles and maintain an energy efficiency of 80% without electrolyte refueling.

Keywords: flow battery; all vanadium; electrode design; carbon felt

Dr. **Qixing Wu** received his B.S. degree and M.S. degree in Thermal Engineering from Huazhong University of Science and Technology, China in 2005 and 2007, respectively, and earned his Ph.D. degree in Mechanical Engineering from the Hong Kong University of Science and Technology in 2011. He is a winner of PhD Research Excellence Award from HKUST (2012) and a finalist to the Young Scientist Award from the Hong Kong Institute of Science (2013). After graduation, he worked as a postdoctoral researcher in the Department of Mechanical Engineering at HKUST. In 2012, he began his independent career at Shenzhen University and currently is an Associate Professor of Energy Science and Engineering. As a Principal Investigator, he has received 10 research funds (> 7 million CNY) from National Science Foundation of China and Shenzhen Science, Technology and Innovation Commission, and published more than 50 papers in peer-reviewed journals. His research interest focuses on the understanding of transport phenomena and structural design in electrochemical energy system including fuel cells, metal-air batteries and flow batteries.

Topic 3: Recent Advances in Vanadium Flow Battery Design and Manufacture at Institute of Metal Research, Chinese Academy of Sciences

Ao Tang
Institute of Metal Research, Chinese Academy of Sciences, Shenyang, China
Email: *a.tang@imr.ac.cn*

Abstract

As one of the earliest flow battery developers in China, Institute of Metal Research Chinese Academy of Sciences (IMR-CAS) starts its research and development in vanadium redox flow battery (VFB) since 2003. Recent activities in vanadium flow battery development at IMR-CAS covers key materials development, stack design and manufacture, and system scale-up and demonstrations. Over the last decade, IMR-CAS has published over 60 research papers and filed more than 40 Chinese patents on vanadium flow batteries. In this presentation, the most recent advances in VFB design and manufacture together with fundamental research progress on novel organic/metal based flow batteries at IMR-CAS will be summarized.

Dr. **Ao Tang** is currently a Professor at the Institute of Metal Research, Chinese Academy of Sciences (IMR-CAS). He received his PhD in Chemical Engineering at the University of New South Wales (UNSW) under the supervision of Emeritus Professor Maria Skyllas-Kazacos, the inventor of vanadium redox flow battery. After that, he firstly started his academic career as a postdoctoral research associate at UNSW, and subsequently served as the Technical Director for Vanadis Energy Ltd in China who acquired the exclusive licence from UNSW to commercialize the UNSW vanadium flow battery technology. In 2016, he joined the Institute of Metal Research, Chinese Academy of Sciences, receiving an outstanding scholar award to continue his research and technology development on electrochemical energy storage systems, in particular flow batteries. He has over 10 years' experiences on flow battery design and development and his current research interests include (but not limit to) novel redox chemistry design, synthesis and fabrication of key materials, multi-scale modelling and simulaiton for both metal and organic based flow batteries.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-004 (invited)

Topic 4: Optimizing the flow and transport in VRFB for improved performance

Weiwei Yang
School of Energy and Power Engineering, Xi'an Jiaotong University, China
yangww@mail.xjtu.edu.cn

Abstract

Vanadium Redox Flow Battery (VRFB) is regard as a promising choice for electricity storage. As we know that the performance of VRFB are tightly related to the coupling processes of electrolyte flow, species-ions-electrons transport, and electrochemical reactions inside the cell. It will be beneficial for boosting overall battery performance by optimizing battery components and managing the flow and transport processes. In this report, we will first introduce the development of a rotary serpentine flow field and modification of blocked serpentine flow field to intensify electrolyte penetration, convection and improve the uniform electrolyte distribution with the purpose of improving battery net discharging performance. Secondly, asymmetric electrode and flow field are proposed and optimized by genetic algorithm in consideration to the different polarization behaviors of electrochemical reactions in both electrodes. It is proved that the net discharge power is obviously improved with asymmetric structure. Thirdly, based on the understanding of ions crossover mechanism and the identification of key influencing factors for imbalanced species transport, asymmetric electrode compression strategy is proposed for eliminating the imbalance of ions crossover and suppressing capacity decay during cycling.

Dr. **Wei-Wei Yang** got his PhD in 2009 at Hong Kong University of Science and Technology (Hong Kong, China). He is currently a Professor at Xi'an Jiaotong University and serves as the dupty director of Department of Thermo-fluid Science & Technology in School of Energy and Power Engineering. His research is focused on renewable energy utilization, fuel cells and energy storage. Especially, he has acquired significant research experience in modeling and simulation of Fuel Cells and RFBs. He has co-authored 1 book and 2 book chapters, over 70 peer-reviewed international journal publications in energy field, and 4 authorized patents. He also obtained 1 State Natural Science Award (2nd class, 2013, 5th winner) for the research project on fuel cell, and 1 State Scientific & Technological Progress Award (1st class, 2017, 14th winner) for the research on numerical heat/mass transfer.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-005 (invited)

Topic 5: Local Porosity and Microstructure Optimization for Redox Flow Battery Electrode

Menglian Zheng
School of Energy, Zhejiang University, Hangzhou, China
menglian_zheng@zju.edu.cn

Abstract

Redox flow batteries are expected to provide a variety of applications ranging from kW- to MW- scales in future's energy systems. This is enabled by the unique feature of RFBs wherein they exhibit decoupled energy and power capacities and scalable configurations. Despite that many flow field designs have been proposed over the last few decades for enhancing mass transfer uniformity of reactants, reactants are yet uniformly distributed within the porous electrode. In addition, the circulating process may cause high pumping losses, especially in large-scale battery stacks. The above factors are limiting the maximum current density applied to the battery stack. With advanced manufacturing technologies becoming available, such as electrospinning technology and three-dimensional printing technology, the essential fiber properties can be adjusted by modifying the manufacturing parameters, enabling a bottom-up design of the electrode structure. The question is could we optimize heterogeneous electrode structure with varying properties such as fiber arrangement and porosity at different locations of the cell to improve the reaction distribution uniformity within the porous electrode? The present study aims to answer the above question through the development of an optimization model for optimizing local porosities and fiber alignment for redox flow batteries.

Dr. **Menglian Zheng** is currently an Associate Professor in the School of Energy Engineering at Zhejiang University. She earned a B.S. degree in Energy & Environment Systems Engineering from Zhejiang University, China in 2011. She then came to the U.S. in 2011 and earned her Ph.D. degree from Columbia University in 2015. Her research focuses on three different aspects of flow batteries and energy systems, including (1) storage dispatch strategies to enable intelligent energy systems; (2) flow field design and mass transfer enhancement of redox flow batteries; (3) structure and system optimizations for non-aqueous flow batteries.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-006 (invited)

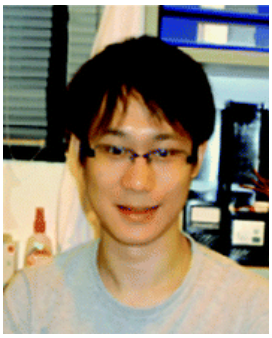
Topic 6: Material designs and testings of organic redox flow batteries based on multi-electron quinone molecule

Jackie Puiki Leung
School of Energy and Power Engineering, Chongqing University, Chongqing, China
leungpuiki@hotmail.com

Abstract

To ensure deeper market penetration, electrolytes of redox flow batteries (RFB) should be based on low-cost and abundant materials. All-organic systems based on new types of organic molecules are developed, from a study of theoretical calculations, fundamental chemistry to full-cell testing. The selection of organic active materials in relation to their physical and chemical properties (reaction kinetics, electrode potentials and solubilities) were facilitated by density functional theory (DFT) calculations. Based upon the results, we proposes new multi-electron active molecules with new reaction mechanisms that are capable of delivering multi-electron transfers and exhibiting superior electrode potentials in both aqueous and non-aqueous electrolytes. The proposed molecules were successfully demonstrated with reasonable solubilities (> 1 M) while demonstrating reversible behaviours using conventional electrochemical techniques. Following these, stable charge-discharge cycling performances of these active molecules were also performed with relatively high energy efficiencies (> 60 %) over prolonged operations, demonstrating the prospects of alternative organic molecules for future redox flow battery applications.

Keywords: flow battery; organic; reaction mechanism



Dr. Puiki Leung received his BEng in Engineering Sciences and PhD in Electrochemical Engineering both from the University of Southampton. His PhD project focused on the development of a zinc-cerium redox flow batteries. After the graduation, he has held a number of research positions in several leading universities/institutions under the supervisions of top experts in the areas of energy storage and material processing. His research interests lie in the fields of electrochemical devices, mathematical modelling, mechanical testing and novel characterization/manufacturing techniques. Now he is a Professor in Chongqing University, China. Dr. Puiki Leung has published more than 60 peer-reviewed journal papers with more than 2700 citations (h-index 23). He was also awarded a “Marie Curie fellowship” and has been proactive in seeking teaching experiences and collaborating with industrial companies.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-007 (invited)

Topic 7: Adapted Thin-film Photovoltaics Coupled to Redox Flow Batteries for Unbiased Solar Energy Storage

S. Murcia-López[1], C. Flox[2]

1. Catalonia Institute for Energy Research (IREC) C/ Jardins de les Dones de Negre 1, Sant Adrià de Besòs, Spain smurcia@irec.cat

2. Department of Chemistry and Materials Science, School of Chemical Engineering, Aalto University, 16100, FI-00076, Aalto, Finland

Abstract

The electrical conversion and storage of solar energy is a crucial world target in the long-term scenario. Therefore, the use and integration of photovoltaic (PV) technologies into different electrochemical processes such as water splitting and CO_2 reduction have been strongly developed in the last years. Following this approach, the direct coupling of PV to electrochemical storage systems as batteries, in order to directly convert and store the solar energy in a single device is an ideal alternative. Among several other configurations, the application of this concept to redox flow batteries has attracted attention considering their advantages, including decoupling of energy and power and large-scale development.

The selection of the redox pair used into the reported studies has been deeply dependent on the photo-active system. Therefore, many studies focused on metal oxides such as TiO2 3 and/or on PV tandem configurations, for instance, CdS/DSSC,4 have been applied to organic redox pairs and/or to vanadium redox flow batteries (VRFB) reaching limited state of charge (SoC). In this work, we report the adaptation and integration of thin film photovoltaics (multijunction Si and CIGS solar cells) to VRFB in a single device, showing the importance of matching the maximum power point of the PV device with the photocharge voltage of the RFB. Ultimately, promising solar-to-charge and overall round trip energy conversion efficiencies have been achieved, in unbiased devices reaching SoC values close to 100%.

Dr. Sebastian Murcia-Lopez obtained his PhD (Excellent Cum Laude) by Universidad de Sevilla (Spain) in 2013. He is currently a Senior Researcher at Catalonia Institute for Energy Research (IREC) in Barcelona, Spain. He has participated in several European, national and industrial projects, in activities related to photocatalytic and (photo)electrochemical approaches for energy storage, including production of synthetic fuels and development of redox flow batteries (RFB) based on vanadium and Zn-I2 chemistries. In this aspect, he has worked on the optimization of materials and in their evaluation in full devices, but also has focused on the possibilities to develop the so-called ”solar batteries”, through the integration of photoabsorbers and photovoltaic systems. During his career, he has earned several competitive grants such as Juan de la Cierva – Formación and a co-funded Marie Sklodowska Curie Actions fellowship, under which he carried out a one year postdoctoral research stay at Politecnico di Torino (Italy). Likewise, he has co-authored > 30 publications, has established strong international collaboration and has been involved in the supervision of several master and doctorate theses.

Special Session: **Water/Vapor Electrolysis**

Session Description:

Water or vapor electrolysis using membranes or other mediums has a good application prospect in hydrogen production, water treatment, and even air dehumidification. This technology is promising as it is also suitable for using renewable energy. Transport phenomena (heat, mass, momentum, and energy transport) at different scales from molecular to macros determine the electrolysis performance and energy efficiency. This session aims to address the research related to the modeling and performance improvement of water/vapor electrolysis. The topics include, but are not limited to, multi-scale modeling of transport phenomena, numerical simulation, system thermodynamics, transport enhancement, system optimization, energy utilization improvement, and renewable energy applications (solar, wind, etc.).

Session Organizers:

Ronghui Qi
(South China University of Technology)

Chuanshuai Dong
(South China University of Technology)

Session Contents:

Topic 1: Multi-scale modelling and material manipulations on PEM-based electrolyte dehumidifier:

Topic 2: Modulating molecular and microscopic structures of polymeric carbon nitride for boosting photocatalytic hydrogen and oxygen evolution

Topic 3: Hot carriers in metal-semiconductor photoelectrode for solar water splitting

Topic 4: A new liquid desiccant regeneration method for air dehumidification coupled with hydrogen production

Topic 5: Study of solid-state hydrogen storage based on metal hydride and its application in fuel cell power system

Topic 6: Experimental Study of Two-phase Flow in PEM Electrolytic Cells

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-011 (Invited)

Topic 1: Multi-scale modelling and material manipulations on PEM-based electrolyte dehumidifier:

Ronghui QI*, Lijuan Huang

Key Laboratory of Enhanced Heat Transfer and Energy Conservation of Education Ministry, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou 510640, China

qirh@scut.edu.cn

Abstract

As an independent and ultra-compact method, PEM-based dehumidifiers are promising. This system operates through a low DC electric field, without any cooling/regeneration equipment. The dehumidifier can operate efficiently under extreme conditions, such as sub-zero dew point, high temperature (>60°C) and low humidity conditions (<45%). However, the accurate modelling of heat and mass transport with electrochemical reactions is still challenging. The presentation will introduce the multi-scale theoretical model developed for PEM-based dehumidifier, which is combined with the mesco-scale modelling of anode-side catalyst layer (CL) with reconstructed microstructures by the lattice Boltzmann method and the macro-scale modelling of air channel and diffusion layer (DL) by finite different method and the software COMSOL. Results showed that the CL microstructure (especially the particle shape) significantly affects the air outlet parameters of PEM dehumidifiers, especially in the beginning state. The randomly arranged catalyst particles makes CL the hottest (2~3°C higher) and driest (half the DL concentration) part of PEM element, which severely limits the whole performance. By applying the linear fillings of CL, the dehumidification rate was almost doubled. Based on this study, several material manipulations of catalyst were conducted.

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, such as electrolytic and desiccant absorption/adsorption ones, and heat&mass transfer enhancement mechanism. As the first or corresponding author, she have published more than 50 international peer-reviewed papers, including 35 SCI papers. She has received the Distinguished Young Scholar from Natural Science Foundation of Guangdong Province. She has in the editorial board for SCI journal <*International Journal of Green Energy*>, used to be a guest editor of SCI journal <*Heat Transfer Engineering*>.

Topic 2: Modulating molecular and microscopic structures of polymeric carbon nitride for boosting photocatalytic hydrogen and oxygen evolution

Xiaoming Fang*, Zehao Li, Qiong Liu

cexmfang@scut.edu.cn

Key Laboratory of Enhanced Heat Transfer and Energy Conservation, The Ministry of Education, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou 510640, China.

Abstract

Photocatalytic water splitting to produce hydrogen provides an ideal solution to address the issues concerning energy shortage and environmental contamination. Developing semiconducting photocatalysts is critical to realize this hydrogen production technology. Although large quantities of semiconductor-based photocatalysts have been widely explored in recent years, none of them can meet the requirements for the practical application of this technology. It is still necessary to develop high-performance, low cost and robust photocatalysts. Amongst the reported photocatalysts, polymeric carbon nitride (GCN), a metal-free polymeric semiconductor, is a promising one, owing to its advantages of low cost, favorable energy band positions, and good stability. However, only a moderate photocatalytic activity has been achieved by PCN up to now. Consequently, it is of significance to explore effective strategies to increase the photocatalytic activity of PCN. In this talk, two kinds of highly active PCN photocatalysts, developed by our group, will be presented. The first one is a doped PCN prepared via the copolymerization between urea and theobromine, which exhibits improved performance for oxygen evolution; the second one is highly porous PCN microtubes, obtained from a one-dimension supramolecular precursor synthesized from a liquid-liquid interfacial self-assembly strategy, which showed remarkably enhanced activity for hydrogen evolution.

Short Bio

Professor Xiaoming Fang received her bachelor's degree in organic chemical engineering from Chengdu University of Science and Technology (now Sichuan University), China, in 1990 and her Ph.D. in chemical engineering from South China University of Technology in 2002, and did postdoctoral research at Kyushu Center, AIST, Japan, in 2003. She is now a full professor at South China University of Technology. Her research interests include photocatalytic materials, photo-thermal conversion materials, and composite phase change materials for thermal energy storage. She has contributed to more than 150 peer reviewed papers with over 7000 citations, along with an H-index of more than 40.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-013 (Invited)

Topic 3: Hot carriers in metal-semiconductor photoelectrode for solar water splitting

Lixia Sang*, Lei Lei, Zexin Yu, Yunlong Gao

Key Laboratory of Enhanced Heat Transfer and Energy Conservation, Ministry of Education and Key Laboratory of Heat Transfer and Energy Conversion, Beijing Municipality. Beijing University of Technology, Beijing, China, 100124

sanglixia@bjut.edu.cn

Abstract

Hot carrier is the basic energy transfer medium between photon energy, electric energy and chemical energy. More and more researches have paid increasing attention to the solar energy conversion theory based on hot carrier, which is of great significance to develop the eco-friendly "solar-to-hydrogen" technology. Above all, how to fabricate the metal-semiconductor composite with the optimized structure which is beneficial for the formation and transfer of the hot electrons. Another important problem is how to develop the hot carrier device in photoelectrochemical hydrogen production system. This talk aims to give some answers and reveal the energy transfer mechanism of hot carrier excited by the solar energy in micro/nano scale and the specific interface.

Keywords: Hot carrier, solar-to-hydrogen, water splitting, photoelectrode

Short Bio

Professor Lixia Sang received her Ph.D. in 2004 in Industrial Catalysis from Tianjin University with Professor Shunhe Zhong, studying photo-stimulated surface catalysis. Since then, she has been a faculty member at Beijing University of Technology and Full Professor since 2013. She pursued his research as a Visiting Scholar at Case Western Reserve University from 2012 to 2013, where she was exposed to the advanced nanomaterials and the femtosecond laser technique under the directorship of professor Clemens Burda. She also became a member of 2019 International Clean Energy Talent Program of CSC and completed the three-month study and exchange mission in Sweden. Currently, her research is focused on solar energy conversion materials with specific interest in charge-transfer mechanism for solar fuels.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-014 (Invited)

Topic 4: A new liquid desiccant regeneration method for air dehumidification coupled with hydrogen production

Qing CHENG

School of Energy Science and Engineering, Nanjing Tech University, Nanjing, China, 211816

chengqingny@njtech.edu.cn

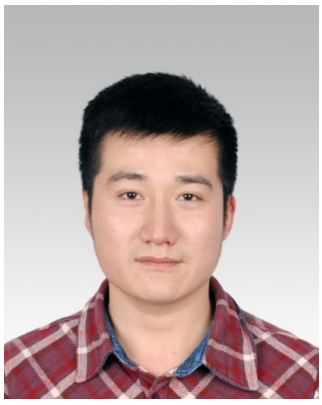
Abstract

In recent years, the energy shortage caused by refrigeration and air-conditioning equipment in buildings has increased seriously, especially in high-temperature and high-humidity areas. When the dehumidification load of air is large, traditional refrigeration dehumidification method needs to cool the air below its dew point temperature to meet the dehumidification requirement. Then, the air requires to be heated to meet the temperature requirement, which causes a great waste of energy. Liquid desiccant air-conditioning method can solve this problem perfectly. In order to increase the regeneration performance of liquid desiccant under severe climate, this topic proposed a liquid desiccant regeneration system which can also produce hydrogen. The system can assist the solar thermal regeneration method for liquid desiccant under high temperature and humidity climate, meanwhile, this system effectively uses the polarization reaction in the electrode chamber of the electrodialysis regenerator to produce hydrogen, which is especially suitable for enterprise buildings carrying out hydrogen production. Moreover, this system can use low-cost electricity at night to store energy, alleviating the peak-to-valley difference in power load and achieving the goal of improving system economy.

Keywords: Dehumidification; Liquid desiccant regeneration; Electrodialysis; Hydrogen production

Short Bio

Dr. Qing Cheng has rich research experience in air dehumidification, building energy-saving and solar energy use, solar heat pump and heat pump drying and reverse Brayton air circulation. He has authored more than 30 technical papers published on and not limited to Renewable and Sustainable Energy Reviews, Energy, International Journal of Refrigeration, Building and Environment, Energy and Building.



Topic 5: Study of solid-state hydrogen storage based on metal hydride and its application in fuel cell power system

Zhen WU

School of Chemical Engineering and Technology, Xi'an Jiaotong University, Xi'an, China, 710049

wuz2015@mail.xjtu.edu.cn

Abstract

Hydrogen storage technology is one of the bottlenecks in the hydrogen energy industrial chain, especially when used in the portable and mobile occasions. Compared with traditional compressed hydrogen storage technology, the solid-state hydrogen technology based on metal hydride (MH) has the advantages of high energy density, low cost and intrinsic safety. During the hydrogen absorption process, the reaction between MH and hydrogen gas releases a large amount of heat; while the reaction needs external heating during desorption process. Therefore, efficient heat management is necessary for metal hydride reactor (MHR). In this study, we designed a kind of high-capacity metal hydride by co-doping transition metal and nonmetal for hydrogen storage, which has the hydrogen capacity of 9.7 wt.% at the dehydrogenation temperature of 85 ^{o}C. Besides, we proposed phase change material (PCM) as MHR heat management to recycle the heat released during hydrogen absorption process for hydrogen desorption process. The results showed that the hydrogen storage efficiency can achieve approximately 60% with no degradation of more than 10 cycles. As a result, the hydrogen storage process can be more energy-saving. In addition, the fuel cell power (FCP) system with this kind of MHR is independent from heat/cold sources, which makes the system simpler and more compact. It helps to facilitate the application of FCP system in the field of portable devices.

Keywords: Hydrogen storage, Metal hydride, Reactor design, Fuel cell

Short Bio

Dr. Zhen Wu, Ph.D, Associate Professor. He is the associate editor of *International Journal of Science and Technology: Material & Chemical*, the editorial board member of *Rare Metal* and *Science Journal of Chemistry* and the topic editor of *Energies*. He is also the reviews of the leading international journals of '*Applied Energy*', '*Nanoscale*', '*International Journal of Hydrogen Energy*', '*Fuel*' and '*Energy*'. In 2017, he was selected as Hong Kong scholar fellowship in the Hong Kong Polytechnic University. His research interests include hydrogen storage materials and systems based on metal hydride, energy system modeling and optimization, DFT design and analysis, and so on. So far, he has published more than 100 scientific and conference papers in the research field of hydrogen energy system. In 2015, his paper published in *Applied Energy* was awarded as the 'Best Paper Award of Excellence' jointly by *Elsevier* Publishing Co. Ltd. and the prestigious international journal of *Applied Energy*

Topic 6: Experimental Study of Two-phase Flow in PEM Electrolytic Cells

Fang YE*, Zhao Yi WANG, Jun CHENG, Hang GUO, Hao CHEN
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
chenh@bjut.edu.cn

Abstract

A proton exchange membrane (PEM) electrolytic cell can be utilized at the areas of civil diving equipment, aerospace, etc. A PEM electrolytic cell can serve as a hydrogen reactant generator, which is combinedly utilized with PEM fuel cell to generate the electricity, on the other hand, oxygen is also produced to be supplied for breathing when it is used at the areas like submarines. In previous studies of our group, the gas and liquid two-phase flow characteristics in PEM electrolytic cells and the cell performance under various operation conditions are experimentally studied. A PEM electrolytic cell with a transparent window is fabricated to observe the two-phase flow behaviors during the cell operating. Experimental results show that the gas and liquid two-phase flow behaviors and cell performance are affected under various operation conditions, such as the flow field structure types, inclination angle, cell temperature and different gravity environments. Higher current densities and cell temperatures increase the generated bubble sizes, and higher current densities facilitates expelling the generated gases. In micro-gravity environment, bubble moving is slowed down. The cell performance is increased under higher cell temperature, and paralleled channel structure provided higher performance; in addition, the liquid water flow rate exhibits obscure effect on performance.

Keywords: PEM electrolytic cell; two-phase flow; mass transfer; microgravity

Short Bio

Hao CHEN received the Ph.D. degree at Beijing University of Technology in 2019. He is a post doctor at Beijing University of Technology. He researched the thermal fluid issues of proton exchange membrane fuel cells for 10 years, and the research interests include the numerical model improvement, two-phase mass transfer in proton exchange membrane fuel cell, and designing of flow channel structures. He has published 10 journal papers cited by SCI as the first author, including the top journals like Journal of Power Sources, Energy Conversion and Management. He received 1 excellence award and 3 special awards of science and technology innovation awards of Beijing University of Technology. He was invited to give the invited lecture at the 2nd International Conference on Electrochemical Energy Systems at May 2021, and serve as the session chair of 7TH International Conference on Renewable Energy Research and Application at October 2018. E-mail: yefang@bjut.edu.cn

Chuanshuai Dong (Session Organizer)

South China University of Technology

Biography

Dr. Dong received his Ph. D. in 2018 from Department of Building Services Engineering, the Hong Kong Polytechnic University, Hong Kong, China. He is currently an Assistant Professor/ Postdoc in South China University of Technology. Dr. Dong's research focuses on energy-related two-phase flow and heat/mass transfer, such as falling film liquid desiccant dehumidification, two-phase slug flow in pipes, etc. He has developed several constitutive equations for two-phase flow analysis. Dr. Dong has also authored 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.

Special Session: **Advances in Fuel Cells**

Session Description:

Climate change mitigation and environmental issues require developing a new sustainable energy solution. As an energy conversion device that converts the chemical energy of fuels and oxidants directly into electricity, fuel cells are widely accepted as promising substitutes for the present non-renewable energy system due to their high energy efficiency, zero-emission capability, high reliability, and low noise operation. To further improve fuel cell performance, various advanced electrocatalysts, materials, and systems have been under intensive research and development. This special session will focus on the latest development for fuel cells, ranging from fundamental materials to hydrogen evolution, oxygen reduction reaction (ORR) catalysts, and real lifetime evaluation of fuel cell power systems.

Session Organizers:

Yunqi Li (Beihang University)

Jing Tang (East China Normal University)

Session Contents:

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-031 (invited)

Topic 1: Materials Space-Tectonics: A Conceptual Paradigm for Creating Second-Generation Porous Materials

Yusuke Yamauchi
Australian Institute for Bioengineering and Nanotechnology (AIBN), The University of Queensland, Brisbane, Queensland 4072, Australia
y.yamauchi@uq.edu.au

Abstract

Different types of inorganic nanomaterials have been designed using various methods, including sol-gel, electrochemical/chemical reduction, calcination, hydrothermal reaction, etc. The dimensionality of these nanomaterials (*x*, *y*, *z*) can be classified as zero-dimensional (0D), one-dimensional (1D), two-dimensional (2D), or three-dimensional (3D), respectively. Accordingly, for 0D nanomaterials, dimensions are measured on the nanoscale (< 100 nm for each dimension). 0D nanomaterials, for example, nanoparticles (or sometimes nanocrystals), most commonly have isotropic morphologies where the usually thermodynamically stable planes of lower reactivity are exposed at the nanoparticles' surfaces. For 1D nanomaterials, a single dimension is extended beyond the nanoscale. This class of nanomaterials includes nanotubes, nanorods, and nanowires.

In contrast to 0D and 1D nanomaterials, 2D nanomaterials have recently attracted great interest for the next generation. However, such 2D materials are often formed by stacking/assembly, processes that vastly reduce their active surface areas and negatively affect their performance in potential applications. Despite recent and significant advances in inorganic nanomaterials of different dimensionalities, we remain active in making substantial efforts to develop new nanomaterials to help address energy- and environmental-related issues. Our group is fully aware of the serious limitations of the currently available materials' designs. The continued use of the current nanomaterials design paradigm based on traditional 0D, 1D, 2D nanomaterials obscures the innovative approaches required to address the aforementioned serious issues. Therefore, we have developed a new conceptual paradigm "materials space-tectonics" which is defined as the creation of novel mesoporous/nanoporous materials with precisely controlled internal space (or pore size), composition, and morphology with the assistance of nanomaterials informatics to optimize their functional applications (Figure 1).

The overarching aims are to:

- Control and enhance the "space-tectonics" of conductive nanoporous materials (carbons, metals, sulfides, phosphides, *etc*.): (i) large increase in accessible surface area, (ii) selection of exposed crystal facets (*e.g.*, facet selection, chirality), (iii) generation of catalytically ultra-active sites on kinks and step sites (*e.g.*, high index facets), and (iv) increased diffusion rates of guest molecules (reactants) inside the components, especially in the case of 2D materials.
- Connect nanoporous components in hybrid nanoarchitectures: development of methodologies for the hybridization of novel nanoporous conductive materials with precisely controlled building blocks (like Lego®) for hybrid architectures to bring out many advantages beyond what is currently known, such as (i) unlimited increases in

the interface between different components (e.g., hetero-junctions, charge-separation), (ii) maintaining high diffusion rates of guest molecules (reactants) inside the hybrid materials through the introduction of multiple and hierarchical pore structures, and (iii) formation of gradient potential energy or polarization within assembled materials (e.g., one-directional electron/energy transfer, light-harvesting, up-conversion, multi-electron reduction).

- Combine "machine learning (MI)" with inorganic synthetic techniques: this will accelerate the optimization of synthetic parameters for target nanomaterial design and enable selection of the optimal combinations of parameters for each inorganic building block for effective integration of the materials.

Increasing demand for sustainable energy and environmental remediation has accelerated research of various technologies, such as energy storage and conversion (*e.g.*, fuel cells, water splitting, secondary battery). These technologies rely heavily on the catalyst (or electrode) materials, which can significantly increase the efficiency of chemical reactions by reducing their activation energy or by modulation of the reaction mechanism. Although traditional porous materials (including mesoporous silicas, zeolites and coordination polymers) have been extensively studied, the poor electrical conductivity of those materials has restricted their utilization in future potential applications, *esp*. electrochemical-based applications. Therefore, our main target is to establish a platform for the synthesis of the second generation of highly conductive materials. We strongly believe that our new synthetic concept of "second-generation porous materials" can be considered to have significant potentials for the further development of secondary battery electrodes, (electro)catalysts, optical or electronic sensors, *etc*. Today, we will present several important examples from our on-going projects.

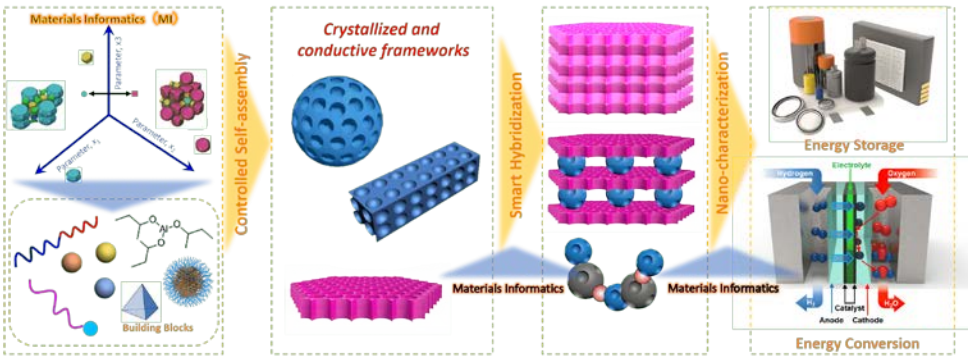


Fig. 1. Concept of "materials space-tectonics" for achieving precise control of the design of conductive nanoporous materials towards energy and environmental applications.

Prof. **Yusuke Yamauchi** received his Bachelor's degree (2003), Master's degree (2004), and Ph.D. degree (2007) from the Waseda University, Japan. After receiving his Ph.D., he joined the National Institute of Materials Science (NIMS), Japan, to start his own research group. At the same time, he started to serve as an adjunct professor to supervise Ph.D. students at the Department of Nanoscience and Nanoengineering, Waseda University. After being granted the ARC Future Fellowship, in May 2016, he joined the Institute for Superconducting & Electronic Materials (ISEM), the Australian Institute for Innovative Materials (AIIM), the University of Wollongong (UOW) as a Professor. In 2018, he moved to the University of Queensland (UQ). Presently, he is a Senior Group Leader at the Australian Institute for Bioengineering and Nanotechnology (AIBN) (on secondment from the School of Chemical Engineering until 2026), a Professor at the School of Chemical Engineering, and a Director at the Australian Materials nanoTectonic Centre. He concurrently serves as an ERATO Research Director at the JST-ERATO Yamauchi Materials Space-Tectonics, a Group Leader at the Mesoscale Materials Chemistry Group, the International Center for Materials Nanoarchitectonics (WPI-MANA), the National Institute for Materials Science (NIMS), a Visiting Professor at the Waseda University, an Advisory Board Member of prestigious journals (Small, Small Structures, ChemCatChem, J. Inorg. Organomet. Polym. Mater., etc.), and an Associate Editor of the Journal of Materials Chemistry A published by the Royal Society of Chemistry (RSC) and Chemical Engineering Journal (Elsevier).

He has published more than 850 papers in international refereed journals (>10 Nature's and Science's sister journals, >20 J Am Chem Soc, >10 ACS Nano, >10 Chem Sci, >30 Angew Chem Int Ed, >25 Chem Mater, >10 Mater Hor, etc.) with > 50,000 citations (h-index > 115, Google Scholar; h-index > 100 Web-of-Science). **He is selected as one of the Highly-Cited Researchers in Chemistry in 2016, 2017, 2018, 2019, and 2020 and in Materials Science in 2020.** He has received many outstanding awards, such as the NISTEP Award by the National Institute of Science and Technology Policy (2016), the Chemical Society of Japan (CSJ) Award for Young Chemists (2014), the Young Scientists' Prize of the Commendation for Science and Technology by MEXT (2013), the PCCP Prize by the Royal Society of Chemistry (2013), the Tsukuba Encouragement Prize (2012), the Ceramic Society of Japan (CerSJ) Award (2010), and the Inoue Research Award for Young Scientists (2010). **Recently, he was selected as one of Australia's Top 40 Researchers of Research Report published by The Australian in 2019 and 2020.**

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-032 (invited)

Topic 2: Application of Carbon-Metal Hybrid Electrocatalyst in Hydrogen Evolution

Zhong-Li Wang
School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, China
wang.zhongli@tju.edu.cn

Abstract

As a new energy with high energy density and environmental protection, hydrogen energy is regarded as the most potential renewable clean energy carrier. Hydrogen production from electrolyzed water is an important way to obtain high purity hydrogen and realize the effective storage of intermittent renewable energy such as solar energy and wind energy. However, the activity, stability and cost of the catalyst have become one of the bottlenecks restricting its development.

In this report, we will introduce three strategies for the construction of high-efficiency carbon-metal hybrid materials for the hydrogen evolution reaction (HER). 1. We propose a facile anisotropic surface modification and etching strategy for the synthesis of hollow structured ZIF-67 nanoframes. Our strategy relies on the structural and compositional distinctions between each crystallographic facet of truncated rhombic dodecahedrons ZIF-67 (tZIF-67 RDs) and the moderate coordinating and etching effects of cyanuric acid (CA). 2. Inspired by binary cooperative complementary materials in nature, we successfully apply redox units of polyaniline (PAni) to cooperatively in situ assemble Ru nanoclusters in a hierarchically-ordered carbon electrode. 3. We develop a new class of Co-C-N complex bonded carbon for HER with self-supported and three-dimensional porous structure, which shows an unexpected catalytic activity with low overpotential and long-term stability.

Keywords: hydrogen energy; water electrolysis; HER catalysts

Dr. **Zhong-Li Wang** received his Ph.D. degree from Changchun Institute of Applied Chemistry (CIAC), Chinese academy of Science (CAS) in 2010. After graduation, he worked as an assistant professor at CIAC. He became an associate professor in 2012 at CIAC. In 2015, he joined Prof. Yusuke Yamauchi's group as JSPS international research fellow in NIMS, Japan. Currently he is a full Professor at School of Chemical Engineering and Technology, Tianjin University. His research interests are advanced carbon and inorganic functional materials for electrochemical energy storage and conversion.He has published over 60 peer-reviewed journal papers (23 of them are ESI hot papers) with more than 9000 citations (Google Scholar, H-Index 37).

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-033 (invited)

Topic 3: Electrosynthesis promoted hydrogen evolution/hydrogenation reaction

Lisong Chen
Shanghai Key Laboratory of Green Chemistry and Chemical Processes, School of Chemistry and Molecular Engineering, East China Normal University, Shanghai 200062, P. R. China
lschen@chem.ecnu.edu.cn

Abstract
Oxygen evolution reaction (OER), the anodic reaction of both electrocatalytic water splitting and hydrogenation reaction, is a kinetically slow process which needs large overpotential to drive and results in much increased energy consumptions. Moreover, the produced oxygen can be obtained from the air, therefore is of poor value. Additionally, the produced oxygen will not only lead to the possible formation of degradable reactive oxygen species but also may be mixed with hydrogen produced at the cathode, implying the potential explosion risk. Here, the coupling of electrosynthesis by biomass electrooxidation with hydrogen evolution/CO2 hydrogenation reaction have been advocated, in which OER is replaced by kinetically favorable biomass oxidation reactions. Thus, not only the energy consumption can be lowered, but also hydrogen/CO2 reduction products and high value biomass oxidation products can be obtained concurrently.
Keywords: electrosynthesis; hydrogen evolution; CO2 hydrogenation reaction

Dr. Lisong Chen received his Ph.D. degree in Materials Physics and Chemistry under the supervision of Prof. Jianlin Shi from Shanghai Institute of Ceramics, Chinese Academy of Sciences (SICCAS) in 2016, Since then he joined East China Normal University (ECNU). Currently he is an associate professor at School of Chemistry and Molecular Engineering, East China Normal University, China. He has published over 40 papers in peer-reviewed journals, including Nature Communications, Angewandte Chemie International Edition et.al. His research interest is focused on the System design and catalysts development for efficient hydrogen electrocatalysis, including hydrogen evolution and hydrogen oxidation reactions.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-034 (invited)

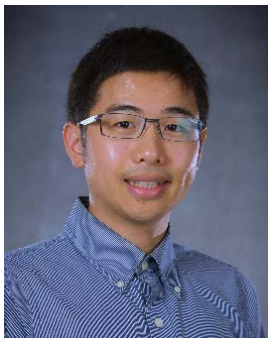
Topic 4: Transient Performance Loss of Pt/C Fuel Cell Catalyst Hindering High Efficiency Operation

Liang-Chen Lin, Yun-Sheng Cheng, Wei-Chieh Liao, Yi-Hong Huang, and Yung-Tin Pan*
Department of Chemical Engineering, National Tsing Hua University, Hsinchu 300044, Taiwan
ytpan@mx.nthu.edu.tw

Abstract

The continuous decay of Pt/C ORR catalyst, commonly referred as “transient performance loss”, is studied at 0.8 V by chronoamperometry under membrane electrode assembly (MEA) testing conditions. Based on the results from the time-resolved cyclic voltammetry (CV), surface oxidation was identified as the primary cause of the transient loss at small time scales. The reduction of surface oxide was observed to occur at 0.6 V, and the recovery of cathode performance can hence be achieved at equal or lower potentials. In addition, the effect of operating temperature and cathode humidity was also studied. The coverage of Pt surface oxides and the extent of the transient loss both were significantly reduced as temperature decreased. The benefit of a lower operating temperature however came with the cost of slower recovery kinetics. In terms of the impact of humidity, the presence of liquid water was identified to be the critical factor leading to much severer performance loss over time.

Keywords: Fuel Cell Catalyst, Transient Performance Loss, Recovery



Dr. **Yung-Tin (Frank) Pan** is an assistant professor at the Department of Chemical Engineering, National Tsing Hua University (NTHU). He received his PhD. degree in Chemical Engineering from the University of Illinois Urbana-Champaign, USA. Before joining NTHU Chemical Engineering, he worked as a postdoc researcher at Los Alamos National Laboratory and is the major contributor to the US-DOE 2019 Annual Merit Review Awards wining project in Fuel Cell R&D. He started off his profession career at NTHU by receiving the Young Scholar Award from the Ministry of Science and Technology of Taiwan, and has been granted research funds from Industrial Technology Research Institute (ITRI) and industrial sources. His current research focus lies in the development of active and durable catalyst materials for polymer electrolyte membrane (PEM) reaction systems such as fuel cell (PEMFC), water electrolysis (PEMWE), and other gas phase electrochemical reactions.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-035 (invited)

Topic 5: Lifetime Evaluation Methods for Vehicle Fuel Cells and Analysis of Key Influencing Factors

Huicui Chen
School of Automotive Studies, Tongji University, Shanghai 201804, China
chenhuicui@tongji.edu.cn

Abstract

Lifetime is one of the key factors that restrict commercialization of vehicle fuel cell. It is of great significance to study the lifetime evaluation methods and the key influencing factors of lifetime under different application scenarios of fuel cells for promoting the wide application of vehicle fuel cells. When the fuel cell is used as a fixed power source, its lifetime can reach 30000~50000 hours, while when it is used as a vehicle power source, its lifetime is only about 10000 hours. The frequent load change is the main reason that leads to its lifetime attenuation. In this report, we present the recent research results on the lifetime evaluation methods for vehicle fuel cells, and the judgement of internal state of fuel cells based on the internal gas and liquid transfer process and mechanism.

Keywords: Proton Exchange Membrane Fuel Cells, lifetime evaluation, internal gas and liquid transfer, gas starvation

Dr. **Huicui Chen** received her PhD degree from School of Vehicle and Mobility, Tsinghua University in July 2015 and joined School of Automotive Studies, Tongji University as an assistant professor in the same year. She has been devoted to the research on the core technologies of vehicle fuel cell engines, including the degradation mechanism of vehicle fuel cell dynamic process, fuel cell durability evaluation method and high-durability vehicle fuel cell control strategy, etc. She has presided over several major scientific research projects such as the National Key Research and Development Program and Project supported by the National Natural Science Foundation of China. In the past five years, she has published 23 SCI/EI papers, including 17 SCI papers, 4 ESI highly cited papers Top 1%, and 2 papers won the Applied Energy 2018 highly cited research paper award. She won the Science and Technology Special Award of China Transport Association in 2020 and was selected in the Sailing Program of Shanghai Youth Science and Technology Talents in 2018.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-036 (invited)

Topic 6: Graphene Nanomesh as An Effect Electrocatalysts for Oxygen Reduction in Acid Media

Wei Xia, Jing Tang*, Jianping He*, Yusuke Yamauchi*

School of Chemistry and Molecular Engineering, Shanghai Key Laboratory of Green Chemistry and Chemical Processes East China Normal University, Shanghai, 200062, China
wxia@chem.ecnu.edu.cn

Abstract

Two-dimensional (2D) materials usually exhibit extraordinary performance in lots of applications. Although graphene nanomesh is quite attractive as a member of 2D carbon materials, general synthetic routes to produce functional graphene nanomesh on a large scale are complex and tedious. Here, we elaborately design a simple two-step dimensional reduction strategy for exploring nitrogen-doped graphene nanomesh by thermal exfoliation of crystal- and shape-modified metal-organic frameworks (MOFs).

MOF nanoleaves with 2D rather than 3D crystal structure are used as the precursor, further thermally unraveled into nitrogen-doped graphene nanomesh by using metal chlorides as the exfoliators and etching agent. The prepared nitrogen-doped graphene nanomesh shows a unique ultrathin two-dimensional morphology, high porosity, rich and accessible nitrogen-doped active sites, and defective graphene edges, contributing to an unprecedented catalytic activity for oxygen reduction reaction (ORR) in acid electrolytes. This approach is suitable for scalable production and is probably universal for the synthesis of thousands of novel low-dimensional functional carbon materials by breaking the dimensional limitation of traditional three-dimensional MOFs and further executing thermal exfoliation.

Keywords: two-dimensional (2D); graphene nanomesh; ORR; exfoliation

Dr. **Wei Xia** received his Ph.D. degree in Materials Chemistry from the Nanjing University of Aeronautics and Astronautics in 2020. Currently, he is a postdoctoral researcher at East China Normal University. In 2019, he worked at National Institute for Materials Science (NIMS), Japan as a visiting scholar and made contributions in the areas of fuel cells, Metal-air batteries, electrocatalysis and computational modeling. He has published over 40 peer-reviewed journal papers (2 of them are ESI hot papers), as well as the reviewer for more than 10 international academic journals.

Abstracts of Oral Presentations

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-101

MODELING THE SPRAY CHARACTERISTICS OF BLENDED FUELS FOR GASOLINE DIRECT INJECTION APPLICATIONS

Akhil Ailaboina, Kaushik Saha*

Engines and Unconventional Fuels Laboratory, Centre for Energy Studies, Indian Institute of Technology Delhi, New Delhi 110016, India
*kaushiksaha@ces.iitd.ac.in

ABSTRACT
Methanol and ethanol are considered potential candidates for alternative fuels for gasoline fuel. Such alcoholic fuels have high latent heat of vaporization (h_{fg}), higher volatility, and they are high octane fuels that help the engine to run under high compression ratios. In this study, the alcoholic fuels (ethanol and methanol) are blended with isooctane, and the ternary blends of isooctane, ethanol, and methanol were also studied. In this work, a numerical study is carried out to understand the vaporization and spray-breakup characteristics of multi-component blended fuel and ternary fuel blend compared to single-component fuel. The spray characteristics of pure isooctane fuel and their blends with ethanol and methanol are studied and compared among each other for a gasoline direct injection (GDI) system. For this study, the Spray G operating condition (non-flashing) has been taken from the Engine Combustion Network (ECN). The simulated data for isooctane has been validated with the experimental data from the ECN, and a similar model setup has been used for pure and blended fuel sprays. The discrete phase modeling (DPM) approach is carried out, and the URANS turbulence model is considered in understanding the spray characterization. The blended methanol fuels have higher penetration lengths compared with ethanol ones. The penetration of the blended fuels (binary and ternary) is less than the isooctane. It is to be noted that the model is validated for the isooctane, which could be different for the alcohol-blended fuels. The ternary blends showed similar results that of E85, and it implicates that the ternary blended fuel can be used as a drop-in fuel for flex-fuel vehicles.

Keywords: Gasoline direct injection (GDI), Alternative fuels, Spray modelling

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-104

EFFECTS OF DIFFERENT MAIN INJECTION TIMINGS AND INJECTION PRESSURES ON COMBUSTION AND EMISSIONS OF DIESEL-THF-ETHANOL BLENDED FUEL

Yangyi Wu[a], Xin Liu[b], Tianyun Sun[b], Zhao Zhang[a], Chao Jin[b,c], Haifeng Liu[a], Mingfa Yao[a]*
a State Key Laboratory of Engines, Tianjin University, 300072 Tianjin, China
b School of Environmental Science and Engineering, Tianjin University, 300072 Tianjin, China
c Tianjin Key Lab of Biomass/Wastes Utilization, Tianjin University, 300072 Tianjin, China
The first author's e-mail: yangyiwu@tju.edu.cn
*Corresponding author's e-mail: haifengliu@tju.edu.cn

ABSTRACT

A six-cylinder turbocharged diesel engine was used to study the effects of tetrahydrofuran (THF) and ethanol on the combustion and emissions of the diesel engine under different injection timings and pressures. Four fuels (pure diesel, T15E0, T5E10 and T5E20) were tested and the numbers represent the volume ratio of the THF or ethanol and the rest was diesel. Results indicated that the brake specific fuel consumption (BSFC) increased and brake thermal efficiency (BTE) decreased with the addition of THF. The addition of ethanol increased BTE by up to 1.34% compared with pure diesel. The optimal NOx and soot emissions of T5E20 at different injection strategies were increased by 0.51%, and reduced by 66.94%, respectively, compared with pure diesel. With the application of T5E20, the BTE of that was slightly higher than pure diesel. It can be achieved that the soot emissions of T5E20 was comparable to the optimized soot emissions of pure diesel, and the NOx emissions of T5E20 was lower at the same time with the delay of the injection timing or the decline of the injection pressure. In general, THF acted better as a co-solvent and ethanol acted better as a main component of the blended fuel.

Keywords: diesel engine, ethanol, tetrahydrofuran (THF), injection strategies, combustion, emissions.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-110

EFFECTS OF SCAVENGING PORT ANGLE AND COMBUSTION CHAMBER GEOMETRY ON COMBUSTION AND EMMISSION OF A HIGH-PRESSURE DIRECT-INJECTION NATURAL MARINE ENGINE

Haifeng Liu[1]*, Weifan, Luo[1], Jingrui Li[1], Ying Ye[1], Hu Wang[1], Mingfa Yao[1]
([1] State Key Laboratory of Engines, Tianjin University, Tianjin, China;)
*Corresponding author. Haifeng Liu, Tel./Fax: +86-022-27383362, E-mail:haifengliu@tju.edu.cn

ABSTRACT
Pilot-ignited high-pressure direct-injection natural gas engines can reduce NOx and PM emissions while maintaining high thermal efficiency compared with conventional diesel engines. In this study, a three-dimensional (3D) computational fluid dynamics (CFD) model of a pilot-ignited high-pressure direct-injection natural gas marine engine is set up. The effects of geometry parameters on in-cylinder turbulent flow, mixing, combustion, and emissions were presented and discussed. The geometry parameters include scavenging port angle (SPA) and three combustion chamber geometries (shallow-basin-shaped (SBC), shallow-ω-shaped (SWC), and deep-pit-shaped combustion chamber (DPC)). The results show that increasing the SPA can significantly swell the swirl ratio, but too large the swirl ratio is not conducive for improving the scavenging effect. As SPA is varied from 30° to 60°, a richer-than-flammable region gets greater and the penetration distance is shortened by the larger vortex. Then the mixing and combustion process get worse. With the increase of the SPA, the emissions of soot, carbonic oxide (CO), and unburned hydrocarbons (HC) can be optimized. Also, a larger scavenge port angle is not conducive to improving NOx emission and the indicated specific fuel consumption (ISFC). The combustion chamber geometries have fewer effects on the in-cylinder flow and combustion process than that of SPA. The CO/HC and soot emissions of the three tested combustion chamber geometries are similar. The effect of the shallow basin-shaped combustion chamber (SBC) is much better than that of the other combustion chamber geometries with respect to NOx emission.

Keywords: two-stroke marine engine; dual fuel; pilot diesel; scavenge port angle; combustion chamber.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-113

TWO-DIMENSIONAL MODELING OF SOLID OXIDE FUEL CELL WITH THERMALLY INDUCED DELAMINATION

Yang Wang[a,b], Kui Jiao[a], Chengru Wu[a], Bingfeng Zu[c], Qing Du[a,*], Meng Ni[b,**]
a State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin, China
b Department of Building and Real Estate, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China
c Internal Combustion Engine Research Institute, Tianjin University, 92 Weijin Road, Tianjin, China
*Corresponding author: duqing@tju.edu.cn (Q. Du); meng.ni@polyu.edu.hk (M. Ni)

ABSTRACT
During the thermal cycles of solid oxide fuel cell (SOFC), the thermal expansion coefficients mismatch can lead to delamination between electrodes and electrolyte. This delamination phenomenon is one of the main reasons for the degradation of SOFC performance during long time operation. In this study, a two-dimensional (2D) model of SOFC is developed to quantify the effects of delamination on cell performance. The model results indicate that the cell electrochemical performance declines with the increase of delamination length. The delamination also has a significant effect on local current density due to the blocked ion transport paths. The electrochemical reaction will concentrate into the contact region, which leads to the increase of overpotential. The cell performance is also found insensitive to the location of delamination. Besides, the temperature distributions under different degrees of delamination are also studied by the 2D model.

Keywords: SOFC, delamination, 2D model, cell performance.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-116

ANALYSIS OF NOVEL FLOW FIELD CHARACTERISTICS BASED ON A 3-D PROTON EXCHANGE MEMBRANE FUEL CELL MODEL

Zhiming Bao[a], Fei Gao[b*], Kui Jiao[a*],
a State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, 300350 Tianjin, China, kjiao@tju.edu.cn
b School of Energy and Computer Sciences, University of Technology of Belfort-Montbéliard, 90010 Belfort Cedex, France, fei.gao@utbm.fr

ABSTRACT
In recent years, the innovative component design has largely contributed to the development and application of proton exchange membrane fuel cell (PEMFC). As one of the key components, the flow field plate (FFP) plays an important role in the mass transfer and heat conduction of PEMFCs. Many different types of flow channels/fields have been proposed, including 3-D fine mesh flow field, wavy flow channel, porous metal foam flow field, etc. However, it is hard to figure out their contribution on mass transfer and heat conduction through cell performance test or ex-situ test for individual FFP. Thus, it is necessary to figure out the internal transport processes in a total PEMFC. For this purpose, we developed a 3-D PEMFC model based on an open-source computational fluid dynamic platform OpenFOAM. This model considers the multi-phase and multi-species mass transport in different PEMFC components. The heat production and conduction from catalyst layer to FFP surface are also considered. Furthermore, the electrochemical reaction at catalyst layer is coupled with heat and mass transfer processes. Specially, the phase changes among liquid water, vapor, and dissolved water in membrane are also considered.

The model is firstly validated with the experimental results with different operation conditions, including inlet gas pressure, humidification, and ionomer mass fraction. Then, the wavy flow channel with a varied trapezoid cross section utilized in the model cathode FFP is compared with the conventional parallel flow channel. The current density, electrochemical reaction rate, net water flux, temperature, pressure drop, and their distribution are compared. It is found that the trapezoid-shape cross section together with a wavy flow pattern helps to create a gas flow convection towards gas diffusion layer, which improves the mass transport rate and thus oxygen concentration in catalyst layer. Compared with parallel channel, the wavy flow path of wavy channel can enlarge the interface area and mass transport between flow channel and gas diffusion layer while has a comparable pressure drop. In addition, the forced convection also improves membrane humidification at a 100% humidity condition of hydrogen inlet. This study can provide a deep understanding for the relationship between flow channel/field structure and PEMFC transport properties.

Keywords: PEMFC; flow field plate; mass transfer; thermal management; water management.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-119

A COMPREHENSIVE THREE-DIMENSIONAL MODEL OF PEM ELECTROLYZER CONSIDERING DETAILED CHANNEL TWO-PHASE FLOW

Yifan Xu, Guobin Zhang, LiZhen Wu, Biao Xie, Zhiming Bao, Bingfeng Zu, Kui Jiao*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin 300350, China
Authors' e-mails:kjiao@tju.edu.cn

ABSTRACT
In this study, a 3D (three-dimensional) multi-phase model of the proton exchange membrane (PEM) electrolyzer is developed on an open-source computational fluid dynamics (CFD) platform, OpenFOAM. The model accuracy is validated by comparing with the experimental data regarding the polarization curve and ohmic loss, and the agreement is reasonable at low to medium current density regime. But when it extends to the high current density regime, there is a non-negligible deviation, which is attributed to neglecting the oxygen in channel region in the model framework, despite that it is common in current PEM electrolyzer modeling work. Therefore, to further investigate the effect of two-phase transport on cell performance, a detailed two-phase flow morphology is considered into this 3D multiphase model. With the modified integrated model, a good agreement is obtained at high current density conditions, which shows that the channel two-phase flow could have a significant influence on the performance of PEM electrolyzer, and thus cannot be neglected in the model development. In addition, the effects of gas/liquid diffusion layer (L/GDL) properties, i.e., porosity, contact angle, thickness, on cell performance are also investigated using this 3D model.

Keywords: PEM electrolyzer, OpenFOAM, 3D model, two-phase flow, gas/liquid diffusion layer.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-122

EXPERIMENTAL EVALUATION ON THE PERFORMANCE OF CATHODE PARALLEL-STAGGERED-BAFFLE FLOW FIELD FOR PROTON EXCHANGE MEMBRANE FUEL CELL

Zhengguo Qin, Zhiming Bao, Chasen Tongsh, Kui Jiao, Qing Du*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin, China, 300350
*Corresponding author emails: duqing@tju.edu.cn

ABSTRACT
For original proton exchange membrane fuel cell (PEMFC) designs, the parallel flow field was often used because of its low pressure drop and high manufacture capacity. However, with an increased current density, the parallel flow field can lead to a poor performance of PEMFC due to the weak water management capacity. Therefore, we made a modification on the conventional parallel flow field by inserting staggered small baffles in it. There are two types areas in this new flow field, named baffle-contained area and baffle-free area. These two areas are alternately arranged to create a pressure difference between adjacent channels and improve the mass transfer and water removal capacity of PEMFC. Different stoichiometric ratios and relative humidity at cathode inlet of PEMFC are considered in the experiments. Test techniques including constant-current polarization curve test (I-V), electrochemical impedance spectroscopy (EIS), inlet and outlet pressure measurement are used to identify the PEMFC performance under different operation conditions. With parallel-staggered-baffle flow field plate (FFP), the pump loss of PEMFC is found low. In addition, the performance is also promoted by utilizing parallel flow field because the hindrance effect of staggered baffles strengthens the through-plane gas transport to gas diffusion layer. For practical application, the optimized operation condition for PEMFC with this new flow field is presented.

Keywords: PEMFC, parallel-staggered-baffle flow field, water removal, polarization curve test.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-125

EXPERIMENTAL INVESTIGATION ON THE PERFORMANCE AND ELECTROCHEMICAL CHARACTERISTICS OF PEM FUEL CELL WITH THE 3D DOT MATRIX FLOW FIELD

Xiangyang Chen, Qing Du, Kui Jiao, Zhijun Peng, Guobin Zhang*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Rd, Tianjin, China, 300350
*Corresponding author emails: gbzhang@tju.edu.cn

ABSTRACT

As a key component in proton exchange membrane (PEM) fuel cells, the bipolar plate with flow field grooved plays a significant role in the gas/liquid transfer, heat and electric conduction, mechanical support and hence greatly affects the cell performance and durability. In this study, a novel three-dimensional (3D) dot matrix flow field is proposed and its applicability is experimentally investigated by assembling a PEM fuel cell of 108 cm^2, including the polarization curves under various operation conditions and different losses characterized by the electrochemical impedance spectroscopy (EIS). In comparison with the conventional parallel flow field (CPFF), the 3D dot matrix flow field significantly increases the cell performance at high current density regime, which is mainly because it largely increases the oxygen transfer volume and hence decreases the concentration loss. In addition, it also facilitates the liquid water removal. However, this is at the expense of increased pumping power loss due to the larger pressure drop. At middle current density where the ohmic loss is dominant, the less area for current collection is likely to increase the ohmic loss and slightly decrease the cell performance. Hence, the dot density in this flow field should be properly designed in practical applications to balance the ohmic and concentration losses.

Keywords: PEM fuel cell, 3D dot matrix flow field, experimental test, cell performance, EIS

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-128

EXPERIMENTAL STUDY ON A DEAD-ENDED ANODE AND CATHODE RECIRCULATION H_2-O_2 PEM FUEL CELL UNDER DIFFERENT OPERATING CONDITIONS

Ben Hou, Zhi Liu, Qing Du, Zixuan Wang, Kui Jiao*, Fuqiang Bai*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin, 300350, China
*Corresponding author: kjiao@tju.edu.cn; bbfq@163.com

ABSTRACT

H_2-O_2 proton exchange membrane fuel cells (PEMFCs) have attracted great research interest in under water vehicle and aerospace fields. The strategy of dead-ended anode and cathode recirculation can achieve an extremely high utilization efficiency of hydrogen and oxygen. However, seldom efforts have been put to understand this exhaust strategy under different operation conditions comprehensively. In this paper, we have design a dead-ended anode and cathode recirculation PEMFC without external humidification. The PEMFC have been tested under various operation conditions, including current density and pressure difference between anode and cathode. The results indicate that the voltage decline process has three stages: voltage drop caused by ohmic loss and concentration loss, quasi-equilibrium stage and water flooding stage. Reducing the current density and increasing the pressure difference between anode and cathode can effectively increase the gas purge interval, thus increasing the fuel utilization and reducing hydrogen emissions. This research can provide a guideline for applications powered by hydrogen and oxygen fuel cells.

Keywords: PEM fuel cell, dead-ended anode, experimental test, cathode recirculation

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-131

TWO-DIMENSIONAL SIMULATION OF PURGE PROCESSES FOR DEAD-END H2/O2 PROTON EXCHANGE MEMBRANE FUEL CELL WITH DIFFERENT HYDROGEN FLOW ARRANGEMENTS

Hengyang Tao, Kangcheng Wu, Kui Jiao*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin, 300350, China
* Corresponding author emails: kjiao@tju.edu.cn

ABSTRACT

Proton exchange membrane fuel cells (PEMFCs) with dead-ended anode (DEA) and dead-ended cathode (DEC) can achieve high utilization of hydrogen and oxygen, but also cause the accumulation of liquid water in the cell and performance degradation. In this study, a two-dimensional multiphase transient PEMFC model is developed to investigate the purge strategy in the PEMFC with DEA and DEC. This model is well validated with the experimental data. The simulation results show that the cell voltage increases to a certain extent at the beginning of operation due to the self-humidification effect, and then decreases gradually. During the purging period, the voltage reaches a peak value and then decreases. Compared with the purging anode and cathode operation, the peak value of the purging cathode operation decreases gradually. Compared with the counter-flow operation, the co-flow operation leads to earlier purging moment, larger ohmic resistance and voltage decay rate in the PEMFC. The accumulation of liquid water leads to a more poor uniformity of current density distribution. The purging cathode and counter-flow operation is the most ideal purge strategy during short-time operation, due to the highest energy efficiency, the second highest output performance and the second longest purge interval.

Keywords: PEMFC, Dead-end, Flow configuration, Purge, 2D-transient model

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-134

SIMULATION STUDY ON EFFECTS OF WATER INJECTION STRATEGIES ON OXY-FUEL COMBUSTION (OFC) IN A GASOLINE DIRECT INJECTION (GDI) ENGINE AT ECONOMICAL OXYGEN-FUEL RATIOS

Xiang Li [a,*], Tahmina Ajmal [a], Khaqan-Jim Rana [a], Abdel Aitouche [b, c], Raouf Mobasheri [b, c], Zhijun Peng [d,*]

[a] School of Computer Science and Technology, University of Bedfordshire, Luton, UK
[b] Univ. Lille, CNRS, Centrale Lille, UMR 9189 - CRIStAL - Centre de Recherche en Informatique Signal et Automatique de Lille, F-59000 Lille, France
[c] Junia, Smart Systems and Energies, F-59000 Lille, France
[d] School of Engineering, University of Lincoln, Lincoln, UK

*Corresponding author:
Xiang Li, School of Computer Science and Technology, University of Bedfordshire, Luton, LU1 3JU, UK
Email: xiang.li@beds.ac.uk
Zhijun Peng, School of Engineering, University of Lincoln, Lincoln, LN6 7TS, UK
Email: jpeng@lincoln.ac.uk

ABSTRACT
In order to decrease Carbon Dioxide (CO_2) emissions for mitigating the global warming problem, Oxy-Fuel Combustion (OFC) technology with Carbon Capture and Storage (CCS) is being developed in Internal Combustion Engine (ICE). In this article, a 1-D simulation is conducted to explore the effects of Water Injection (WI) strategies on OFC in a Gasoline Direct Injection (GDI) engine at economical oxygen-fuel ratios. The results show that under OFC, there is a considerable increase in Brake Specific Fuel Consumption (BSFC) compared to Conventional Air Combustion (CAC). With the increase of R_{wf} (water/fuel mass ratio) from 0 to 1.0, in-cylinder pressure and temperature have a considerable decline. BSFC has a deterioration of 4.05% and 6.33% under Oxygen Mass Fraction (OMF) of 23.3% and OMF of 32%, respectively. The combustion characteristics and engine performance are sensitive to t_{WI} (WI timings). Advancing WI timing could slow down the combustion process by stronger cooling functions from the heat absorption of injected water, which leads to a deterioration in BSFC. For OFC of a GDI engine at economical oxygen-fuel ratios, appropriate WI strategies are feasible to control combustion characteristics and performance, but the benefit in fuel economy is limited.

Keywords: Oxy-Fuel Combustion (OFC); Gasoline Direct Injection (GDI) engine; Water Injection; Simulation.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-137

RESEARCH ON A SELF-BREATHING H-SHAPE MICROFLUIDIC FUEL CELL WITH ASYMMETRIC CATALYST STRUCTURE

Peiyao Zhi, Zhi Liu, Jicheng Ma, Kui Jiao, Qing Du*
State Key Laboratory of Engines, Tianjin University, 135 Yaguan Road, Tianjin 300350, China
*Corresponding authors: liuzhi16@tju.edu.cn
Tel: +86-22-27404460; Fax: +86-22-27383362

ABSTRACT
The microfluidic fuel cell (MFC) has advantages features such as small volume, portable structure, sustainable operation, and no pollution mainly due to its lamination flow of the fuel and electrolyte in microchannel. Based on this flow characteristic at a low Reynolds number, they have attracted worldwide researchers' attentions. However, the poor output power density and low fuel utilization limit its applications in portable mobile devices. Therefore, understanding the mass transfer and electrochemical reaction mechanisms are critical issues to improve the MFC performance. To address these issues, a novel strategy with H-shape MFC has been proposed to improve the fuel utilization and output power density. With numerical simulation method, this proposal aims at revealing mechanisms of the content and distribution of catalyst in microchannel on the diffusion and chemical reaction in MFC. The research results are helpful to improve the performance, which can provide significant theoretical suggestions for the practical applications.

Keywords: Microfluidic fuel cell, self-breathing, asymmetric catalyst structure, numerical simulation。

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-146

Numerical study of coupled internal nozzle flow and spray formation of dodecane and biodiesel in then ECN Spray A injector

Arun R S, Kaushik Saha*
Engines and Unconventional Fuels Laboratory, Centre for Energy Studies, Indian Institute of Technology Delhi, New Delhi 110016, India
*kaushiksaha@ces.iitd.ac.in

ABSTRACT
A numerical simulation has been performed to assess the effects of internal nozzle flow and needle motion on the spray formation for the Engine Combustion Network (ECN) Spray A injector. The dynamic coupling of the internal nozzle with external spray formation is treated using the Eulerian Lagrangian Spray Atomization (ELSA) model. This method is used to analyze the spray characteristics of dodecane and biodiesel fuels. The results obtained from these simulations show that the ELSA model can capture the spray characteristics reasonably well in the internal nozzle flow and near nozzle flow. Additionally, the liquid and vapour penetration is validated for dodecane with the experimental results. However, the computational cost is higher compare to the commonly used Discrete Droplet Method (DDM).

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-149

TRANSFORMATION OF AMORPHOUS POLYMER TO CRYSTALLINE COVALENT ORGANIC FRAMEWORK MEMBRANE VIA MONOMER EXCHANGE

Chunyang Fan[a,b], Hong Wu[a,b,c*], Niaz Ali Khan[a,b*] and Zhongyi Jiang[a,b,d*]

a Key Laboratory for Green Chemical Technology of Ministry of Education, School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, China

b Collaborative Innovation Center of Chemical Science and Engineering (Tianjin), Tianjin 300072, China

c Tianjin Key Laboratory of Membrane Science and Desalination Technology, Tianjin University, Tianjin 300072, China

d Joint School of National University of Singapore and Tianjin University, International Campus of Tianjin University, Binhai New City, Fuzhou, 350207, China

e-mails: cyfan@tju.edu.cn, wuhong@tju.edu.cn, niaz@tju.edu.cn, zhyjiang@tju.edu.cn

ABSTRACT
Covalent organic frameworks (COFs) are emerging as promising materials platform for separations and energy-related applications due to their tunable porosity and highly ordered structures. However, their typical insoluble and unprocessable powder-like form severely impedes the potential widespread applicability. Here, a two-step approach is developed to prepare large-area Schiff base-type COF membranes. The strategy demonstrated here firstly takes full advantage of the solution processability of polymer: making amine and aldehyde monomers into amorphous polyimine membrane through solution-casting and then the amorphous-to-crystalline transformation is implemented by monomer exchange, achieving the spatiotemporal decoupling of membrane fabrication and crystallization. Moreover, the representative COF membrane loaded with Phosphotungstic acid demonstrates a proton conductivity of 0.53 S cm^{-1} (80 °C, 100% RH), which is the highest value amongst all proton-conducting COF materials reported to date. This two-step methodology could be extended to diverse COF monomers, potentially paving the way to facile and scalable synthesis of COF membranes.

Keywords: Covalent organic framework membrane, solution processability, two-step method, amorphous-to-crystalline, monomer exchange, proton conduction.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-152

FABRICATING TIGHT COVALENT ORGANIC FRAMEWORKS ANION EXCHANGE MEMBRANES *VIA* MOLECULAR PRECURSOR ENGINEERING

Yan Kong[a,b], Xueyi He[a,b], Hong Wu[a,b] and Zhongyi Jiang[a,b,c*]
a Key Laboratory for Green Chemical Technology of Ministry of Education, School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, China
b Collaborative Innovation Center of Chemical Science and Engineering (Tianjin), Tianjin 300072, China
c Joint School of National University of Singapore and Tianjin University, International Campus of Tianjin University, Binhai New City, Fuzhou, 350207, China
e-mails: yankong@tju.edu.cn, 18222288716@163.com, wuhong@tju.edu.cn, *zhyjiang@tju.edu.cn

ABSTRACT
Covalent organic frameworks (COFs) with well-defined nanopores and tunable functionality hold great potential as novel high-performance anion conductors. However, processing COFs membranes into tight structure, which is imperative for superior conduction performance, remains a grand challenge. Herein, through molecular precursor engineering of COFs, we reported the successful preparation of tight COFs membranes for efficient anion transport. A series of quaternary ammonium (QA)-functionalized COFs were proposed by assembling QA-functionalized hydrazides and six different aldehyde precursors, which featured permanently ordered channels with precise arrangement of cationic groups. Based on an organic-aqueous reaction system, the fine tuning of aldehyde precursors (the size, electrophilicity and hydrophilicity) enabled facile synthesis of COFs membranes with desired morphological structures and optimized water microenvironments within the channels under ambient conditions. In particular, by altering the hydrophilicity of aldehyde precursors, we have unveiled a picture of switching the reaction zone from the interface region to the aqueous phase for preparing COFs, which enabled the creation of tighter membranes with lower grain boundary resistance. Meanwhile, higher hydrophilic aldehydes also benefited the water microenvironments for anion transport within the COFs. We have found that smaller, higher electrophilic and higher hydrophilic aldehydes are preferable to prepare tight COFs membranes with superior hydroxide ion conductivity over 200 mS cm^{-1} at 80 °C. Our exploitations offer valuable guidance on the rational design and preparation of tight membranes based on ionic organic frameworks as high-performance anion conductors.

Keywords: molecular precursor engineering, covalent organic frameworks, tight membrane, anion transport, phase-transfer polymerization.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-155

DESIGN OF SOFC-GT HYBRID SYSTEMS WITH MEMBRANE REACTOR FOR CO2 REMOVAL

Yi-li SHEN, Wen-jia LI, Hai-qiao WEI*
State Key Laboratory of Engines, Tianjin University, Tianjin300072, China
whq@tju.edu.cn*

ABSTRACT
The solid oxide fuel cell (SOFC) using methanol will emit high concentration of CO_2 in the anode exhaust. A SOFC based hybrid system integrated with CO_2 capture can easily yield clean power. In this work, two different membrane reactor processes were proposed in combination with a conventional SOFC and gas turbine (GT) hybrid system. One was the cathode off-gas sweep on the permeate side (SOFC-$MR_{cathode}$), the other was a vacuum to reduce the permeate side pressure (SOFC-MR_{vacuum}). The effects of key parameters (i.e. the steam-to-carbon (S/C) ratio, fuel utilization factor, and operating pressure) on the power production, electrical efficiency, system efficiency, and CO_2 capture capacity of two processes were studied and compared. It was found that under standard conditions, the electrical efficiency of the SOFC-MR_{vacuum} process was 5.68% higher than the SOFC-$MR_{cathode}$ process due to the high utilization of fuel in the SOFC. For the SOFC-$MR_{cathode}$ process, the results show that the CO_2 concentration and CO conversion rate were increased by 13.51% and 5%, respectively. Therefore, its CO_2 capture capacity is better than that of the SOFC-MR_{vacuum} process. As for the system efficiency, it is closely related to the turbine power output and auxiliary work consumption, among which the power consumed by the air compressor has the most obvious influence on its change.
Keywords: SOFC, GT, CO_2 capture, membrane reactor, efficiency.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-158

A COMPONENT-LEVEL MODEL OF POLYMER ELECTROLYTE MEMBRANE ELECTROLYSIS CELLS FOR HYDROGEN PRODUCTION

Daniela Ruiz, Yun Wang*
University of California Irvine
Department of Mechanical and Aerospace Engineering, The University of California, Irvine, CA 92697-3975, USA
druizdia@uci.edu
*yunw@uci.edu

ABSTRACT

Nowadays, Proton Exchange Membrane Electrolyzer Cells (PEMEC) have gained interest for being one of the most promising technologies for high-purity hydrogen production with zero emissions when coupled with renewable energy. Therefore, studying the factors affecting PEMEC performance is one of the most important areas of study for this field. This work presents a cell-level PEMEC model implementing water exchange between electrodes, proton conductance, electrochemical reaction kinetics, two-phase oxygen-liquid water mixture in the flow channel, and two-phase transport in the PTL. At the channel/PTL interface, an interfacial resistance sub-model is considered for oxygen removal. The model investigates the cell performance under high current density considering 1.) homogeneous properties in each component, 2.) isothermal conditions, and 3.) Tafel equation to approximate electrochemical reaction kinetics. The model is implemented in MATLAB/Simulink for predicting the contribution the different voltage losses to the polarization curve under different temperature (40℃ to 80℃), pressure (1 to 10 bar), current density (0 to 5 A/cm2), and liquid saturation percentages (100 to 45%). The present model is validated against various sets of experimental data available in the literature. The obtained results show that ohmic and activation overpotential contribute to a major voltage loss representing about 27% and 19% when working at 5 A/cm2, 1 atm, and 80℃. Additionally, when working at high current density, oxygen bubbles are found to occupy an area as large as 55% at the PTL/Ch interface, blocking the available region for water transport to the catalyst layer, reducing the cell performance. Furthermore, high temperature operation helps the overall voltage to decrease around 4% when changing from 40℃ to 60℃, and about 8% when changing from 60℃ to 80℃ thanks to the thermal energy added. The change in operating pressure revealed that the rise in pressure raised the overall voltage of the cell due to its effect on the open-circuit voltage, but this rise is considered small compared with the effects of temperature. From these observations, it can be concluded that a deeper study should be performed to account for the effects of oxygen removal in PEMEC when working under high current density, temperature, and its effect on gas bubble removal at the channel/PTL interface.

Keywords: PEM, Electrolysis, Model, Component, Mass transport.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-164

THREE-DIMENSIONAL NUMERICAL STUDY OF A CATHODE GAS DIFFUSION LAYER WITH A THROUGH/IN PLANE SYNERGETIC GRADIENT POROSITY DISTRIBUTION FOR PEM FUEL CELLS

*Xiaoai Wang[a,b], Yong Wang[a,b], Yuanzhi Fan[a,b], Yanzhou Qin[c], Yulin Wang[a,b,c]**
[a] School of Mechanical Engineering, Tianjin University of Commerce, Tianjin, 300134, China.
[b] Tianjin Key Lab of Refrigeration Technology, Tianjin University of Commerce, Tianjin, 300134, China.
[c] State Key Laboratory of Engines, Tianjin University, Tianjin 300350, China.
Yulin Wang, E-mail address: wangylok@yeah.net, wangylfcs@gmail.com.

ABSTRACT (FONT, ARIAL, SIZE 9.5, BOLD)
This study proposes a through-plane (TP) and in-plane (IP) synergetic (SYN) gradient porosity distribution (GPD) in the cathode gas diffusion layer (CGDL) to enhance the mass transfer and water removal of a polymer electrolyte membrane (PEM) fuel cell. The novel SYN-GPD CGDL is comparatively evaluated with TP-GPD, IP-GPD and uniform porosity distribution (UPD) CGDL by implementing a three-dimensional multiphase fuel cell model. The results show that a higher porosity within CGDL near the cathode flow channel (CFC) for TP-GPD CGDL, however, a higher or lower porosity near the cathode outlet for IP-GPD CGDL improves the mass transfer and water removal within fuel cell, which benefitting the uniform distributions of oxygen and current density, and the cell performance. Additionally, as compared with the TP-GPD, IP-GPD and UPD CGDL, the SYN-GPD CGDL has a greater advantage in the enhancement of mass transfer and water removal, consequently resulting in much more homogeneous internal physical quantity profiles and a higher overall cell performance. Ultimately, the optimal SYN-GPD CGDL improves the maximum power density by 6.73%, while reducing the coefficient variations (CVs) of the oxygen mass fraction and current density by approximately 10.24% and 40.69%, respectively, compared with those of the UPD CGDL.

Keywords: PEM fuel cell, Mass transfer and water removal, Cathode gas diffusion layer, TP and IP synergetic gradient porosity, Cell performance.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-167

TRANSPORT OF REACTANT GAS IN PEM FUEL CELLS WITH METAL FOAM FLOW FIELDS

Mengshan Suo [a], *Xingxiao Tao* [a], *Qifeng Li* [a], *Zhizhao Che* [a], *Kai Sun* [a], *Rui Chen* [b], *Tianyou Wang* [a, *]
[a] State key laboratory of engines, Tianjin university, 135 Yaguan Rd, Tianjin 300350, China
[b] Department of aeronautical and automotive engineering, Loughborough university, Loughborough LE11 3TU, UK
Authors' e-mail: suomengshan@tju.edu.cn, taoxingxiao2018@tju.edu.cn, lqf01@tju.edu.cn, chezhizhao@tju.edu.cn, sunkai@tju.edu.cn, R.Chen@lboro.ac.uk, * wangtianyou@tju.edu.cn.

ABSTRACT

Metal foam flow field (MFFF) has been applied to proton exchange membrane (PEM) fuel cells and has great potential in improving the fuel cell performance. However, the effects of metal foam key parameters on reactant gas transport are not well understood. In this study, metal foam structures are reconstructed by representative unit-cells, reactant gas transport in the cathode side of PEM fuel cells is simulated by a three-dimensional multi-species lattice Boltzmann model with the electrochemical reaction considered. Comparison is done between the MFFF and the channel-rib flow field, and parametric studies are carried out on the porosity, the pores per inch (PPI), and the compression ratio of the MFFF at different inlet velocities. The results demonstrate that the flow and mass transfer of the reactant gas is significantly affected by metal foam parameters. Within the ranges of parameters considered in this paper, the convection mass transfer rate can be enhanced by reducing the porosity, increasing the PPI, and increasing the compression ratio. The decrease in the porosity can enhance reactant transport only when the inlet velocity is large enough, while the increase in the PPI and the increase in the compression ratio can enhance reactant transport for all inlet velocities.

Keywords: PEM fuel cell, metal foam flow field, lattice Boltzmann method, reactant gas transport.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-176

STUDY ON THE LOAD CHANGE AND GAS SUPPLY STRATEGY OF A PROTON EXCHANGE MEMBRANE FUEL CELL UNDER DYNAMIC CONDITION

Jing Liu, Peiqi Wang, Tong Zhang*
Tongji University
School of Automotive Studies, Tongji University, Shanghai 201804, China
E-mail address: jingliu@tongji.edu.cn (J. Liu)
1410808@tongji.edu.cn (P. Wang)
*tzhang@tongji.edu.cn (T. Zhang)

ABSTRACT

The loading capacity of proton exchange membrane fuel cell (PEMFC) is an important factor to evaluate its reliability in different applications and also relates to the lifetime of the fuel cell. This paper aims at illustrating the effect of load change and gas supply strategy on cell voltage response. For this purpose, a three-dimensional numerical simulation on the transient response of a PEMFC subjected to variable loading strategy is presented. The model is built based on a laboratory-scale cell with 16 cm2 active area and five serpentine flow paths. By changing current and gas supply, the response voltage is recorded as an indicator of transient response. The prediction results show that the undershoot behavior in cell potential would be observed under transient gas flow and load change conditions. When the current density increases from 0.2 A/cm2 to 1.0 A/cm2, the amount of cell voltage decreasing till the minimum level is smaller in linear variable load mode than in instant load change mode. And it takes less time for cell voltage to reach the stable state under the condition of linear variable load. Water content is of significant importance to the dynamic performance of PEMFC undergoing load changes. Sufficient loading time is necessary to make membrane hydration to meet the need of proton transfer, which is indispensable for a successful dynamic loading. In addition, three reaction gas co-feeding modes under load changing are studied: stable gas supply at low current, stable gas supply at high current, gas supply varies with the load. The cell potential shows better performance when given a large amount of reactant gas under dynamic loading conditions. During current loading, gas supply speed cannot keep up with the current change, which will cause a short-term gas starvation inside the fuel cell. The gas starvation causes cell potential undershoot or even to decrease to 0 V when the current density increases. It can be concluded that undershoot is a result of the delay of gas supply, non-uniform oxygen distribution and insufficient water accumulation in the membrane. The instantaneous decrease in cell potential is due to increased activation and ohmic polarization. The ohmic polarization is mainly related to the membrane resistance, which depends on membrane water content, while the activation polarization is mainly caused by the reactant starvation under transient gas supply and load change. Thus, it is essential to formulate a fuel cell gas supply strategy under load change condition to reduce the amplitude of cell potential undershoot and the time of voltage to reach stable state. The study can provide guideline for the design of dynamic loading strategy and gas supply strategy in PEMFC.

Keywords: Proton exchange membrane fuel cell, transient response, load change, gas starvation, water content.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-179

DIFFUSIVE AND CONVECTIVE MASS TRANSPORTATIONS IN PROTON EXCHANGE MEMBRANE FUEL CELLS WITH ORIENTATIONAL FLOW CHANNELS HAVING POROUS BLOCKS

Hao CHEN, Hang GUO *, Fang YE, Chong Fang MA
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

Orientational flow channels having baffles with proper shapes enhance the reactant transportation and facilitate improving performance of proton exchange membrane fuel cells. For the purpose of further increasing reactant supplying into gas diffusion layers, porous blocks can be constructed between baffles and gas diffusion layer surfaces. It has been known that using orientational flow channels having baffles with porous blocks can further enhance the reactant transporting, however, the transporting process of reactants from channels into gas diffusion layers includes diffusion and convection processes, and how the diffusion and convection transporting processes perform in such channel structure is still unknow, which is probably beneficial to better understanding the mass transferring strategy in flow channels with porous-blocked baffles. In the present study, a two-dimensional, two-phase, non-isothermal, and steady state model considering non-Darcy flow effect is employed to numerically study reactant and products transportation strategy by using orientational flow channels having porous-blocked baffles. The diffusion and convection of species are separately discussed. Simulation results reveal that by constructing porous blocks in flow channels, the convective flux of reactant is enhanced significantly, as a result, the main transporting approach switches to convection. However, produced water vapor removal is weakened due to porous blocks.

Keywords: Proton exchange membrane fuel cell; mass transfer enhancement; flow channel design; orientational flow channel; porous blocks

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-182

CELL VOLTAGE AND TWO-PHASE FLOW IN A UNITIZED REGENERATIVE FUEL CELL OPERATING IN ALTERNATE FUEL CELL AND ELECTROLYTIC CELL MODES

Jia Xing LIU, Hang GUO*, Fang YE, Chong Fang MA
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

Unitized regenerative fuel cell (URFCs) can operate in fuel cell (FC) mode and electrolytic cell (EC) mode. Thus mode switching between EC and FC is inevitable for actual applications. During the mode switching, complicated electrical response and gas-liquid phase changing occur due to the different operation conditions in these two modes. In this paper, the continuous mode switching between FC and EC within three cycles is studied by experimental works. It is found that the voltage decreases slightly with the cycle running, and the two-phase flow in the corresponding mode of each cycle is similar through analyzing the two-phase flow phenomenon of the two modes during mode switching. It is also found that bubbles are generated during EC mode, the residual water in the cell is consumed and there is only water mist at the transparent end plate during EC mode without water. A small amount of liquid water accumulates at the bottom of the flow channel during FC mode. Experiments of the cycle test process are also conducted. It is shown that with the cell mode switching periodically, the cell voltages of the EC and FC both decrease periodically. The FC performance changes more, especially under high current density.

Keywords: Unitized regenerative fuel cell, Mode switching, Two-phase flow, Visualization.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-185

MULTI-PHYSICAL TRANSPORT PHENOMENON IN CAPACITIVE DEIONIZATION: A DEMENSIONLESS ANALYSIS

J. F. Zhang, M. Yang, Q. L. Ren, Z. G. Qu*
MOE Key Laboratory of Thermo-Fluid Science and Engineering
School of Energy and Power Engineering, Xi'an Jiaotong University
Xi'an, Shaanxi 710049, China
* E-mail: zgqu@mail.xjtu.edu.cn

ABSTRACT
Ion transport in porous electrode materials plays an important role in capacitive deionization. However, many parameters are involved in the dynamic migration process, and it is difficult to find out the interaction among these parameters and their influence on the capacitive deionization performance through experiments. To identify the complex dynamics of ion transient transport, based on Navier-Stokes equations and Poisson-Nernst-Planck equations, a dimensionless transient-state computational model is developed for capacitive deionization with porous electrodes. The dimensionless nature of the model has high versatility because a single dimensionless modeling analysis can explain a wide range of capacitive deionization processes from the physical and chemical properties. Based on the dimensionless model, 14 main parameters involved in ion transport are converted into 8 dimensionless numbers, summarized into four aspects: ion adsorption characteristics, ion mobility characteristics, ion motion driving force, and ion adsorption equilibrium time. The results announce the cooperative and competitive relationship among various parameters, and clarify how these parameters impose effects on the performance of capacitive deionization. Based on the results, one can directly analyze and qualitatively compare the influence of each parameter on the capacitive deionization process in further theoretical and experimental work.

Keywords: capacitive deionization, ion transport, dimensionless model.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-194

ANALYSIS OF INFLUENCING FACTORS AND PREDICTION OF COUNTY-LEVEL CARBON EMISSION FROM ENERGY CONSUMPTION BASED ON STIRPAT MODEL

Hongjiang Liu, Fengying Yan *
Tianjin University
Tianjin 300072, China
hongjiang@tju.edu.cn; * fengying@tju.edu.cn

ABSTRACT
The key to coping with climate change is to control carbon emissions from energy consumption. Scientific prediction of energy consumption carbon emissions based on influencing factors is of great significance to the determination of carbon control aim and emission reduction strategies. Given the lack of previous studies on county-level carbon emissions, this paper proposed a systematic approach to study the influencing factors of county-level energy consumption carbon emissions and to predict future emissions. Firstly, the annual energy consumption carbon emissions are calculated based on the IPCC method. Then the STIRPAT model is established to predict future emissions according to the influencing factors of carbon emissions decomposed by the extended Kaya formula. Finally, the emission reduction aims and low-carbon strategies were determined based on scenario analysis. The method is applied to Changxing, a typical county with large energy consumption and carbon emissions. Based on 16-years data, the STIRPAT carbon emission prediction model is established and the forecast results of future emissions under three different scenarios are obtained. The results indicated that population size, industrial structure, and affluence degree are the three most influential factors, and the influence degree of each factor is quantified to support targeted low-carbon strategies for county-level cities.

Keywords: energy consumption; carbon emission; IPCC method; STIRPAT model; scenario forecast.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-197

NANOFLUIDIC OSMOTIC ENERGY CONVERSION MODULATION WITH THERMAL AND PH VALUE GOVERNED INTERFACIAL REACTIONS

X. Zhang, Z. G. Qu*, Q. L. Ren, J. F. Zhang
MOE Key Laboratory of Thermo-Fluid Science and Engineering
School of Energy and Power Engineering, Xi'an Jiaotong University
Xi'an, Shaanxi 710049, China
* E-mail: zgqu@mail.xjtu.edu.cn

ABSTRACT

Mixing seawater and river water through charged nanochannel is regarded as a promising technique to convert osmotic energy. Limited to the properties of materials, nanochannel devices suffer the bottleneck of relatively low ion selectivity and power density. Bulk environment regulation, such as increasing the pH value and temperature of bulk solution, can be the effective way to boost the osmotic energy conversion. In this study, the coupling effect of the pH and thermal effect is investigated. The numerical model considering the cooperation of surface deprotonation/protonation reactions and thermal effect was established. The temperature can alter the equilibrium constant through Van't Hoff equation, resulting in the change of surface charge density. The concentration ratio of 0.5 M/0.01 M was applied on the nanochannel to test the performance. The result shows that as the pH increases, the osmotic power and energy conversion efficiency are significantly improved due to the increased surface charge density. The temperature demonstrates nearly no influence on the surface charge density along the nanochannel, which can be attributed to the equal thermal effect on the deprotonation and protonation reactions. As the temperature rises, the improved osmotic power is mainly caused by the increased osmotic current. This work provides a perspective for understanding the synergy of pH value and thermal effect on the osmotic energy conversion.

Keywords: Nanochannel; Ion selectivity; pH value; Thermal; Osmotic energy conversion.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-200

THE TITLE: TRANSIENT MODEL OF DYNAMIC POWER OUTPUT UNDER PEMFC LOAD CURRENT VARIATIONS

Qinwen Yang1, Bin Gao1,2, Gang Xiao1,2,3, Dong Hao 4, Shujun Chen1*

1 State Key Laboratory of Advanced Design and Manufacturing for Vehicle Body, College of Mechanical and Vehicle Engineering, Hunan University, Changsha 410082, China

2 Collaborative Innovation Center of Engineering Technology, Jiangxi University of Applied Science, Nanchang 330100, China

3 CRRC Zhuzhou Institute Co., Ltd., Zhuzhou 412001, China

4 China Automotive Technology &Research Center Co., Ltd., Tianjin, 300300, China

xiao1221@hnu.edu.cn

ABSTRACT

A PEMFC transient model that describes the output performance under dynamic power output situation is proposed in this research. It considers the numerical relationships among the operating parameters like gas pressure, relative humidity and heat source temperature, dynamic transport parameters like gas concentration, liquid saturation, membrane water content and temperature and output performance. Experimental data are utilized for validation of the transient model. The result shows that, the variation tendency of output voltage at steady state indicated by this model is reasonably follows the experimental values under the variations of operating parameters. Furthermore, the transient model is able to simulate the undershoot of the output voltage using different operating parameters under transient load. The transient model developed in this research is proved to be able to predict the global PEMFC performance of steady and dynamic state in the whole operating period. The average relative errors of voltage predictions are 0.4732% at the steady state and less than 0.4000% at the dynamic state.

Keywords: transient model, dynamic state, undershoot.

* Corresponding author.
E-mail address: xiao1221@hnu.edu.cn (Gang Xiao), +86 137 5518 2469

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-206

Dynamic wettability model development for liquid water transport in PEMFC gas flow channel

Qiaoyu Guo, Mengjie Li, Yanzhou Qin*
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT
Water management in the proton exchange membrane fuel cell (PEMFC) is a critical issue in improving fuel cell performance. With the progress of cognition, it is found that the static wettability model that only includes one static contact angle cannot accurately simulate the shape deformation and movement of the droplet. In our previous study, a dynamic wettability model was developed based on the force analysis using an elliptical contact line including the dynamic contact angle and sliding angle effects. In this study, we further improve this model using a more accurate arc differential formula to calculate the adhesion force. The simulations of water transport in the PEMFC flow channel are conducted based on the improved dynamic wettability model. The results show that the improved methodology has significant effects on contact angle hysteresis. Overall, the water coverage ratio and the contact angle hysteresis of the improved model are both smaller than the previous model in the dynamic water transport process.

Keywords: Dynamic contact angle, Contact angle hysteresis, Water transport, Fuel cell

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-209

Numerical simulation of hydrogen filling process in novel high-pressure microtube storage device

Guokun Liu, Yuwen Liu, Suhui Ma, Yanzhou Qin*
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT

Novel high-pressure microtube hydrogen storage device has higher hydrogen storage density and safety than conventional hydrogen tanks. An one-dimension numerical model for hydrogen filling process in microtubes is established, with reasonable calculation methods and accurate physical properties adopted. Based on the analysis of flow parameters variations, three stages of the filling process are summarized: fast-filling, stable-filling and slow-filling stages. At the beginning of the filling process, the maximum temperature appears at the inlet, but the average temperature does not rise significantly during the whole process. The effects of microtube length, filling pressure and environmental temperature are investigated and discussed. The results show that excessively long microtube greatly increases the filling time and higher filling pressure reduces the filling time and improves the filling efficiency. The microtube hydrogen storage device achieves higher hydrogen storage density and filling efficiency in low temperature mediums. It reveals that high filling pressure, low temperature encapsulation and reasonable microtube size design are the future development directions of microtube hydrogen storage for better application.

Keywords: hydrogen storage, high pressure gas, microtube, flow characteristics, CFD.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-212

Determining the Effect of Intake Air Pressure on Combustion Characteristics of a Diesel Engine Using Ethanol-Diesel Fuel Blends

Mustafa Vargün [1], Ökkeş Sefa Buçaklı [2] and Ahmet Necati Özsezen [3,]*

[1]Department of Mechanical Engineering, Technology Faculty, Marmara University, 34722 Istanbul, Turkey, e-mail: mustafa.vargun@marmara.edu.tr

[2]Günsel Headquarters and Production Facility, 99138 Lefkoşa-KKTC, MERSIN on Turkey, e-mail: sefa.bucakli@günsel.com.tr

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

[*]Corresponding author: Tel: +90 262 3032288, Fax: +90 262 3032203, e-mail:nozsezen@kocaeli.edu.tr

ABSTRACT
Aim of this study is to determine combustion and exhaust emission characteristics of use of ethanol-diesel fuel blends (E10B2, E20B4) by increase intake air pressure (boost pressure) 10%, 20% and 30% at 1600 rpm constant engine speed and 50% constant engine load in a single cylinder diesel engine. In addition, to prevent of ethanol-diesel blend fuels from phase separation, butan-2-ol was added to blend fuels as a solvent. Original boost pressure of diesel engine at 1600 rpm was 240 mbar, by increase boost pressure 10%, 20% and %30 are equal to 264 mbar, 288 mbar and 312 mbar, respectively. As result of this study, the highest maximum cylinder gas pressure was seen as 86.1 bar in use of E20B4 in 30% boost pressure increase. In addition, as alcohols ratio increased in blend fuels, important rise was seen in heat release rate. Although there was a significant decrease in CO and CO_2 emissions with use of fuel blends and boost pressure increase, NO_x emission was not stable in tests. Moreover, compared to diesel fuel (D100), exhaust gas temperature was decreased more than 5% with use of fuel blends at each boost pressure application.

Keywords: Boost pressure; ethanol; 2-butanol; diesel engine; combustion; emission.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-215

INVESTIGATION ON TRANSIENT OPERATION SWITCHING WITH DIFFERENT CATHODE FLOW FIELDS IN A SINGLE PROTON EXCHANGE MEMBRANE FUEL CELL

Zhifeng Xia, Huicui Chen*, Tong Zhang
School of Automotive Studies, Tongji University
No. 4800 Caoan Road, Jiading District, Shanghai, China
Authors' e-mails: *chenhuicui@tongji.edu.cn

ABSTRACT
This paper investigated the effect of cathode flow field on transient operating condition switch based on a single small area (25 cm^{-2}) scale PEMFC experimentally. Three kinds of cathode flow field were adopted to assembly a single PEMFC with a straight anode flow field. The short-winded voltage overshoot was confirmed by monitoring real-time voltage variation, and thus the voltage returning to a new stable value was observed. The physic parameters, e.g. initial pressure, high frequency resistance and voltage recovery period were recorded. This work aims to shed the light of overcoming local gas starvation during operating PEMFC engine condition switching for a longer FCV lifespan.

Keywords: proton exchange membrane fuel cell, flow field, transient operation switching

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-218

COMPARISON OF DEVELOPING GREEN ENERGY TECHNOLOGIES WITHIN THE FRAMEWORK OF SUSTAINABILITY

Murat AYAR*
Department of Airframe and Powerplant Maintenance,
Faculty of Aeronautics and Astronautics
SARES, International Sustainable Aviation and Energy Society
Eskisehir, Turkey
muratayar@eskisehir.edu.tr

T. Hikmet KARAKOC
Department of Airframe and Powerplant Maintenance,
Faculty of Aeronautics and Astronautics
HAVEN, Aviation Energy Engineering Ind. Trade. Co. Ltd.

Eskisehir, Turkey
hkarakoc@eskisehir.edu.tr

ABSTRACT
Renewable energy has an extremely important place in terms of meeting the energy needs of countries with domestic resources, reducing their external dependence, ensuring sustainable energy use by diversifying resources, and minimizing the damage to the environment as a result of energy consumption. Since traditional renewable energy sources cannot provide the desired efficiency values, researchers are trying to overcome these deficiencies by radically searching for new energy technologies. Approximately 20 percent of the energy consumed worldwide is obtained from renewable sources. In this study, one of the green energy fields sourced from biomass, geothermal, hydropower, solar, wind and hydrogen was compared from the sustainability vaccine. The comparison was made using the Analytic Hierarchy Process method based on the three main pillars of sustainability among these six alternatives. As a result, the most sustainable alternative was found and the effect weights of the factors affecting this result were calculated.

Keywords: Green energy; sustainability; Analytic Hierarchy Process.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-221

MODELING AND OPTIMIZATION OF SMALL-SCALE SPIRAL BLADE VERTICAL AXIS WIND TURBINE (VAWT)

Iftikhar Ahmed, Hafeez Khoharo, Laveet Kumar*

Department of Mechanical Engineering, Mehran University of Engineering and Technology, 76020 Jamshoro Pakistan

ABSTRACT
In this study, design and development in wind energy technologies are major concern. The Vertical Axis Wind Turbine titled Savonius Wind Turbines have many advantages over Horizontal Axis and Darrieus Vertical-axis Wind Turbines. Savonius VAWT has a simple design and producing high power potential than Darrieus VAWT. Conical straight blade increases the negative torque acting on returning blade thus reducing the power coefficient. This negative torque occurs due to the low discharge of air flow so it causes low CP (max) value and decreases efficiency. The main research objective is the optimization of the Savonius Vertical Axis Wind Turbine (VAWT) by considering different design parameters. CFD simulation is carried out with the incompressible, steady, and Reynolds average Navier-Stokes (k-e, RNG) model for the analysis of flow characteristics. By changing 10%, 15%, and 20% of overlap and shaft at a twist angle of 0°, 45° and 90° respectively with end plate used in all designed models, appropriate conditions for optimum performance was achieved. The results concluded that the CP values are greater with shaft ratio instead of overlap ratio. Maximum CP value was achieved at 20% shaft ratio that is 1.631 times greater than 20% overlap ratio at 45° twist angle.

Keywords: Savnious VAWT; Twist Angle; Shaft ratio; overlap ratio; Wind Power

*Corresponding author: laveet.kumar@faculty.edu.pk (Laveet Kumar)

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-224

Zeolitic Imidazolate Framework derived PtCo@NG cathode catalyst for Proton exchange membrane fuel cell

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

ABSTRACT
Proton exchange membrane fuel cell (PEMFC) has drawn much attention because of its furnishing electrical energy with high efficiency and negligible environmental pollution. However, platinum-based nanomaterials, as the most commonly adopted electrocatalysts, have very limited world reserves and high price, becoming the key obstacles for the widespread commercialization of PEMFC. Here, we reported a new approach to preparing a Co-ZIF supported fine Pt/Pt alloy electrocatalysts for oxygen reduction reaction. Co-ZIF@GO was obtained by in-situ controllable growth of ZIF-67 nanocrystals on both surfaces of graphene oxide (GO) sheets with different nanoscale sizes. After pyrolysis and platinum loading, PtCo@N-doped graphene (PtCo@NG) cathode catalyst was obtained with well dispersed Pt/Pt alloy nanoparticles (~5 nm). The optimal PtCo@NG catalyst shows superior performance and stability in acidic medium, exhibiting the half-wave potential up to 0.89 V vs reversible hydrogen electrode (RHE) and 3 times of mass activity against the commercial Pt/C catalyst. It reveals that this new synthesis approach provides an eff ective strategy to develop active and stable Pt alloy catalysts by in-situ growing ZIF on graphene oxide.

Keywords: proton exchange membrane fuel cell, cathode catalyst, oxygen reduction reaction, pt alloy electrocatalysts.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-227

THERMODYNAMIC ANALYSIS OF A GREEN MULTIGENERATIONAL PLANT

[1]Yunus Emre Yuksel, [2]Murat Ozturk, [3]Ibrahim Dincer*
[1*]Afyon Kocatepe University, Bolvadin Vocational School, Electricity and Energy Department, Kirkgoz Campus, Afyonkarahisar, Turkey
[2] Isparta University of Applied Sciences, Faculty of Technology, Department of Mechatronics Engineering, Cunur West Campus, Isparta, Turkey
[3] Faculty of Engineering and Applied Science, Ontario Tech. University, 2000 Simcoe Street North, Oshawa, Ontario, Canada
e-mails: * yeyuksel@aku.edu.tr; muratozturk@isparta.edu.tr, Ibrahim.Dincer@ontariotechu.ca

ABSTRACT
Geothermal power-based multigeneration plants have a significant potential among power production plants as they generate valuable outputs, such as electricity, liquid hydrogen, heating-cooling, fresh-hot water from geothermal energy-based integrated plants. In this study, producing valuable products such as electricity, hydrogen, heating-cooling, fresh-hot water with a geothermal power-based multigeneration plant is described. A geothermal power-based multigeneration plant is developed, and a thermodynamic assessment is carried out. Some parametric studies are undertaken to evaluate the influence of various plant indicators on the offered plant. The beneficial outputs obtained from the provided plant are illustrated comprehensively. The impacts of various plant indicators on the plant's performance characteristics and its subsystems are comparatively assessed.

Keywords: Multigeneration, geothermal power, energy, exergy, efficiency, energy conservation, sustainability.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-230

THE BLENDING AND TRANSMISSION OF HYDROGEN AND NATURAL GAS IN TRANSMISSION AND DISTRIBUTION PIPELINES

Arash Khabbazi[*1], Ri Li[*2], John Quinn[‡3], Mina Hoorfar[*4]
[*]: School of Engineering, University of British Columbia,
1137 Alumni Ave, Kelowna, BC V1V 1V7, Canada
[‡]: Renewable Gas Supply, FortisBC,
16705 Fraser Hwy, Surrey, BC V4N 0E8
[1]: arashjkh@student.ubc.ca
[2]: sunny.li@ubc.ca
[3]: John.Quinn@fortisbc.com
[4]: mina.hoorfar@ubc.ca

ABSTRACT

Hydrogen can be used for storing surplus electrical energy from the grid during periods of low demand for electrical energy. Hydrogen can also be used to carry the electrical energy generated from renewable energy sources such as solar and wind farms that are not connected to the grid. For these applications, electrical energy is consumed to generate hydrogen. In other words, the electrical energy is converted to hydrogen as gaseous fuel, which is referred to as the power-to-gas technology. As a result, hydrogen is used as a green energy carrier due to its zero emission.

Hydrogen generated from these power-to-gas applications has to be transported to the place of utilization. The most cost-effective transmission solution is to use the natural gas (NG) transmission system by injecting hydrogen into the natural gas pipeline, in which the two gaseous fuels are transmitted as a mixture, called H2NG. Due to different thermodynamic parameters of the two gases, H2NG has significant changes in pipeline transport conditions as compared to natural gas transmission. These changes are associated with pressure drop and temperature profiles in the pipeline. The changes also vary with the high-pressure, medium-pressure and low-pressure pipelines. Overall, H2NG has beneficial influence on the conditions of its transmission. However, the molar fraction of hydrogen in H2NG should not exceed 15%–20% due to the drop in heating value. Differences between transporting H2NG and natural gas also take place at compression and decompression stations.

One objective of this talk is to provide a brief review of the research work on the transmission of H2NG in pipeline as discussed above. This talk will also focus on the future research on the injection of hydrogen into local natural gas infrastructure or even in the natural gas supply to a single building. As compared to the transmission in main and regional pipelines, the injection into local pipeline features low pipeline pressure and is subject to dynamically changing demand, which could affect end-use NG appliances. Experimental and analytical studies are required to understand how a dynamically changing supply of H2NG can be implemented with steady energy quality in the pipeline for varied demand functions.

Keywords: hydrogen, natural gas, pipeline, transmission

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-233

EVALUATION OF A MULTIGENERATIONAL PLANT WITH THE PARABOLIC TROUGH COLLECTOR FIELD FOR PRODUCING ELECTRICITY, HYDROGEN, COOLING-HEATING AND FRESH WATER

[1]Murat Koc, [2]Yunus Emre Yuksel, [3]Murat Ozturk*
[1*]Isparta University of Applied Sciences, Technical Sciences Vocational School, Electricity and Energy Department, Cunur West Campus, Isparta, Turkey
[2]Afyon Kocatepe University, Bolvadin Vocational School, Electricity and Energy Department, Kirkgoz Campus, Afyonkarahisar, Turkey
[3]Isparta University of Applied Sciences, Faculty of Technology, Department of Mechatronics Engineering, Cunur West Campus, Isparta, Turkey
Authors' e-mails: *muratkoc@isparta.edu.tr, yeyuksel@aku.edu.tr, muratozturk@isparta.edu.tr

ABSTRACT
Considering the environmental concerns and ecological problems, certain precautions which will prevent these problems should be taken. There are many reasons for environmental and ecological issues such as fossil fuel usage, low efficient energy systems, and high energy consumption. Many renewable energy sources are able to take the place of fossil fuels. In this study, solar energy is selected as the primary energy source of the system. To utilize solar energy, a parabolic trough collector is used due to its features. On the other hand, the solar energy system is integrated into a CO_2 cycle, an organic Rankine cycle, a hydrogen production plant, and a fresh water production system for the purpose of improving the system's performance. The proposed system's valuable outputs are electricity, hydrogen, fresh water, heating, and cooling. In the analysis part, each stream is numbered and assigned balance equations. Then the thermodynamic analysis is performed by using engineering equation solver (EES) software. According to the analysis results, the energetic and exergetic efficiencies of the parabolic trough collector-based multigeneration system are found as 48.36% and 41.55%, respectively. Finally, parametric analyses have been performed in order to see how and which parameters affect the system performance.

Keywords: Energy, exergy, solar energy, multigeneration, thermodynamic analysis.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-239

COST-EFFECTIVE PHOTOCATALYTIC H_2 GENERATION FROM H_2S

Maali-Amel Mersel[1]*, Lajos Fodor[1], Ottó Horváth[1]
[1] Research Group of Environmental and Inorganic Photochemistry – Center for Natural Sciences – Faculty of Engineering – University of Pannonia – 8200 Veszprém, Hungary
E-mail: *sam003miloo@gmail.com, lajos@almos.uni-pannon.hu, horvath.otto@mk.uni-pannon.hu

ABSTRACT
Photocatalytic hydrogen production by H_2S splitting offers sustainable energy generation and abatement of environmental pollution, which is energetically more favorable than photocatalytic water splitting [1]. Sulfide-based materials, as photocatalysts, are regarded as good candidates for H_2 evolution due to their excellent solar spectrum response and high photocatalytic activity [2]. The loading of proper co-catalysts that are based on cheap and earth-abundant materials on those semiconductors was shown to play an important role in the improvement of their efficiency [3].

In our research, we focused on the use of CdS-ZnS composite because of its controllable band gap and excellent performance for H_2 evolution under visible light [4]. We mainly investigated the effect of several parameters on the H_2 production activity of this type of photocatalysts in order to obtain a cost-effective material.

The CdS-ZnS composite with an enhanced photocatalytic activity for H_2 production was synthesized from ammine complexes, then, compounds of Ni-group metals (NiS and Pt) were applied as co-catalyst on its surface. The illuminations were performed using simple LED lamps and the effects of the ammonia content, the hydrothermal treatment and the washing of the catalyst were investigated. It was found that 0.1% of NiS (or Pt) on the surface of CdS-ZnS, could remarkably enhance its photocatalytic activity if this catalyst is not hydrothermally treated. It was also shown that the performance of this semiconductor was not affected by the initial pH of preparation. However, the hydrothermal treatment and the ammonia content were proven to highly influence the rate of H_2 production in this system and so XRD measurements were performed to explain this dependence.

The excellent photoactivity of the CdS-ZnS catalysts for hydrogen generation encourages further investigations to enhance its performance by optimization of the reaction conditions.

Keywords: Photocatalytic H_2 production, H_2S, CdS-ZnS, Photoactivity

ACKNOWLEDGEMENT
This work was supported by the Széchenyi 2020 program under the GINOP-2.3.2-15-2016-00016 project and the EFOP-3.6.1-16-2016-00015

REFERENCES
[1] S.V. Tambwekar, M. Subrahmanyam, 1997, Photocatalytic generation of hydrogen from hydrogen sulfide: An energy bargain. International Journal of Hydrogen Energy 22:959-965.

[2] K. Zhang, L. Guo, 2013, Metal sulphide semiconductors for photocatalytic hydrogen production. Catalysis Science & Technology 3:1672-1690.

[3] X. You, X. Rong, 2015, Nickel-based co-catalysts for photocatalytic hydrogen production. Applied Surface Science 351:779-793

[4] L. Fodor, B. Solymosi, O. Horváth, 2019, Investigation of hydrogen production from alkaline sulfide solution with nanosized CdS/ZnS-PdS photocatalyst of various compositions. Journal of Nanoscience and Nanotechnology 19:509-515

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-242

DEEP ENERGY EFFICIENCY RETROFITS VERSUS DIRECT ELECTRIFICATION FOR URGENT EMISSIONS REDUCTION: A CASE STUDY USING 33,780 RESIDENTIAL ENERGY PROFILES IN WATERLOO, CANADA

Heather McDiarmid[1], Paul Parker[2]

1 Research Associate and 2 Professor,

Faculty of Environment

University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

1 heatheratp2@gmail.com

2 pparker@uwaterloo.ca

ABSTRACT

Keeping global average temperature rise to less than 1.5-2°C will require significant efforts to reduce the greenhouse gas emissions generated from all human activities. For the buildings sector, which accounted for nearly 40% of global emissions in 2018, this will require constructing new buildings to higher standards and upgrading existing buildings to be more energy efficient and to be powered with emissions-free sources. Conventional wisdom dictates that the first step should be making renovations to reduce total heat loss through the addition of insulation, air sealing, and the use of high performance windows and doors. Only after these renovations are completed should buildings consider upgrading the heating equipment to more energy efficient and low carbon alternatives. However, despite decades of policies and programs promoting energy efficient retrofits, most existing buildings have not undergone these critical upgrades. Considering the urgency of the need to reduce greenhouse gas emissions, direct electrification of a building's space and water heating as the equipment is replaced at the end of its useful life may be a simpler and more effective approach for all but the most energy inefficient buildings. A database of 33,780 residential building energy profiles from a community in Southern Ontario, Canada was used to model the effects of historical and deep energy efficiency retrofits and direct electrification using heat pumps. With Ontario's low carbon electricity supply, which is generated predominantly from nuclear and hydro-electricity, direct electrification achieves a modeled 90% reduction in greenhouse gas emissions whereas historical retrofit activity has only achieved an 18% reduction and major energy efficiency upgrades to all parts of the building envelope achieves a modeled 58% reduction in greenhouse gas emissions. Because heat pumps are also substantially more energy efficient than conventional heating sources, direct electrification also achieves better energy efficiency gains: 61% versus 50% for deep retrofits and 15% for historical retrofits. The conclusion is clear: if we are to achieve deep cuts to the greenhouse gas emissions from existing buildings within two to three decades, we should focus our policies on cleaning up and modernizing the electricity supply, and on electrifying space and water heating directly as the equipment is renewed.

CATEGORY: Green buildings or Energy education, policy and planning

KEYWORDS: retrofit, electrification, heat pumps, residential

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-245

Renewable Energy Innovation by Recycling Waste Heat Energy by using Graphene-coated Thermoelectric Generator (GTEG)

K.H. Teng [1,2*], V Karunamoothei [1], Shaw A [1], K.B. Goh [3], Khalid Hashim [1], IA Idowu [1], P Kot [1] Jonathan Yong[2] and WY Tey [2]

[1] Built Environment and Sustainable Technology Institution (BEST), Faculty of Engineering and Technology, Liverpool John Moores University, L3 3AF, United Kingdom; k.h.teng@2019.ljmu.ac.uk
[2] Mechanical and Mechatronic Engineering Department, Faculty of Engineering, Technology and Built Environment, UCSI University, Kuala Lumpur, 56000 Malaysia.; TengKH@ucsiuniversity.edu.my
[3] Department of Mechanical Engineering, Monash University, Kuala Lumpur, 56000 Malaysia.

***** Correspondence: TengKH@ucsiuniversity.edu.my / k.h.teng@2019.ljmu.ac.uk

Abstract: Experimental and numerical investigation of heat recovery performance enhancement by using graphene-coated thermoelectric generator (GTEG) are presented in this paper. By comparing the contemporary thermoelectric generator (TEG) with graphene-coated TEG, two different variation parameters; temperature different and coating thickness were observed. A set of experiment is used to stimulate the hot and cold temperature surface to recovery wasted energy sources. Promising results reveal that graphene-coated thermoelectric generator is enhanced significantly of 50% at temperature different of 100 ^{o}C. In addition, the thickness of graphene-coated layer improves the Seeback effect of 20%. In conclusion, it is observed that graphene oxide (GO) layer is potential to enhance the heat transfer performance as well as electric potential generation. These findings could be good practice to implement into a lot of different industrial to regenerate waste heat energy source into renewable electrical source. It is high potential as one of the green technology developments to create a better energy in near future.

Keywords: graphene-coated thermoelectric generator (GTEG); temperature different; coating thickness; recovery energy; green technology

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-248

FLEXIBLE INTEGRATED MICROSENSOR FOR PROTON EXCHANGE MEMBRANE WATER ELECTROLYZER INTERIOR MONITORING

Chi-Yuan Lee[1,*], Chia-Hung Chen[2], Guo-Bin Jung[1], Shih-Hung Chan[1], Yu-Chun Chiang[1], Hsiu-Li Lin[1], Shih-Chun Li[1], Shan-Yu Chen[1]
[1]Department of Mechanical Engineering, Yuan Ze Fuel Cell Center, Yuan Ze University, Taoyuan, Taiwan, R.O.C.
[2]HOMYTECH Global CO., LTD, Taoyuan, Taiwan, R.O.C.
*Correspondence: cylee@saturn.yzu.edu.tw; Tel.: +886-3-4638800 (ext. 2478); Fax: +886-3-4558013

ABSTRACT

The proton exchange membrane water electrolyzer (PEMWE) has such advantages as simple system, low operating temperature and small-scale hydrogen production according to real time requirement, and the hydrogen production process is clean, meeting the environmental requirements. The PEMWE hydrogen production is the reverse reaction of fuel cell, but the water electrolysis requires high operating voltage, the resistance is likely to generate a lot of waste heat, and the nonuniform current density results in hot spots, the internal temperature rises, accelerating the decomposition of hydrogen molecules, the water electrolyzer is likely to age and fail. In addition, three important physical parameters (voltage, current and temperature) in the running PEMWE can influence its performance and life, but the present bottleneck is external, theoretical, simulated or single measurement, the authentic information in the PEMWE cannot be obtained accurately and instantly. This paper uses micro-electro-mechanical systems (MEMS) technology to develop a flexible integrated (voltage, current and temperature) microsensor applicable to the high voltage and electrochemical environment in PEMWE, which is integrated with a 20μm thick polyimide (PI) film material. The real-time microscopic diagnosis and measurement in the PEMWE can measure the internal local voltage, current and temperature distribution uniformity instantly and accurately, so as to optimize the operating conditions and analysis.

Keywords: proton exchange membrane water electrolyzer, micro-electro-mechanical systems, flexible integrated microsensor, interior monitoring.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-251

ANTI-CORROSION MICROPOROUS LAYER AND DUAL CATALYST COMPONENTS OF LONG-LASTING PEM ELECTROLYSIS ANODE

Jyun-Wei Yu, Guo-bin Jung, Shih-Hung Chan, Huai- Chien Chang, De-Cheng Huang, Chi-Yuan Lee*
College of Engineering of Yuan Ze University
135 Yuan-Tung Road, Chung-Li, Taiwan 32003.
*S1085002@g.yzu.edu.tw

ABSTRACT
PEM water electrolysis is a suitable role for associating renewable energy to overcome unstable statement. It transfers the power of remaining to Hydrogen gas and storage at the rush time and it also good to be energy carried. This study is the anti-corrosion microporous layer for carbon-paper, Homemade Antimony-doped Tin Oxide (ATO) powder for carbon paper anti-corrosion microporous layer is between the catalyst layer and gas diffusion layer. For the EIS test, the ATO 3mg/cm^2 show better performance and durability than the other group. Consequently, the group with and without ATO 3mg/cm^2 are compared in the 500-times interruption and in the 120hr stability test. The lifetime of the group with ATO 3mg/cm^2 is respectively twice and six times as long as the group without it. Using the SEM to obvious the anode GDE surface. the result shows the ATO group has high catalyst utilization than without group.

Keywords: Proton exchange membrane、PEM water electrolysis、Membrane electrode assembly, Anti-corrosion layer

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-254

NUMERICAL SIMULATION OF THE GEOTHERMAL-SOLAR CHIMNEY POWER PLANTS

Fei Cao*, Jialing Qliu, Qingjun Liu, Hao Chang and Jianbo Bai
College of Mechanical and Electrical Engineering, Hohai University
100 North Jinlin Rd., Changzhou, 213022, China
e-mail: fcao@hhu.edu.cn (Dr. F. Cao)

ABSTRACT
In the present study, the performance of a geothermal-solar chimney power plant (GSCPP) is numerically analyzed under different operation parameters and ambient conditions. The inside field properties of GSCPP, viz. the temperature and the airflow velocity fields, are first investigated for improving the GSCPP performance. An asymmetrical temperature field is observed in the GSCPP, which is influenced by the temperature distribution of the water-to-earth heat exchanger. When the solar radiation is 500W/m^2 and geothermal water is 40 kg/s, the updraft wind velocity reaches a maximum of 10.65 m/s. Increasing the geothermal water temperature can increase the airflow velocity at the chimney outlet. When the geothermal water inlet temperature is 373K, the chimney inlet air velocity reaches a maximum of 10.69m/s. The daily GSCPP performance under five different ambient conditions are then simulated. The higher the solar radiation is, the higher the air flow velocity is observed at the chimney inlet. The GSCPP performance are finally compared with the conventional SCPP performance. It is found that introducing the geothermal water can greatly enhanced the airspeed stability in the GSCPP.

Keywords: Geothermal energy, Solar chimney, Combined system, Numerical simulation, Power plant.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-257

TRANSIENT MODEL OF A SOLAR AIDED THERMAL ENERGY STORAGE UNIT INTEGRATED HEAT PUMP SYSTEM

Nezir Yağız ÇAM[1*], Mehmet Akif EZAN[2]
[1*] Nezir Yağız ÇAM, Yaşar University, Department of Energy Systems Engineering, Izmir, Turkey,
nezir.cam@yasar.edu.tr
[2] Mehmet Akif EZAN, Dokuz Eylül University, Department of Mechanical Engineering, Izmir, Turkey
mehmet.ezan@deu.edu.tr

ABSTRACT

Environmental issues such as climate change and global warming are threading our planet more than any other time. Renewable energy is a solution to decrease these effects. However, renewable energy sources have an essential issue which is not being continuous. Although the use of renewable energy has increased considerably, renewable energy sources would have been used if sources are continuous. Energy storage systems make these intermittent resources available when the user needs them. Therefore, renewable energy sources must work in an integrated manner with energy storage systems. In addition, most of the energy is used for the air conditioning of buildings. The systems in which renewable energy sources, energy storage systems and heating-cooling systems are integrated the increase in energy efficiency and reduce the negative effects on the environment. In this study, the transient model developed to investigate the effects of the integration of renewable energy and thermal energy storage systems on the heat pump which used for air conditioning of a space was developed in TRNSYS environment. Thermal performance of an air source heat pump designed for the heating and cooling demand of a space was determined and compared with the thermal performance of the solar collector aided water source heat pump with thermal energy storage unit designed for the supply heating and cooling demand. Moreover, the COP of the heat pumps, energy efficiencies of the combined systems and different operation strategies of thermal energy storage unit integrated combined system were investigated.

Keywords: Thermal energy storage, energy modelling, heat pump, TRNSYS

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-260

A STUDY ON THE EFFECTS OF ELECTRONIC EXPANSION VALVE ON NOVEL HOT-GAS BYPASS DEFROSTING PERFORMANCE FOR AN AIR SOURCE HEAT PUMP UNIT

Long ZHANG[a], Menglong LU[b], Jiankai DONG[c], Jun SHEN[a], Yiqiang JIANG[c], Mengjie SONG[a,*]
[a] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China (yilizl@126.com, jshen@mail.ipc.ac.cn, mengjie.song@bit.edu.cn)
[b] Sustainable Buildings Research Centre (SBRC), University of Wollongong, NSW, 2522, Australia (hitlml89757@163.com)
[c] Department of Building and Thermal Engineering, School of Architecture, Harbin Institute of Technology, Harbin, 150006, China (djkheb@163.com, jyq7245@163.com)

ABSTRACT
Frosting problem impends the development of air source heat pump (ASHP) technology and periodic defrosting is necessary for ASHP units operated in frosting regions. In a previous study, a novel hot-gas bypass defrosting method using heat dissipated by the compressor of an ASHP unit was proposed and experimentally investigated preliminarily. To further improve the defrosting performances, in this study, the effects of electronic expansion valve (EEV) on the novel hot-gas bypass defrosting performances for the ASHP unit are investigated. The experimental results showed that the defrosting time and defrosting electrical energy consumption were decreased by 64.7% (from 510 to 180 s) and 52.1% (from 1061.7 to 508.8 kJ), respectively, when the EEV opening increased from 120-steps to 480-steps. Besides, since indoor air fan was opened during defrosting, EEV opening significantly impacted the air temperature supplied to the indoor room. The averaged heating capacities for indoor room during defrosting were 1.18, 1.11, 0.95, 1.11 and 1.10 kW with EEV opening of 120-steps, 180-setps, 280-steps, 380-steps and 480-steps, respectively. It was noted that cold air was supplied to indoor room for around 60 s during defrosting when using EEV opening of 480-steps due to insufficient energy stored by phase change material-heat exchanger.

Keywords: air source heat pump, hot-gas bypass defrosting, electronic expansion valve, thermal energy storage.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-263

RESEARCH AND DEVELOPMENT OF HIGH-DURABILITY ANODE CATALYST FOR PEM WATER ELECTROLYZER MEA TECHNOLOGY

Chih-Wei Lin, Guo-Bin Jung, Shih-Hung Chan, Jyun-Wei Yu, De-Cheng Huang, Chi-Yuan Lee*
Fuel Cell Center & Mechanical Engineering Department, Yuan Ze University
135 Yuan-Tung Road, Chung-Li, Taiwan 32003
*S1085006@g.yzu.edu.tw

ABSTRACT

In this study, the membrane electrode assemblies (MEA) with commercial and home-made PbO_2 powder were used to investigate their capacity as anode in ozone generation via proton exchange membrane water electrolysis. We found that degrade phenomena happened for current interruption during operation period for both home-made and commercial powder. To investigate this degradation and recovery phenomena roughly, several operation parameters were used accordingly, accompany with XRD, XPS and SEM analysis. PbO_2 and antimony-doped tin oxide (ATO) nanostructures with high specific surface areas were synthesized and their crystalline structures before and after current interruption were analyzed. According to XRD and SEM analysis, current interruption results destroyed crystalline structure of PbO_2, and this is harmful for electrochemical ozone generation. Also, we found that generation of OH radial during water electrolysis will attack catalyst and result in MEA permanent degradation.

Keywords: Proton exchange membrane water electrolysis, membrane electrode assemblies (MEA), Ozone, PbO_2 Anti-corrosion anode

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-269

AN ASSESSMENT OF THE GREEN AIRPORT CONCEPT IN TURKEY

Kacar, B.[1], Turhan, E.[1], Dalkiran, A.[2], Orhan, I.[1], Karakoc, T.H.[1]
[1]Eskisehir Technical University, Faculty of Aeronautics and Astronautics, Eskisehir, Turkey
[2]Suleyman Demirel University, School of Aviation, Isparta, Turkey
betulkacar@eskisehir.edu.tr, eylemturhan@eskisehir.edu.tr, alperdalkiran@sdu.edu.tr, iorhan@eskisehir.edu.tr, hkarakoc@eskisehir.edu.tr

ABSTRACT
The air transport industry is committed to meet the growing demands of its customers sustainably while maintaining an optimal balance between economic progress, social development, and environmental responsibility. This means balancing the needs of passengers, society, economy, and the environment, and making the best use of existing facilities while responding to recent developments. The growth and development of our civilization have a wide and devastating effect on our Natural Resources and Environment. To prevent our world from being in a worse situation than now, there are plenty of precautions that every person in the world can take. The increasing usage rate of green buildings is a wonderful transformation for this purpose. In this study, existing airports in Turkey and their operators have been examined and listed. LEED, BREEAM, ACA, and Green Company categorized according to whether the airport operators use these the green energy certifications or their status on that. Actions of the airport operators saving the environment, although their intent doesn't minimize the environmental impact, reducing constructional and operational waste. Also, the differences and attractions of international certificate programs are listed versus a national certification program which is named "Green Company", and "Green Airport" released by SHGM (Turkey's Civil Aviation General Management). Besides, in this study, the activities of airports that do not use a certificate but that carry out sustainable practices were investigated via using various social media tools of airports and communicating with people working at airports in different professions. The annual economic, social, and ecological changes created by some airports in the list after implementing sustainability practices were discussed with the selected airport's annual sustainability reports

Keywords: Green airport, Green certification, Airports of Turkey, Sustainability indicators

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021- 272

SIMULATION STUDY BETWEEN PVDF PIEZOELECTRIC BRIDGE AND CANTILEVER TRANSDUCERS FOR RAINDROP ENERGY HARVESTING

Y. J. Cheong[1], C. H. Wong[1,2], K.H. Teng[1,3]*

[1]Faculty of Engineering, Technology and Built Environment, UCSI University, 56000 Kuala Lumpur, Malaysia
[2]Faculty of Science & Engineering, Maynooth University, Mariavilla, Maynooth, Co. Kildare, Ireland
[3]Built Environment and Sustainable Technology Institution (BEST), Faculty of Engineering and Technology, Liverpool John Moores University, L3 3A, United Kingdom
1001643277@ucsiuniversity.edu.my, *chinhong.wong@mu.ie, tengkh@ucsiuniversity.edu.my

ABSTRACT

This paper presents an investigation on raindrop energy harvesting through COMSOL Multiphysics software simulation which compares the performance of polyvinylidene fluoride (PVDF) cantilever and bridge structure transducer and provides practical insights on the development of a raindrop energy harvesting system. The parameters which affect the output voltage such as beam length, the magnitude of applied force, applied force position, frequency range, and total energy accumulated are analyzed and discussed in this study. Based on the simulation results, the generated voltage and total energy for the bridge transducer are 4.88 V and 6.53 nJ respectively, whereas for the cantilever transducer is 4.59 V and 4.26 nJ. Results show that as the beam length for both bridge and cantilever transducers increases, the voltage generation starts to wear off and the frequency range starts to switch to higher eigenfrequency. An investigation of applied force shifted at different point of the beam was carried out, both designs gradually decrease in effectiveness towards the fixed end of the beam where bridge transducer having 3.2 mm out of 30 mm beam length irrelevant voltage and cantilever having 0.5 mm out of 30 mm beam length irrelevant voltage.

Keywords: Raindrop energy, PVDF, Piezoelectric, Renewable energy, Multiphysics.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-275

OPTIMIZATION OF ENERGY AND DAYLIGHTING METRICS FOR ALGAE INTEGRATED FACADE SYSTEMS

Yonca Yaman[a]*, Berkay Budakoğlu[b], Nilay Altunacar[c], Ibrahim Şener[c], Gülden Köktürk[b], Irem Deniz[d], Mehmet Akif Ezan[c] & Ayça Tokuç[a]
[a]Department of Architecture, Dokuz Eylul University, İzmir, Turkey;
[b]Department of Electrical-Electronics Engineering, Dokuz Eylul University, İzmir, Turkey;
[c]Department of Mechanical Engineering, Dokuz Eylul University, İzmir, Turkey;
[d]Department of Bioengineering, Manisa Celal Bayar University, Manisa, Turkey
Dokuz Eylul University, Department of Architecture, Tinaztepe Campus, 35190, Buca, İzmir, Turkey
Author's e-mail: *yonca.yaman@ogr.deu.edu.tr

ABSTRACT
A photobioreactor (PBR) is an innovative construction element that can be used in the building facades and mimic the natural environment necessary for the growth of microorganisms, algae in this paper algae. A PBR resembles a double window with a fluid, i.e., water and algae mixture, inside. The light transmission of the fluid changes through the growth of algae. Also, it provides additional thermal mass to the adjacent space. Since a PBR is not a standard building element, there is no straightforward model that can be used to evaluate both the indoor daylighting and thermal energy variation for a space on which a PBR façade element is implemented. Therefore, this paper proposes and implements a procedure to investigate the main design variables of a PBR in different climatic regions in a short time. The effects of orientation, types of windows and window geometries on the energy c,onsumption and daylight illumination are investigated in an office under Mediterranean climate conditions. The optimization results show that PBR with 40% or 50% algae concentration with a window geometry of 20% air and 80% algae that faces north show the best performances in terms of both energy use intensity (EUI) and useful daylight illuminance (UDI).

Keywords: photobioreactor, optimization, building simulation, energy use intensity (EUI), useful daylight illuminance (UDI).

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-284

Performance Evaluation and Comparison of Oxy-Fuel Combustion of Biomass Syn-gas Combined Cycle and Steam Turbine Power Plants

Münür Sacit Herdem*[a,b]
[a]Dept. Of Mechanical Engineering, Adiyaman University, 02040, Adiyaman, Turkey
[b]Waterloo Institute for Sustainable Energy (WISE), University of Waterloo, 200 University Ave W., Waterloo ON, Canada N2L3G1
herdem@adiyaman.edu.tr
ORCID: 0000-0003-0079-0041

ABSTRACT
Biomass is a renewable energy source; however, biomass power plants are not exactly environmentally friendly because of the carbon dioxide emissions from these plants. One way to decrease carbon dioxide emissions from biomass power plants is to capture the carbon dioxide by using various methods. In this study, a system based on oxy-fuel combustion of biomass syn-gas that is produced by using a non-combustion heat carrier ball biomass gasifier is suggested to produce power from the biomass. The main advantage of the oxy-fuel combustion is that flue gases after the combustion of the syn-gas mainly consist of carbon dioxide and water; thus, the carbon dioxide and water can be easily separated. Then, the separated carbon dioxide can be captured and used for other processes such as methanol or methane production via hydrogenation of the carbon dioxide. Power is produced using a combined cycle and a steam turbine power plants. The biomass gasification power plants are simulated using Aspen Plus. The results show that the net power generation is equal to ~14.5 MW for the combined cycle power plant while the net power generation is ~9.95 MW for the steam turbine power plant. The results also reveal that the efficiencies for the combined cycle, and steam turbine cycle are ~22% and ~15.24% (based on LHV of the biomass), respectively.

Keywords: Oxy-fuel combustion of biomass syn-gas, non-combustion heat carrier ball biomass gasifier, biomass gasification power plant

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-287

MACHINE LEARNING BASED LI-ION BATTERY PACK STATE OF HEALTH PREDICTION FOR MULTISTAGE CHARGING

Jonathan Couture
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
jonathan.couture@ontariotechu.net

Xianke Lin
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
xiankelin@ieee.org

ABSTRACT
The rise of interest in electric vehicles in these past several years has pointed out the large drawback that they take a long time to recharge. It is important to charge electric vehicle batteries efficiently and safely to prevent rapid degradation of the cells and, consequently, critical failures. The use of a multistage charging protocol has been proven to increase the charging speed by over 40 % but its effects on battery degradation have not yet been thoroughly researched.
This paper develops a new method of predicting the degradation of individual li-ion battery cells within a battery pack, using health indicator extraction and a recurrent neural network. Estimating the state of health (SOH) of individual battery cells, as opposed to the entire pack, will allow researchers to detect anomalies within their data by pinpointing faulty batteries, and even allow manufacturers and users to replace these faulty cells, benefiting the cost of maintenance and reducing the disposal of well-functioning batteries.
A model made of four electrothermal battery cells, connected in parallel, has been created to obtain training data. These cells are charged over many cycles, using a multistage charging protocol, and health indicators were then extracted from charging curves, in which battery capacity loss and resistance increase were examined. These indicators were then fed through a Long Short-Term Memory neural network to train it, using three of the four cells, and then to validate it with the fourth. The effectiveness of the proposed approach was confirmed with more simulated data.

Keywords: machine learning, State of health, lithium-ion batteries, charging

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-290

DEVELOPMENT AND APPLICATION OF HIGH TEMPERATURE RESISTANT FLEXIBLE INTEGRATED MICRO SENSOR

Chi-Yuan Lee*, Fang-Bor Weng, Shuo-Jen Lee, Chun-Wei Chiu, Shubham-Manoj Nawale, Hsiang-Ting Lin
Department of Mechanical Engineering, Yuan Ze Fuel Cell Center, Yuan Ze University, Taoyuan, Taiwan, R.O.C.
*Correspondence: cylee@saturn.yzu.edu.tw; Tel.: +886-3-4638800 (ext. 2478); Fax: +886-3-4558013

ABSTRACT

High-temperature proton exchange membrane fuel cell (HT-PEMFC) during the discharge reaction, there will be problems such as large temperature difference, uneven flow, and unstable pressure, which affect the performance and life of the membrane material and HT-PEMFC. This paper uses micro-electro-mechanical systems (MEMS) technology to develop high-temperature resistant flexible 3-in-1 (temperature, flow and pressure) microsensor. Flexible 3-in-1 microsensors can be embedded in the HT-PEMFC internal real-time monitoring of changes in temperature, flow and pressure. The test results show that in the HT-PEMFC such as temperature difference, thermal accumulation, and uneven flow.

Keywords: HT-PEMFC, MEMS, flexible 3-in-1 microsensor.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-293

FLEXIBLE 4-IN-1 MICROSENSOR FOR IN-SITU MONITORING OF PROTON BATTERY

Chi-Yuan Lee[1,*], Chia-Hung Chen[2], Guo-Bin Jung[1], Yu-Chun Chiang[1], John-Shong Cheong[1], Yun-Hsiu Chien[1], Yi-Chuan Lin[1]

[1]Department of Mechanical Engineering, Yuan Ze Fuel Cell Center, Yuan Ze University, Taoyuan, Taiwan, R.O.C.
[2]HOMYTECH Global CO., LTD, Taoyuan, Taiwan, R.O.C.
*Correspondence: cylee@saturn.yzu.edu.tw; Tel.: +886-3-4638800 (ext. 2478); Fax: +886-3-4558013

ABSTRACT

The proton battery can store hydrogen in the battery and generate electricity by water electrolysis, the battery cost and the space for hydrogen tank can be reduced a lot, it is used more extensively. As the proton battery is a new research area, multiple important physical quantities inside the proton battery should be further understood and monitored, so as to enhance the performance of battery. Therefore, this paper uses micro-electro-mechanical systems (MEMS) technology to develop a flexible 4-in-1 microsensor, which is integrated with temperature, voltage, current and flow sensing functions, and embedded in the proton battery for real-time microscopic monitoring of four important physical quantities inside the battery.

Keywords: proton battery, MEMS, flexible 4-in-1 microsensor.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-296

ANALYSIS AND OPTIMIZATION OF PERFORMANCE AND EMISSIONS OF WATER-INJECTED INTAKE PORT GASOLINE ENGINE UNDER KNOCKING

Zuowen Liu[a] Zhaolei Zheng[a*]
[a]Key Laboratory of Low-grade Energy Utilization Technologies and Systems, Ministry of Education, Chongqing University
Chongqing 400044, PR China
Authors' e-mails:liuzuowen3@163.com

ABSTRACT
Water injection has attracted more and more attention to suppress the knocking phenomenon in down-sized gasoline engine. The research applies CFD software to simulate intake port water injection engines under knocking, then use response surface method (RSM) model to predict and optimize engine performance and emissions based on simulation data.The research results show that intake port water injection can reduce the in-cylinder combustion temperature and NOx emissions, decrease the adverse effects of knocking. On the other hand, RSM can predict accurately the performance and emissions of water-injected intake port gasoline engine, the best adjusted correlation coefficient can reach 94%.At the same time, the best operating parameters of the intake port water injection engine are obtained by RSM, which are 17.87% water injection amount, 10.3 compression ratio, and 2121rpm engine speed.
Keywords: gasoline engine; knocking conditions; water injection; artificial neural network; response surface methodology

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-302

EFFECT OF A-SITE NON-STOICHIOMETRY IN PEROVSKITES ON EXSOLUTION OF CATALYTIC NANOPARTICLES AND HYDROGEN OXIDATION REACTION IN SOLID OXIDE FUEL CELLS

Na Yu [a], Guang Jiang [b], Tong Liu *[a], Xi Chen [a], Mengyu Miao [a], Yanxiang Zhang *[b], Yao Wang *[a]
[a] Key Laboratory of Hydraulic Machinery Transients, Ministry of Education, School of Power and Mechanical Engineering, Wuhan University, Wuhan, Hubei 430072, China. E-mail: pmewy@whu.edu.cn
[b] National Key Laboratory for Precision Hot Processing of Metals, School of Materials Science and Engineering, Harbin Institute of Technology, Harbin 150001, China. E-mail: hitzhang@hit.edu.cn

ABSTRACT

As an alternative SOFC anode material, perovskite decorated with metallic nanoparticles exhibits excellent performance by in-situ exsolution method. In this work, NiFe alloy modified $Sr_xFe_{1.3}Ni_{0.2}Mo_{0.5}O_{6-\delta}$ (SFNMx, x=1.90, 1.95, 2.00, and 2.05) materials were prepared. It was found that the microstructure and electrocatalytic properties of SFNMx could be adjusted by manipulating the A-site non-stoichiometry. The exsolution of Ni-Fe alloy nanoparticles can be effectively accelerated by A-site Sr deficiency, reasonably provide more active sites for the hydrogen oxidation reaction, and effectively reduce the polarization resistance of the electrode, which was in good agreement with that predicted by the regular-solution model. Moreover, the results of distribution of relaxation times (DRT) analysis showed that the adsorption/dissociation/ionization of H_2, the predominant rate-determining step, can be strongly promoted by increasing Ni-Fe nanoparticles. Thus, the electrochemical performance of SFNMx can be greatly improved by Sr-deficiency, which promotes the exsolution of nanoparticles. Our results provide guidance on the development and application of other efficient perovskite materials and energy conversion devices.

Keywords: SOFC, Anode, A-site non-stoichiometry, In-situ exsolution.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-305

THE CONCEPTUAL DESIGN AND FLOW INVESTIGATION OF THE NOVEL LAND-BASED DUAL-AXIS AUGMENTATION WIND TURBINE

Wen Tong Chong[1]*, Mahendra Varman[1], Keen Kuan Kong[1], Lip Huat Saw[2], Yi-Hao Pai[3], Wei-Cheng Wang[4],
[1]Centre of Energy Sciences, Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603, Kuala Lumpur
[2]Department of Mechanical and Material Engineering, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, Cheras, Kajang, 43000, Malaysia
[3]Department of Opto-Electronic Engineering, National Dong Hwa University, No. 1, Sec. 2, Da Hsueh Rd., Shoufeng, Hualien 97401, Taiwan
[4]Department of Aeronautics and Astronautics, National Cheng Kung University, Tainan 70101, Taiwan
*chong_wentong@um.edu.my, mahendra@um.edu.my, keenkuan88@um.edu.my, sawlh@utar.edu.my, paiyihao@gms.ndhu.edu.tw, wilsonwang@mail.ncku.edu.tw

ABSTRACT
Nowadays, importance has been attached to preserving the environment, in a vision of sustainable development. To conciliate the energy demand of countries, the international energy policy aims to raise the share of renewable energies and reduce greenhouse gas emissions where wind energy is deemed as one of several solutions. To reach this goal, it is crucial to research new designs of wind turbines that solve technical problems (poor self-starting, mechanical bearing life, maintenance, efficiency improvement, etc). The performance of horizontal axis wind turbine (HAWT) can be reduced by conditions such as low wind speed, high turbulence and frequent wind-direction changes. Certain vertical axis wind turbines (VAWTs) designs can operate well in these harsh conditions but they possess low power coefficient. This project presents a novel dual-axis augmentation wind turbine (DAWT) that complements the HAWT and VAWT is conceptualized to extract on-coming wind energy from both the horizontal and vertical directions to maximize the wind energy generation. The new configuration of DAWT consists of three vertical blades and six horizontal blades arranged in cross-axis orientation. The horizontal blades also serve as the radial supporting arms that link the vertical blades and the hubs through specially designed connectors to form the wind turbine. The proposed DAWT is more stable when compared to the HAWT as its centre of gravity is expected to be located at a lower portion especially during rough wind profiles in bad weather. It will be followed by the conceptual design of the deflector-integrated DAWT system with 3D modelling. Numerical analysis will be conducted on the overall design of the DAWT. This includes the computational fluid dynamics (CFD) study on the interaction of wind flow around the wind turbine and deflector. The deflector-integrated DAWT will be fabricated, and experiments (preliminary testing with blower arrays and wind tunnel testing) will be carried out to analyse the performance of the wind turbine under various parameters to achieve a better design with higher efficiency and good self-starting characteristics. Compared to the typical VAWTs; with the additional horizontal-blades that replace the supporting arms of the VAWT, this DAWT will have double effective surface areas that generating useful forces (with the same rotor volume – height x diameter). With this, the coefficient of power will be higher (expected maximum Cp = 0.40 from the contributions of horizontal and vertical blades) and matches the performance of the HAWT. This will also improve the starting behaviour (minimum cut-in speed ~ 2.8 m/s) by integrating the deflector assembly that diverts the wind to act on the horizontal-blades). The DAWT can be a complementary design to push the limit of wind turbine technology, creating significant opportunities for the use of wind energy and can be therefore alleviating dependencies on fossil fuels. Future integration with solar power generation and tidal power are feasible for more reliable energy supply (able to generate power during rainy and sunny days) that can provide green electricity for offshore platforms or green hydrogen generation.

Keywords: Wind energy, dual-axis augmentation wind turbine, renewable energy, deflector, power augmentation

ACKNOWLEDGEMENT
The authors would like to thank Ministry of Science, Technology and Innovation (MOSTI) for the research grant (International Collaboration Fund, ICF – CF001-2021).

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-308

OPTIMIZATION OF ELECTRODE ASSEMBLY TECHNOLOGY FOR PROTON EXCHANGE MEMBRANE (PEM) DEHUMIDIFICATION SYSTEM

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
Compact dehumidification methods are necessary in precise manufacturing process and special goods storage. Therefore, traditional dehumidification technology is limited for complex equipment and large thermal inertia. The electrolyte membrane dehumidification, driven by low voltage DC electric field, is suitable because of its compact structure and no condensation. However, the assembly technology of membrane electrodes still has many problems, such as the catalyst loading and membrane hot-pressing process, resulting in low efficiency and poor repeatability of the dehumidifying membrane electrode. It still does not reach the commercial standards, hence developing high performance membrane electrode assemblies (MEA) would be favorable for the reduction of the PEM dehumidification cost.
In view of this, the research work of this paper mainly has the following contents:
(1) Firstly, we used the vacuum heating spraying method (VHSM) and swelling-spraying method (SSM) to load the catalyst on the membrane. Vacuum adsorption and heating were used to reduce the swelling of the membrane in the VHSM while hot water was inlet both as a swelling agent and heat source to improve the dimensional stability of Nafion 117 in spraying process in the SSM. In this study, ATO-IrO_2 with high conductivity and Pt-C were used as anode and cathode catalysts respectively and the best spraying effect of the slurry was explored by mixing different proportions of catalyst, isopropanol, Nafion solution and deionized water. After evenly dispersed by ultrasonic spraying and magnetic stirring, the catalyst was directly loaded on the PEM. The dehumidification performance and properties of the prepared MEA were evaluated and analyzed by polarization curves, electrochemistry impedance spectroscopy (EIS) and scanning electron microscopy (SEM).
(2) Then, we explored the influence of hot-pressing process on the structure and performance of membrane electrode module. Moderate hot-pressing process can make the structure of MEA more compact and reduce the internal resistance. By controlling hot-pressing temperature, hot pressing-time, hot-pressing pressure and other factors, we observed the surface morphology by SEM and tested the resistance to acquire the best hot-pressing parameters.
(3) Finally, the shape of bipolar plate was improved to optimize the internal potential and water heat distribution of the dehumidification module. Several kinds of metal plates with optimized shapes were tested, which significantly improved the dehumidification efficiency of the system. It provides an effective exploration for large-scale commercialization of electrolyte membrane dehumidification.

Keywords: Air dehumidification, Electrolyte membrane, Assembly, Performance improvement

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-326

A REGIONAL AND RECRUITMENT-BASED ANALYSIS OF CANADIAN HOUSEHOLD CARBON FOOTPRINTS

Nicholas Palaschuk*
School of Environment, Enterprise, and Development, University of Waterloo
200 University Ave W, Waterloo, Ontario, Canada, N2L 3G1
npwpalaschuk@uwaterloo.ca
Paul Parker
School of Environment, Enterprise, and Development, University of Waterloo
200 University Ave. W, Waterloo, Ontario, Canada, N2L 3G1
pparker@uwaterloo.ca
Jake Miller
Project Neutral
720 Bathurst St., Toronto, Ontario, Canada, M5S 2R4
jake@projectneutral.org
Sydney Hennessy
Reep Green Solutions
20 Mill Street, Kitchener, Ontario, Canada, N2G 2Y3
shennessy@reepgreen.ca

ABSTRACT

Despite deepening public awareness surrounding issues of climate change and the adoption of pro-environmental attitudes, climate action has been limited regarding a substantive change in behavior. The carbon footprint calculator has emerged as an increasingly attractive strategy for pro-environmental behavior change by providing tailored information that allows individuals to understand the relative contribution of their various behaviors and especially how their lifestyles compare to others. With a focus on action as well as recruitment, this research project explored the carbon footprint profiles of Southern Ontario households to assess 'how' and to 'what' degree household carbon footprints differ regionally and by recruitment method. In partnership with REEP Green Solutions (a Waterloo Region environmental non-profit) and the Project Neutral online carbon footprint calculator, this study constitutes a preliminary analysis of carbon emissions associated with various lifestyle choices.

Participants directly engage with the Project Neutral online carbon footprint tool with questions related to home energy; daily transportation; air travel; waste; and food choices. The inclusion of "deep dive" modules provides more accurate measures of personal footprints across three regional cohorts (London, Kitchener-Waterloo-Cambridge, Rural Waterloo Region) and nine recruitment-based cohorts (online, friend or neighbor, school, event, group, workshop, survey, other). Our comparative analysis of 801 individual user profiles shows that there are significant differences regionally and based on recruitment methods concerning transportation, food, waste, and total carbon footprint emissions. Regionally, KWC users reported significantly higher food emissions (A kgCO2/yr) compared to London (B kgCO2/yr) and Rural (C kgCO2/yr) users while London users reporting significantly higher transportation emissions than the other two regional cohorts. Upon comparing recruitment-based differences, users recruited through schools reported significantly higher transportation emissions (compared to users recruited by a friend/neighbor, through a group, and by 'other' means); food emissions (compared to all other recruitment cohorts); waste emissions (compared to all other recruitment cohorts); and household carbon footprints (compared to all other recruitment cohorts).

Cumulatively, this research contributes to deepened understandings regarding the interconnectedness of pro-environmental behaviors. This is foundational for effective energy and environmental policy, as growing concern over anthropogenic climate change and the limited success of individualistic behavioral change programs have generated a renewed interest in strategies that promote efficiency and conservation through comparisons to encourage behavior modification. Framed as a comparative multi-case study project, this research contributes to new understandings of behavior change processes and highlights opportunities for action while encouraging householders to engage in the new decision and behavioral patterns. Moreover, our efforts will provide insights into how we might influence shared behavior's and begin to engage in sustainability transitions at a larger scale.

Keywords: carbon emission management, carbon literacy, community engagement, carbon calculator

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-335

DESIGN AND MODELING OF THE GEOTHERMAL ENERGY DRIVEN INTEGRATED SYSTEM FOR USEFUL PRODUCTS

Fatih YILMAZ*,
Murat OZTURK
Depertmanet of the Mechatronics Engineering, Faculty of Tchonology, Universty of Applied Sciences, Isparta, Tukery
ffatihyilmaz@isparta.edu.tr
muratoztukr@isparta.edu.tr

ABSTRACT

The use of geothermal energy, which is one of the renewable energy sources, for various purposes is becoming widespread with each passing day. The key purpose of this work is to design and thermodynamically analyze the geothermal energy-supported flash-binary g power generation system for beneficial outputs. In this context, the thermodynamic performance of the total plant, as well as the hydrogen generation rate, are examined in detail. Also, the performances of single-generation and overall systems are compared. On the other hand, this system under consideration consists of an organic Rankine cycle (ORC), a steam turbine, a Proton Exchange Membrane (PEM) Electrolysis, and humidifier and dehumidification (HDH) units, for power, hydrogen, and freshwater generation purposes. The results show that the energy and exergy performance of the suggested model is calculated as 23.93% and 17.25%, at 180 ^{o}C geothermal water outlet. In addition, this model has a net electrical power generation capacity of 1159 kW.Finnaly, it has been observed that the performance data of the single-generation model is smaller than the performance data of the whole system, which is multi-production.

Keywords: Energy, exergy, hydrogen, geothermal

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-338

A novel renewable energy based integrated plant with thermal energy storage and hydrogen generation

Fatih YILMAZ*,
Murat OZTURK
Isparta University of Applied Sciences, Faculty of Technology, Department of Mechatronics Engineering, 32200, Isparta/Turkey
E-mails: *fatihyilmaz@isparta.edu.tr ,
muratozturk@isparta.edu.tr

ABSTRACT

In today's world where energy is used and required intensively, energy storage methods are among the important issues. In this proposed study, a newly designed that is renewable energy-based integrated plant combined with compressed air storage is planned and proposed. For this purpose, in order to investigate the performance of this study, comprehensive thermodynamic modeling is conducted using the energetic and exergetic efficiency perspective. This proposed work consisted of a compressed air production plant, a Brayton cycle, a Rankine cycle, an organic Rankine cycle, a single-effect absorption cooling unit, and PEM electrolyzer. With the integration of these subsystems, it is aimed to produce hydrogen, power, heating, and cooling. In addition, the effect of some system parameters on the performance of the proposed model is examined in detail. The results display that energy and exergy efficiency of the overall plant are determined as 48.27% and 43.78% Finally, thermodynamic analysis results indicated that the power generation rate of the gas turbine, steam turbine, and ORC turbine are determined as 75000 kW, 3270 kW, and 613 kW, respectively.

Keywords: Energy, exergy, thermal energy storage, hydrogen, multigeneration

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-341

DEMAND MANAGEMENT AND SUSTAINABLITIY OF ENERGY EFFICIENCY FOR COOLING PROCESSES IN INDUSTRIAL APPLICATIONS

M.Ziya Sogut[1], T.Hikmet Karakoç[2]
[1]Piri Reis University, İstanbul, Turkey, mzsogut@gmail.com
[2]Eskişehir Technical University, Eskisehir, Turkey, hamit@mekanikproje.com.tr

ABSTRACT
In this study, in order to evaluate this approach defined, the system application that depends on the demand management of the cooling choice, which is an important energy user in a metal production process, were examined. Thermo-economic and environmental analyzes of the process were made with the system approach developed. In this analysis, the mechanical system problems were seen an important effect on operational process efficiency. In addition, in the system analysis, the operating efficiency was defined around 34% and this consumptinal irreversibility was found that causes significant cost losses and environmental effects as 225.68 tonCO2/year. Furthermore, a system approach model that takes demand control management into account has been developed and its effects on operational efficiency are evaluated with thermo-economic and environmental parameters.

Keywords: Industrial enterprises, cooling systems, demand management, thermo-economic analysis, efficiency.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-344

A COMBINED RENEWABLE ENERGY-BASED SYSTEM WITH HIGH-TEMPERATURE STEAM ELECTROLYSIS FOR SUSTAINABLE HYDROGEN PRODUCTION

[1]Nejat Tukenmez, [2]Yunus Emre Yuksel, [1]Murat Ozturk
[1]Isparta University of Applied Sciences, Faculty of Technology, Department of Mechatronics Engineering, Cunur West Campus, Isparta, Turkey
[2]Afyon Kocatepe University, Bolvadin Vocational School, Electricity and Energy Department, Kirkgoz Campus, Afyonkarahisar, Turkey
Authors' e-mails: nejattukenmez@isparta.edu.tr; yeyuksel@aku.edu.tr; muratozturk@isparta.edu.tr

ABSTRACT
In this study, the biomass-powered multigeneration system is designed to produce hydrogen primarily, electricity, fresh water, heating, and cooling. For the storage of produced hydrogen, it is liquefied by using liquid nitrogen. Pelton and Rankine turbines are integrated into the multigeneration system for power generation. The double effect absorption cooling system and fresh water production system are the other subsystems of the proposed multigeneration system. Each stream for the system's design is numbered and assigned thermodynamic balance equations in the analysis part. With the help of Engineering Equation Software (EES), thermodynamic balance equations have been solved. Then energy and exergy efficiencies and exergy destruction rates of all subsystems and the whole plant have been calculated. According to the calculation results, the energy and exergy efficiencies of the biomass-powered multigeneration system are found as 57.34% and 51.86%, respectively. To gain more information about the proposed system behavior concerning some parameters, parametric analyses have been performed, too.

Keywords: multigeneration system, hydrogen production, thermodynamic analysis, biomass, steam electrolysis

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-347

STUDY RESIDENTIAL ENERGY CONSUMPTION USING A BOTTOM-UP MONTE CARLO MARKOV CHAIN STOCHASTIC MODEL

Ryan Quan*, Lucas Wen Tang*, XiaoYu Wu
University of Waterloo
200 University Ave W, Waterloo ON
r4quan@uwaterloo.ca, c5wen@uwaterloo.ca, xiaoyu.wu@uwaterloo.ca

ABSTRACT
Residential sector accounts for about 6% of the global CO_2 emissions (International Energy Agency, 2018). Understanding the residential energy consumption is important to determine the energy storage requirement when integrating variable renewable energy in the sector. The location, the building types, and the habits of the residents all influence the energy requirement and thus, need to be accounted for in the model. Here, we constructed a bottom-up Monte Carlo Markov Chain stochastic model for the electrical load of a community in greater Toronto area by simulating their hourly heating/cooling loads and activity loads, accounting for activity time and activity duration. Various building types, as well as residents' habits were examined to characterize their impacts on the electricity consumption. The building types analyzed were categorized by size (1-story, 8-story, 36-story), whereas the altered habits included later sleeping and wake up times, as well as increased duration of certain events such as computer activity. First, we validate the model against the published trends of residential energy loads and profiles. Results showed our models can predict similar trends with peaks of up to 2.1k MW/1000 households in the summer months and 2k MW/1000 households in the higher usage winter months (in greater Toronto area). With the adjusted habits, the summer months showed the most variance between the models, increasing from peaks of 460W per household to 700W per household. Our model, while currently calibrated for greater Toronto area, is applicable to other areas with provided weather data, with the adjusted habits simulation showing their versatility. Further improvements can be done to have more accurate assumptions in appliance power and room temperature settings.

Keywords: Markov Chain, Residential Energy Consumption, Energy Model

* RQ and LWT contributed equally to this work.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-353

ANALYSIS AND ASSESSMENT OF SOLAR ENERGY DRIVEN INTEGRATED GASIFICATION SYSTEM WITH WASTE MANAGEMENT OPTION

B. Gungor* and I. Dincer
Clean Energy Research Laboratory, Faculty of Engineering and Applied Science Ontario Tech. University
2000 Simcoe Street North, Oshawa, Ontario L1H 7K4, Canada
Emails: bogachan.gungor@ontariotechu.net, ibrahim.dincer@uoit.ca

ABSTRACT
This study aimed to integrate renewable energy resources with a gasification combined cycle for the possible waste management of unrecyclable plastics and tires. This integrated gasification unit uses PET and waste tires as feedstocks to produce hydrogen and transform the hydrogen into electricity for community use through a PEM Fuel Cell System. For the reference location, Kingston, ON, was selected because of the availability of landmass to integrate a wind farm into this waste to energy system. This wind farm provides direct electricity to the community and where the excess energy is available, this is stored by using a hydrogen storage system. This stored energy is planned to be used when the energy demand from the community is high to have an economical benefit. Furthermore, an anaerobic digestion system was modeled according to the capita in Kingston ON for biogas and biomass production. For thermodynamic modeling ASPEN PLUS, RET Screen and EES software were used. The hydrogen to fuel ratio at the gasifier and WGSR was found to be 0.145 and 0.246. The total energy provided to the community in a day was calculated to be 4.32GWh. The total biogas production in the digestors was recorded to be 275m^3/h in this order. The overall energy and exergy efficiency of this waste to energy system was stated as 33% and 30%, respectively.

Keywords: Hydrogen, energy, exergy, efficiency, waste tires, PET, waste-to-energy.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No. : IGEC2021-359

SIMULATION AND PARAMETRIC OPTIMIZATION OF A SMALL-SCALE CPV-ORC SYSTEM

Lin ZENG[1], Jiaojiao ZHUANG[1], Ning MAO[1*]
[1]Department of Gas Engineering, College of Pipeline and Civil Engineering, China University of Petroleum (East China), Qingdao, Shandong, China
* Corresponding author: maoning@upc.edu.cn

ABSTRACT
This study concerns a hybrid CPV(Concentrator Photovoltaic) system coupled with an organic Rankine cycle, which mainly contains CPV modules and cooling subsystem. The cooling fluid drived by pump is evaporated in tubes under the CPV modules. When the heat produced by CPV is recovered by cooling fluid, superheated vapor is generated for additional electric power generation with an organic Rankine cycle. However, the performance of the hybrid system should be investigated and optimized to obtain the best operating status. The CPV-ORC system was constructed and simulated using Aspen plus platform which contains the types of fluid and cooling system modules. The working fluid was selected through TOPSIS techniques. It was found that R600 was the optimal working fluid for the coupled system which achieved thermal efficiency of 15.9% and combination efficiency of 18% with net work of 1080.4W. Comparing with conventional sole CPV modules, the combination efficiency of hybrid system increased from 8.4% to 18% with 1000 suns.

Keywords: hybrid system, CPV-ORC, heat dissipation, combination efficiency

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-362

FAULT DIAGNOSIS OF A SINGLE BATTERY CELL VIA TRANSFER LEARNING

Chukwuemeka Nwauche
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
chukwuemeka.nwauche@ontariotechu.net

Xianke Lin
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
xiankelin@ieee.org

ABSTRACT
Being able to identify the type of fault present in a lithium-ion battery is paramount to the efficient utilization of battery packs in electric vehicles. As renewable energy sources start to compete with fossil fuels in terms of accessibility and ubiquity, so too has there be an evolution in their use in areas traditionally dominated by fossil fuels. One of the said areas is in vehicle powertrains where lithium-ion batteries have replaced traditional engines. However, their novelty does not preclude them from the issues that plague any new technology. One area of concern is the ability to gauge the health of these batteries in order to reduce downtime and maintenance costs.
The hypothesis is that a convolutional neural network (CNN) model is capable of diagnosing existing faults in a charged battery via its temperature and voltage charging curves. To this end, an integrated electro-thermal cylindrical LFP battery model is used to generate temperature and voltage charging curves for multiple battery faults, including capacity loss, abnormal temperature generation and internal shorts. To predict these faults, a transfer-learning based CNN with a ResNet-152 as its backbone is constructed and trained on the charging data. The CNN was able to detect the faults with a 98% accuracy for the temperature curves and a 99% accuracy for the voltage curves.
These results, albeit a bit too perfect due to the reproducible nature of the model used for curve generation, suggest that the utilization of temperature and voltage charging curves for fault detection is an effective way of not only detecting the presence of a fault but can also accurately diagnose what type of fault is present. This would allow for the development of finer grain retirement policies for batteries leading to more effective and efficient electric vehicles.

Keywords: fault diagnostics, batteries, transfer learning

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-365

DATA-DRIVEN ANODE POTENTIAL PREDICTION IN LITHIUM-ION BATTERIES FOR LITHIUM PLATING PREVENTION BASED ON GAUSSIAN PROCESS REGRESSION

Kavian Khosravinia
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
kavian.khosravinia@ontariotechu.net

Xianke Lin
Ontario Tech University
2000 Simcoe St N, Oshawa, ON L1G 0C5, Canada
xiankelin@ieee.org

ABSTRACT
The challenging requirements for further development of lithium-ion battery systems are longer life, fast charging, low-temperature charging, self-recovery capability and safety performance. In fact, according to the literature, a variety of factors, including battery degradation, affect these requirements. One of the most detrimental degradation mechanisms that occur during the fast charging process is the deposition of metallic lithium or lithium plating. Lithium plating happens when the anode potential drops below 0V (vs. Li/Li^+). The higher the lithium plating rate, the lower the anode potential. As a result, the first step in preventing lithium plating is to predict anode potential in real-time under various working conditions. To predict anode potential, complex model-based methods (Pseudo-2D Physiochemical model) are widely used in the literature, which are computationally heavy and requires in-depth knowledge of battery chemistry. This means it impractical to be used in real-time control tasks. In order to address this problem, we present a machine learning-enabled data-driven model based on Gaussian process regression (GPR) that accurately predicts the anode potential under various cyclic conditions. To achieve a complete dense (compacted) input data set with a high correlation with anode potential, data pre-processing, correlation analysis, and principal component analysis are applied. The GPR model is built using the compacted data set. Automatic relevance determination is accomplished by setting various length scales for different input features to optimize the weights of different features. An autoregressive model has been developed in addition to the standard GPR model to increase estimation precision and confidence. Four cells are cycled at different dynamic cycles to verify the proposed method. The proposed Gaussian process regression model achieves adequate results for anode potential predictions at constant charging profiles.

Keywords: data-driven, lithium plating

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-368

Interfacial Charge Transfer Transitions, hol doping and sensitization for visible light response in Trivalent Rare earth ions/TiO_2 Nanoparticles Functionalized with Salicylic acid

Chaima Ouled amor
University of Gafsa, Faculty of sciences of Gafsa
amorchaima92@gmail.com

ABSTRACT
Salicylic acid-modified TiO_2 (TiO_2/SA) and Dy-TiO_2 (Dy-TiO_2/SA) complexes were successfully synthesized via sol–gel method followed by impregnation method. XRD, SEM, TEM and photoluminescence techniques were used to characterize the Dy-doped TiO_2 and SA surface modifided samples. The average particle size for TiO_2 samples determined by XRD using the Scherer equation were 6–8 nm and 12–13 nm for Dy-TiO_2 and TiO_2. The SA modification does not affect pure TiO_2 particles in terms of size or shape. However, Dy-TiO_2/SA gives similar morphology to Dy-TiO_2 with the generation of some white aggregates on the surface resulting from the interaction between the SA and TiO_2 surface.
Dy^{3+} doping causes an increase in the PL intensity and appearance of four distinguishable transitions in the range 400–485 nm, associated with band-to-band excitation peak and oxygen vacancy-related defect centers. In the case of the TiO_2/SA and Dy-TiO_2/SA samples, the excitation spectra gave no interband TiO_2 transitions in the visible range, demonstrating that the ligand-to-metal charge transfer(LMCT) surface complex of Ti^{4+} with the salicylate ion alters the electronic states within TiO_2.

Keywords: TiO_2, Dysprosium, Salicylic acid

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021- 371

EXPERIMENTAL DESIGN ANALYSIS OF MUREXIDE DYE REMOVAL BY ACTIVATED CARBON ADSORPTION

Rimene Dhahri[1,*], Younes Moussaoui[2]
[1] Materials, Environment and Energy Laboratory (UR14ES26), Faculty of Sciences of Gafsa, University of Gafsa, Tunisia
[2] Organic Chemistry Laboratory (LR17ES08), Faculty of Sciences of Sfax, University of Sfax, Tunisia
[*] Corresponding author's E-mail: dhahririmene@gmail.com

ABSTRACT
The aim of this work is to investigate the feasibility of using activated carbon, derived from olive waste wood, as a potential and low-cost adsorbent for Murexide dye removal from aqueous solutions. Acidic and basic functional groups and surface structure of the obtained activated carbon were analyzed by Bohem titration, infrared spectroscopy (FTIR) and scanning electron microscopy (SEM).
For the optimization of the process parameters, the effects of pH, adsorbent dosage, and initial dye concentration were analyzed using the full factorial experimental design methodology. Design Expert 11.1.2.0 Trial software was used for generating the statistical experimental design and analyzing the observed data. Langmuir and Freundlich adsorption models were employed to provide a description of the equilibrium isotherm. Furthermore, the pseudo-first-order and pseudo-second-order kinetic models were conducted to investigate the mechanism of dye adsorption by the activated carbon. The thermodynamic studies indicated that the adsorption of Murexide occurs in a spontaneous and favorable process.

Keywords: Activated carbon, adsorption, Murexide, wastwater treatment.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-374

THERMODYNAMIC ANALYSIS OF A SOLAR-WIND ENERGY-BASED INTEGRATED PLANT WITH PEM FUEL CELL STACK

[1]Nejat Tukenmez, [2]Yunus Emre Yuksel, [1]Murat Ozturk
[1]Isparta University of Applied Sciences, Faculty of Technology, Department of Mechatronics Engineering, Cunur West Campus, Isparta, Turkey
[2]Afyon Kocatepe University, Bolvadin Vocational School, Electricity and Energy Department, Kirkgoz Campus, Afyonkarahisar, Turkey
Authors' e-mails: nejattukenmez@isparta.edu.tr; yeyuksel@aku.edu.tr; muratozturk@isparta.edu.tr

ABSTRACT
In this study, an integrated system based on solar-wind energy is designed, and comprehensive thermodynamic analysis is carried out in order to obtain electricity, hydrogen, power, fresh water, and heating as valuable products. While modeling the integrated energy system, System Modeling Language (SysML) modeling tool is used. The system includes organic Rankine cycle (ORC) for power generation in the modeled energy system, proton exchange membrane (PEM) electrolyzer for hydrogen generation, PEM fuel cell stack for electricity generation from hydrogen generated, reverse osmosis subsystem for fresh water generation, and solar collector cycle for heating output. Some of the energy obtained by photovoltaic panels and wind turbines is used in the integrated system when necessary. At the same time, the other part is transmitted to the plant for use when desired. For the comprehensive thermodynamic analysis of the integrated system, the system's mathematical model is created first. Thanks to the Engineering Equation Solver (EES) software package, a comprehensive thermodynamic analysis of the system, whose mathematical model is created, is performed. Together with the performance curves of the system, the effects of different system parameters on the system performance are analyzed comparatively. According to the performance evaluation, the energy and exergy efficiencies of the renewable energy-based plant with high-temperature steam electrolysis for sustainable hydrogen are calculated as 42.57% and 33.61%, respectively.

Keywords: hydrogen production, integrated energy system, solar energy, thermodynamic analysis, wind energy

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-377

AN EXPERIMENTAL AND NUMERICAL STUDY ON UNSTEADY CHARACTERISTICS OF FLOW BOILING IN STRAIGHT MICROCHANNEL UNDER SUDDEN HEAT FLUX INCREASE

Jiaojiao Zhuang[1], Hao Yu[1], Ning Mao[1], Mengjie Song[2]*

[1]Department of Gas Engineering, College of Pipeline and Civil Engineering, China University of Petroleum (East China), Qingdao, Shandong, China

[2] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing, China

* Corresponding author: maoning@upc.edu.cn

ABSTRACT

The high heat flux on the PV cells can lead to the decrease of electricity efficiency. To tackle with the high temperature problems in PV cells microchannel is attracting increasing attentions recently due to its much higher heat flux. To further understand the effect of variation of solar radiation on cooling performance of the PV cells, the pressure drop characteristics, flow pattern characteristics and vapor volume fraction characteristics of the microchannel with a water flow diameter of 400μm under different heat flux increases were studied through experiments and simulations. The results showed that the pressure drop fluctuation intensity and the vapor volume fraction increased with the increase of heat flux, and the instability of flow boiling increases with the increase of heat flux. It was also found that when the sudden heat flux increase was much higher, the deionized water was earlier to boil in the microchannel with more gas phase. The proportion of the annular plug flow gradually increased.

Keywords: microchannel, flow boiling, pressure drop, unsteady heat flux，vapor volume fraction，flow pattern

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-380

DESIGN OF A MOBILE FLOATING NUCLEAR POWER PLANT INTEGRATED WITH A SOLAR BASED HYDROGEN ENERGY SYSTEM

Mert Temiz*, Ibrahim Dincer
Clean Energy Research Laboratory (CERL), Faculty of Engineering and Applied Science, Ontario Tech. University, 2000 Simcoe Street North, Oshawa, Ontario L1H 7K4, Canada
Authors' e-mails: mert.temiz@uoit.ca, ibrahim.dincer@uoit.ca

ABSTRACT
In this study, a floating nuclear station vessel and its integration with a solar-based hydrogen energy system are investigated. High-temperature gas-cooled pebble bed reactor nuclear plant with a closed gas and steam cycle, integrated with a land-based bifacial PV plant, thermochemical Cu-Cl cycle, PEM fuel cell, and a cascaded heat pump. The overall integrated system is thermodynamically analyzed with energy and exergy approaches. A transient study is performed while considering the vessel's year-round travel. The floating nuclear plant is supplied heat and electricity to the local communities; the excess thermal and electrical energy is used to produce hydrogen in order to store the energy for the rest of the year. According to the calculations, a 150 MW_{th} nuclear plant is supplied enough energy to meet the heat and electricity demand of 4 different cities for the whole year. According to the calculations, the vessel is stayed in Iqaluit, Nunavut, for the five months of the year; the overall energy and exergy efficiencies for the average ambient conditions during the stay of the vessel are calculated as 24.48% and 19.67%, respectively, and for the rest of the year the overall energy and exergy efficiencies are calculated as 39.97% and 46.04%, respectively.

Keywords: Floating nuclear power, arctic, bifacial photovoltaic, hydrogen, marine, sustainable energy systems.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-383

FLEXIBLE FOUR-IN-ONE MICROSENSOR PACKAGE AND APPLICATION

Chi-Yuan Lee[1,*], Chin-Lung Hsieh[2], Chia-Hung Chen[3], Chong-An Jiang[1], Chung-Yu Chien[1]
[1]Department of Mechanical Engineering, Yuan Ze Fuel Cell Center, Yuan Ze University, Taoyuan, Taiwan, R.O.C.
[2]Institute of Nuclear Energy Research, Taoyuan, Taiwan, R.O.C.
[3]HOMYTECH Global CO., LTD, Taoyuan, Taiwan, R.O.C.
*Correspondence: cylee@saturn.yzu.edu.tw; Tel.: +886-3-4638800 (ext. 2478); Fax: +886-3-4558013

ABSTRACT

The sensors are required for monitoring the internal signal of vanadium redox flow battery. However, all of the commercial sensors on the present market are two-in-one sensor (voltage and current, temperature and humidity) or three-in-one sensor (temperature, flow and humidity), there is not yet a four-in-one sensor which can measure the voltage, current, temperature and flow simultaneously, and there is no ability to resist acid and electrochemical corrosion. Therefore, this paper will aim at the inside of vanadium redox flow battery and the inside of system electrolyte delivery pipe, and use micro-electro-mechanical systems (MEMS) technology to develop a flexible four-in-one (voltage, current, temperature and flow) microsensor. The design and packaging are completed referring to the specifications of commercial sensors, the reliability and durability are tested, the commercial prototype development is completed for subsequent connection to vanadium redox flow battery. The flexible four-in-one microsensor monitors the internal signal of vanadium redox flow battery to check whether the vanadium redox flow battery is in normal operation or not, and the flexible (temperature and flow) microsensor in the pipeline implements feedback control instantly to return the system to the optimum operating conditions..

Keywords: Vanadium redox flow battery, MEMS, flexible four-in-one microsensor.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-386

ENERGY AND EXERGY ANALYSES OF A SOLAR COMBINED PLANT FOR PRODUCING POWER, HYDROGEN, OXYGEN, HEATING AND COOLING

Mehmet Altinkaynak[1], Murat Ozturk[2]
[1]Department of Mechanical Engineering, Faculty of Technology, Isparta University of Applied Sciences, 32100, Isparta, Turkey
[2]Department of Mechatronics Engineering, Faculty of Technology, Isparta University of Applied Sciences, 32100, Isparta, Turkey
e-mails: mehmetaltinkaynak@isparta.edu.tr; muratozturk@isparta.edu.tr

ABSTRACT

In this paper, the energy and exergy analyses of an integrated solar energy-based plant are proposed. The multigeneration plant produces power, hydrogen, oxygen, heating and cooling through combined solar parabolic dish collector series. The proposed system consists of the solar power plant, S-CO_2 power cycle, organic Rankine cycle, single-effect absorption cooling system, hydrogen production and utilization plant. Also, a PEM fuel cell plant is used for producing electricity during insufficient available solar energy. The overall exergy performance is calculated as 34.86% and the corresponding energy performance is 42.75% under the working situations. Moreover, different parametric works are also performed to define the effects of changing plant conditions on the thermodynamically performance of the developed plant. The developed plant supplies better energetic and exergetic efficiencies under the high solar radiation levels.

Keywords: Solar parabolic collector; integrated plant, multigeneration; hydrogen production and utilization.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-389

CHARACTERIZATION OF OPTIMIZED ACTIVATED CARBON DERIVED FROM PEACH STONES

Souha Harabi*, Sami Guiza
National Engineering School of Gabes
Gabes, Tunisia
*Souhaharrabi20@gmail.Com

ABSTRACT
Activated carbon (AC) is largely known us an excellent adsorbent, which is able to eliminate diverse pollutants from fluids (dyes, COV components, heavy metals...).Many precursors, were used for its synthesis. In our study, we choose to work with peach stones because of its abundance and low cost. An optimized (AC) was obtained, us a result, and characterized physico-chemically. In fact, we submit different analyses for the chemical characterization: measure of iodine index, pH value, pH of zero charge point, functional surface groups and physical characterization also: measure of specific surface area, density, and the determination of ash and moisture

Keywords: activated carbon, characterized, physically, chemically, peach stones

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-401

DURABILITY ENHANCEMENT OF PROTON EXCHANGE MEMBRANE FUEL CELLS BY FERROCYANIDE OR FERRICYANIDE ADDITIVES

Xin Liu[a], Yi Li[a], Mengyuan Li[a], Na Xie[a], Junfeng Zhang[a], Yanzhou Qin[a], Yan Yin[a] *, Michael D. Guiver[a,b] *

[a] State Key Laboratory of Engines, Tianjin University, Tianjin 300072, China
[b] Collaborative Innovation Center of Chemical Science and Engineering (Tianjin), Tianjin 300072, China
E-mail addresses: yanyin@tju.edu.cn (Yan Yin), michael.guiver@outlook.com (Michael D. Guiver).

ABSTRACT

Proton exchange membrane fuel cell (PEMFC) is one of the most promising methods for utilization of the clean and renewable hydrogen energy, which is important to overcome the non-renewable energy crisis and global environmental deterioration. To ensure long service lifetimes of PEMFCs, practical durability of the core component, proton exchange membrane (PEM), is crucially important. Generally, the durability of PEMs under in situ conditions is related to several aspects, such as thermal stability, mechanical stability and chemical stability. Chemical stability mainly refers to the endurance of PEMs toward free radical attack (such as •OH and •OOH), which is a pivotal contributing factor to the overall durability. To improve membrane chemical stability, doping with transition metal ion-based antioxidative additives has been widely exploited, and Ce ion has already attracted considerable interest and support by the US Department of Energy (DOE). Other radical scavenging species, such as organic antioxidants and heteropoly acids have also been investigated to mitigate radical attack. Despite improvements in the chemical stability of PEMs using these approaches, additional challenges appeared in these studies, including reductions in proton conductivity, additive migration, and agglomeration or leaching from membrane matrices, leading to the overall performance being below expectation.

Recently, we discovered unexpectedly robust chemical stability of PEMs, which was demonstrated to be attributable to the radical scavenging ability of the ferrocyanide–ferricyanide (Fc (II)–Fc (III)) redox cycle[1-3]. In these previous studies, the Fc (II)–Fc (III) redox species were introduced into polymer matrices using a strategy of ligand exchange, which restricts the applicable scope of available polymers. Herein, via an alternative route of physical incorporation, Fc (II)/Fc (III) species are introduced into a variety of perfluorosulfonic acid (PFSA) and sulfonated hydrocarbon PEM matrices[4]. The resulting composite membranes display enhanced durability in PEMFC evaluations, compared with pristine membranes, even considerably beyond the composite membranes using US DOE approved state-of-the-art antioxidant Ce ions. Moreover, the incorporation of Fc (II)/Fc (III) species simultaneously introduces additional proton sites after membrane acidification, thereby increasing both ex situ conductivity and in situ power output. In addition, due to hydrogen bonding between the less ionized protons on Fc (II)/Fc (III) species and the sulfonic groups of the polymer matrices, these additives show adequate retention in the composite membranes. The strategy proposed in the present work appears promising as a universal method to greatly improve the chemical stability of both PFSA and hydrocarbon-based PEMs.

Keywords: fuel cell, proton exchange membrane, ferrocyanide/ferricyanide, antioxidative additive, durability.

REFERENCES

[1] X. Liu, Y. Li, J. Xue, W. Zhu, J. Zhang, Y. Yin, Y. Qin, K. Jiao, Q. Du, B. Cheng, X. Zhuang, J. Li and M. D. Guiver, 2019, Magnetic field alignment of stable proton-conducting channels in an electrolyte membrane. *Nature Communications* 10: 842.

[2] X. Liu, J. Zhang, C. Zheng, J. Xue, T. Huang, Y. Yin, Y. Qin, K. Jiao, Q. Du and M. D. Guiver, 2020, Oriented proton-conductive nano-sponge-facilitated polymer electrolyte membranes. *Energy & Environmental Science* 13: 297-309.

[3] X. Zhang, Y. Li, X. Liu, J. Zhang, Y. Yin and M. D. Guiver, 2020, A paradigm shift for a new class of proton exchange membranes with ferrocyanide proton-conducting groups providing enhanced oxidative stability. *Journal of Membrane Science* 616: 118536.

[4] X. Liu, Y. Li, M. Li, N. Xie, J. Zhang, Y. Qin, Y. Yin and M. D. Guiver, 2021, Durability enhancement of proton exchange membrane fuel cells by ferrocyanide or ferricyanide additives. *Journal of Membrane Science* 629: 119282.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-404

FLOW CHARACTERISTICS INVESTIGATION OF A NOVEL POWER-AUGMENTED WATER KINETIC TURBINE FOR AFFORDABLE ENERGY CAPTURING FROM RIVER

Chong Wen Tong[1], Kong Keen Kuan[1*], Christopher Clement Rusli[1], Lip Huat Saw[2], Xianbo Xiang[3], Hooi Siang Kang[4]
[1]Centre of Energy Sciences, Department of Mechanical Engineering, Faculty of Engineering, University of Malaya, 50603, Kuala Lumpur
[2]Department of Mechanical and Material Engineering, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, Cheras, Kajang, 43000, Malaysia
[3]School of Naval Architecture and Ocean Engineering, Huazhong University of Science and Technology, Wuhan 430074, China
[4]Marine Technology Centre, School of Mechanical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, Malaysia
chong_wentong@um.edu.my, *keenkuan88@um.edu.my, ruslifamily5@gmail.com, sawlh@utar.edu.my, xbxiang@hust.edu.cn, kanghs@utm.my

ABSTRACT
River and stream are being considered as a viable source for renewable energy. Many studies are carried out to harness the maximum power from the rivers. However, one inherent issue that affects the kinetic turbine for optimum application is the low current speed, particularly in small-scale applications. The kinetic turbine system generates electricity by harnessing kinetic energy of flowing water in a river or a stream with low elevation. One innovative idea that could boost the water current speed is to use a power-augmented water kinetic turbine, which based upon Bernoulli's principle. The power-augmentation-guide-vane (PAGV) is a device that employs duct or funnels fitted around the kinetic turbine. The device creates a Venturi effect that speeds up the water current, and at the same time, improving the kinetic turbine efficiency by redirecting the water flow before it hits the blades. Since the output power of the turbine increases proportionally to the cube of the current velocity; hence, an increase in the current velocity will cause a significant rise in the total power captured. Furthermore, past studies on the hydrodynamic and flow characteristics of diffuser or guide vane around the kinetic turbine have revealed promising results. Yet, the effect of flow characteristics and flow direction on a power-augmented kinetic turbine are still not presented. Therefore, this project aims to investigate the relationships between duct geometry, current velocity, current direction and flow characteristics to attain optimal flow acceleration, flow angle and power efficiency of the power-augmented kinetic turbine. The project involves the design of different configuration of PAGV models, followed by the fabrication of scaled-down models, and lastly the water tunnel testing. The current velocity, flow characteristics of water passing through the turbine and the corresponding kinetic turbine power efficiency are measured. The computational fluid dynamics (CFD) simulation results will be correlated and validated with the actual water tunnel testing results for PAGV performance evaluation and further design improvement. This investigation would benefit the development and implementation of micro-hydropower technology, especially for the communities living in rural areas with rivers that have no access to the power grid, providing them with the much-needed electricity. This project has the potential as an economic booster and has wide societal impact by developing affordable modern clean energy systems in rural areas, in conjunction with promoting energy production through renewable means.

Keywords: Renewable energy, kinetic turbine, computational fluid dynamics (CFD), hydrofoil blade, river.

ACKNOWLEDGEMENT
The authors would like to thank University of Malaya for the research grants allocated under Interdisciplinary Research Programme Grant (IIRG011B-2019).

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-407

EXHAUST EMISSION EFFECTS OF DIESEL-ETHANOL FUEL BLEND IN COMPRESSION IGNITION ENGINE

Mersin Hürpekli *, Automotive Engineering, Kocaeli University, mhurpekli@gmail.com
Mustafa Vargün, Automotive Engineering, Kocaeli University, mustafavargun@gmail.com
Ahmet Necati Özsezen, Automotive Engineering, Kocaeli University, nozsezen@kocaeli.edu.tr

ABSTRACT

Investigation of exhaust emission of ethanol-diesel fuel blends has been carried out with a single cylinder diesel engine that has 1.12L cylinder volume, by real-time monitoring in-cylinder combustion pressure and exhaust emission measurement. In this study, pure petroleum-based diesel fuel was used as reference fuel and total injected fuel at base condition was kept constant through whole experimentation with ethanol-diesel fuel blends that prepared with different ratio. The injection of fuel completed at once, and combustion was observed during the study. The tests were conducted with 4 different fuel blend (E0, E5, E10 and E15) at 50% load with varying engine speeds between 1000 and 1600 rpm with 200 rpm increments. Increasing ethanol content decreased the CO and soot emissions.

Keywords: Compression ignition engine, ethanol-diesel blend, combustion, start of injection timing, burn duration, emission

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-410

FUZYY INFERENCE SYSTEM-BASED TEMPERATURE COOLANT SYSTEMS CONTROL OF SHIPS

Ezgi DEMİR(1), Batuhan ATASOY(2), M. Ziya SÖĞÜT(3)

(1)Pîrî Reis University, Department of Management Information Systems
(2)Pîrî Reis University, Department of Mechanical Engineering
(3)Pîrî Reis University, Department of Marine Engineering

edemir@pirireis.edu.tr, batasoy@pirireis.edu.tr, mzsogut@pirireis.edu.tr

ABSTRACT

Water coolant systems, being widely used in internal combustion engines, are preferred for the engines of high power because of the capability to transport high amount of heat. With this high amount of power requirements, coolant systems of ships are also based on water cooling. In ships, where the coolant element is seawater, it enables the engine coolant water and engine oil, respectively. However, this coolant systems are mostly controlled by on-off control systems or traditional PID control systems, in which it requires mostly constant set values.

In this study, a novel autonomous control method has been developed to provide the energy efficiency of the coolant systems of the ships. By means of machine learning and fuzzy logic methods, outlet temperatures of oil and engine coolant water are modeled in membership functions, and then the pump speeds are controlled by Mamdani-based fuzzy inference systems in relation with these temperatures and pump speeds. With the help of these algorithms, satisfactory results in energy efficiency have been obtained, and the studies are currently continuing.

This study has been fully-funded by Piri Reis University Support Program of Scientific Research Projects.

Keywords: Energy efficiency, Internal combustion engines, Ship coolant systems, Fuzzy inference systems, Temperature control.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-413

AIRCRAFT FUEL EFFICIENCY IN AIRLINE OPERATIONS

Ilkay Orhan
Eskisehir Technical University, Faculty of Aeronautics and Astronautics, Eskisehir, Turkey
iorhan@eskisehir.edu.tr

ABSTRACT

The fuel efficiency in flight operations brings together economic and ecological benefits to airlines. According to the IATA data of 2020, fuel costs constitute 16.4% of operating costs, and it is estimated that airlines spend 78 billion dollars in total. In the aviation industry, where competition is changing very dynamically, meagre cost savings can become significant annually for airlines. Airlines can provide significant advantages with planning that can be made to consume the amount of fuel at an optimum rate. However, commercial aviation contributes between 2% to 3% of total global CO_2 emissions. Airlines undertaking responsibility for solving global climate change have set targets to reduce CO_2 emissions from air transportation. Accordingly, it is aimed to reduce aviation-originated CO_2 emissions by 50% in 2050 compared to 2005. Optimal fuel consumption can be classified under topics such as aircraft technology and design, airline operations, socioeconomic and policy measures, and alternative fuel. Within this study's scope, it aims to create an awareness for airline operators and authorities, and operational practices and savings that can be achieved are evaluated in detail during the departure of an airplane from an airport and its arrival at another airport.

Keywords: Fuel efficiency, Airline operation, Aircraft emission, Sustainability

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-416

GEOTHERMAL PLANT COMBINED WITH ABSORPTION AND RANKINE CYCLES FOR TRIGENERATION

Ali M. M. I. Qureshy[1], Ibrahim Dincer

Clean Energy Research Laboratory, Faculty of Engineering and Applied Science, Ontario Tech University,
2000 Simcoe Street North, Oshawa, Ontario L1G 0C5, Canada.
[1]Corresponding Author: ali.ismael@ontariotechu.ca & ali.ismael@ontariotechu.net

ABSTRACT

A comprehensive thermodynamic analysis based on energy and exergy is conducted for a combined geothermal energy system using the Engineering Equation Solver for hot water, cooling, and clean electricity production. The parametric studies results indicate that the maximum useful output power of the turbine that could be obtained was 5991 kW occurred at the highest heat rates of the heat exchangers 1 and 2 were 78736 kW and 72769 kW, respectively, at a geothermal injection temperature of 460 K. Moreover, the highest heat cooling rate of the evaporator was 4397 kW which happened at the inlet mass flowrate to pump 1 of 30 kg/s. The highest energy and exergy coefficient of performance occurred at inlet temperature to pump 1 of 30 ^{o}C are 0.584 and 0.287, respectively. Furthermore, the maximum energetic and exergetic coefficient of performance values that can be achieved at -5 ^{o}C of the outlet temperature of the evaporator was found to be 0.58 and 0.231, respectively.

Keywords: Geothermal Plant, Rankine Cycle, Power Generation, Absorption refrigeration cycle, Energy, Exergy.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-419

MODELLING OF SESSILE WATER DROPLET FREEZING PROCESS ON THE HORIZONTAL COLD PLATE SURFACE

LU Menglong[a], SONG Mengjie[b,a,*], PANG Xiaoling[c], ZHANG Long [b], DANG Chaobin [d]
[(a)] Sustainable Buildings Research Centre (SBRC), University of Wollongong, NSW, 2522, Australia (hitlml89757@163.com)
[(b)] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China (yilizl@126.com, mengjie.song@bit.edu.cn)
[(c)] Department of Emergency, Fourth Affiliated Hospital of China Medical University, Shenyang, 110032, China (xlpang@cmu.edu.cn)
[(d)] Department of Human and Engineered Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Chiba 277-8563, Japan (dangcb@k.u-tokyo.ac.jp)

ABSTRACT
The solidification of water droplet is common in many engineering fields, including aerospace, power production, food cold storage, air-conditioning and refrigeration, etc. Droplet solidification is the beginning of frosting or icing. Therefore, for better predicting and controlling a frosting-defrosting or icing-deicing cycle, the studies on the droplet freezing process of water droplets on the cold substrate are significantly necessary. Although many experiments were performed as well as many models were developed, there are still a big gap to fully understand the solidification process. In this study, considering the supercooling effect on the physical properties, and the effects of gravity and volume expansion on the droplet shape, a theoretical model is developed to numerically investigate the freezing behaviors of water droplets. Based on the collected data from different reported researches, this model is validated on both the hydrophilic and hydrophobic surfaces with different cold plate temperature. The influences of the water droplet dimension, and the temperature and wettability of the cold plate on the droplet freezing process are discussed. Results of this study are helpful for better understanding the droplet freezing mechanism, and the structure design as well as material optimization of anti-icing or de-icing surfaces.

Keywords: droplet freezing, modeling study, gravity effect, supercooling effect, volume expansion.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-422

DESIGN TO COMPENSATE THE END LOSS EFFECT OF FIXED LINEAR-FOCUS FRESNEL LENS SOLAR SYSTEM

WANG Hai [a,b], SONG Mengjie [a,c]*, LI Haoteng [d], XIAO Jiayu [d], HUANG Jin [d]

a Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China
b Department of Mechanics Engineering, School of Mechanics and Automotive Engineering, Zhaoqing University, Zhaoqing, 526061 China
c School of Environment & Architecture, University of Shanghai for Science & Technology, No. 516, Jungong Road, Shanghai, 200093, China * (mengjie.song@bit.edu.cn)
d Department of Energy Engineering, School of Materials and Energy, Guangdong University of Technology, Guangzhou 510006, China

ABSTRACT

End loss accounts for a large part of optical loss in single axis solar concentrators. To reduce end loss, fixed linear-focus Fresnel lens solar system (FLFS) is proposed and two newly designed rail is added. The focal line movement of the Fresnel lens is investigated using optical software Tracepro®. The results show that when the incident angle is equal to sun declination angle δ the focal line of the Fresnel lens moves both horizontally and vertically. The upward movement cannot be ignored which maximum has reached 98.7 mm when the focal length is 650 mm. The frame of straight slip rails and curved slip rails is determined base on the results. Comparison of polar-axis tracking system with straight slip rails, curved slip rails and without any slip is carried out. The results show that the end loss effect is effectively reduced and the average annual relative optical efficiency of system adding straight slip rails and system adding curved slip rails have increased by 9.4% and 14.1% respectively.

Keywords: Solar concentrator, Linear Fresnel lens, Slip adjustment, Fixed linear-focus, Optical efficiency.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-425

A MODELLING STUDY OF SOLID-LIQUID HEAT TRANSFER AREA AND DISTANCE OF SESSILE DROPLETS ON THE HORIZONTAL PLATE SURFACE

DANG Qun[(a)], SONG Mengjie[(a,b,*)], PANG Xiaoling[(c)], LEI Shangwen[(a)], ZHANG Long[(a)]
[(a)] Department of Energy and Power Engineering, School of Mechanical Engineering, Beijing Institute of Technology, Beijing, 100081, China (3220200459@bit.edu.cn, 3120200258@bit.edu.cn, yilizl@126.com)
[(b)] School of Environment & Architecture, University of Shanghai for Science & Technology, No. 516, Jungong Road, Shanghai, 200093, China (mengjie.song@bit.edu.cn)
[(c)] Department of Emergency, Fourth Affiliated Hospital of China Medical University, Shenyang, 110032, China (xlpang@cmu.edu.cn)

ABSTRACT
To understand the effect of liquid physical properties on droplet profile, a theoretical model was developed in this study, based on the Young-Laplace equation with gravity effect specially considered. After the model was experimentally validated by comparing the geometric shape of water droplets, it was further used for predicting droplet shapes of other materials, and thus analyze the influences of temperature and surface wettability. Results show that those materials at gas status at normal pressure and temperature are more sensitive than those at liquid status. Meanwhile, the variation of droplet profile is similar with increasing same contact angle for different materials. Results of this study are meaningful for predicting the evaporation and solidification process of droplets on horizontal surface by controlling their initial profiles.

Keywords: Sessile droplet, Modeling study, Gravity effect, Droplet profile, Different materials.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-428

ANALYSIS ON THE DYNAMIC VARIATION OF FROST THICKNESS AND ITS INFLUENCING FACTORS IN THE EARLY FROSTING STAGE

LEI Shangwen[(a)], SONG Mengjie[(a,b,*)], DANG Qun[(a)], DANG Chaobin[(c)]
[(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)
[(b)] School of Environment & Architecture, University of Shanghai for Science & Technology, No. 516, Jungong Road, Shanghai, 200093, China (mengjie.song@bit.edu.cn)
[(c)] Department of Human and Engineered Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Chiba 277-8563, Japan (dangcb@k.u-tokyo.ac.jp)

ABSTRACT
To accurately control the frosting process, analyzing the influence of different factors on frosting is meaningful and challengeable, especially in the early frosting stage. According to the sensitivity analysis, influence of different surface wettability and environmental factors on the growth of frost layer are quantitatively analyzed. Based on the experimental data on cold plate surface under forced convection conditions, new models with emphasis on the initial conditions of frosting are developed. Results show that supersaturation degree, supercooling degree and cold plate temperature are the key factors on the growth of frost layer, but their specific influence varies in the early frosting stage. Compared with previous models, the whole frosting process and early stage could be predicted at a higher accuracy with the new models developed. Contributions of this study are expected to predict the growth of frost layer in the early frosting stage and provide a reference for the optimal defrosting control of air source heat pumps.

Keywords: Early frosting stage, Forced convection, Surface wettability and environmental factors, Sensitivity analysis, Model optimization

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-431

EXPERIMENTAL VISUALIZATION OF TWO-PHASE FLOW INSIDE A REAL-SIZE PISTON OF A CROSSHEAD-TYPE MARINE ENGINE

B. Liang[a], P.J. Ming[b,*], G.P. Yu[b]
[a] *College of Power and Energy Engineering, Harbin Engineering University, Harbin 150001, China*
[b] *Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University, Zhuhai 519082, China*

E-mail address: mingpj@mail.sysu.edu.cn (P.J. Ming)

ABSTRACT

The cooling cavities method is one of the most effective cooling solutions to improve the piston cooling ability for diesel engines. Most of the experimental studies were focused on the simplified model, few were based on the actual complex piston cooling cavities. To give a better insight into the flow mechanism inside the actual cavities, a flow visualization test rig was built based on a real-size piston model with a stroke of 1550mm and a cylinder diameter of 350mm. The model replicates the piston and its cooling cavities of a typical low-speed two-stroke crosshead marine engine MAN B&W 6S35ME. The test rig ensures that the coolant supply mode, the coolant flow path and the kinematic curve of the piston head are consistent with the real machine. The piston model is an exact replica of the original scale made of PC material. A high-speed camera was used to capture the transient flow patterns of the two-phase flow as the coolant is mixed with air inside the cooling cavities during the reciprocating motion of the whole stroke. which provided more accurate boundary conditions for the numerical simulations. Analysis of the piston's oscillatory cooling method is beneficial to optimizing the thermal management of engines in the future.

Keywords: Original scale piston, Cooling cavities, Visualization.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-434

AIRCRAFT BATTERIES FOR HYBRID ELECTRIC PROPULSION CERTIFICATION AND RELATED ISSUES

Melih Yildiz[*,1], Elif Koruyucu[2]

[1]: Girne University, Faculty of Aviation and Space Sciences, Girne, TRNC
[2]: Eskisehir Technical University, Porsuk Vocational School, Eskişehir, Turkey
melih.yildiz@kyrenia.edu.tr, elifkoruyucu@eskisehir.edu.tr

ABSTRACT
As aviation is one of the main actors in atmospheric emissions, there are numerous efforts in order to reduce emissions. The use of electric motors instead of internal combustion engines reduces noise emissions. There are problems with regard to the application of the electric propulsion system to aircraft, both from a technological point of view and from the public acceptance of this system. Some of these problems are the weight of the battery and the battery energy-power densities, the increasing number of components, reliability and most specifically certification issues.
Hybrid-electric propulsion system design is an optimization problem, which presents a more complex problem compared to current knowledge of conventional aircraft design. With this technology, a new dimension in form of multiple energy management is introduced to the field of aircraft design, bringing the battery and power electronic system technologies along. These technologies are also new to the aviation industry both by means of design and operation. In the literature, the propulsion and battery analysis are generally isolated, depending on the assumption of using a battery as a constant electrical power supply. This enables the design approach to be simplified, but detailed requirements of the battery system is left undefined.This research is intended to lay down the specific issues regarding the battery systems, their differences from the literature and specifications and its possible certification process.

Keywords: Propulsion battery, battery certification, hybrid electric propulsion, energy storage.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-437

AN INTEGRATED SYSTEM BASED ON AMMONIA ALKALINE FUEL CELL WITH HEAT RECOVERY

Khaled H.M. Al-Hamed and Ibrahim Dincer
Clean Energy Research Laboratory, Faculty of Engineering and Applied Science, University of Ontario Institute of Technology, 2000 Simcoe Street North, Oshawa, Ontario, L1H 7K4, Canada
Authors' e-mails: khaled.alhamed@ontariotechu.net, Ibrahim.Dincer@uoit.ca

ABSTRACT
This work presents an integrated system that produces multiple outputs which are electricity, space heating, and freshwater using an ammonia molten alkaline fuel cell and two Rankine cycles for additional power generation using waste heat recovery. The ammonia molten alkaline fuel cell heat losses are then recovered by an organic Rankine cycle to produce more electricity and increase the overall performance of the integrated system. This system is modeled using energy and exergy analyses to evaluate the thermodynamic overall performance and perform a parametric study to observe its behavior under varying operating settings. The results of the modeling show that the overall energy and exergy efficiencies of the integrated system can reach values of 0.497 and 0.505, respectively. The overall energy efficiency is higher than a standalone ammonia alkaline fuel cell by almost 14 percentage points. This integration proves that using waste heat recovery for an alkaline fuel cell can enhance the overall efficiencies of the system.

Keywords: Ammonia, integrated system, energy, exergy, efficiency, fuel cell.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-440

Rithu Muthalathu* and XiaoYu Wu
University of Waterloo
200 University Ave W, Waterloo
rmuthala@uwaterloo.ca, xiaoyu.wu@uwaterloo.ca

TECHNO-ECONOMIC ANALYSIS OF PLASMA CATALYSIS POWER TO AMMONIA (PCP2A) PROCESS

Abstract Category: Renewable and clean energy

Keywords: Ammonia, Green Energy, Plasma Reactor

ABSTRACT

Annually over 200 megatons of ammonia are produced, with most of it being used for agriculture purposes.[1] The Haber-Bosch process is the primary method used to produce ammonia but generates CO_2 as a by-product and requires a large amount of energy to operate. Global ammonia production creates over 451 million tons of CO_2 annually which accounts for approximately 1% of global annual CO_2 emissions.[2] Ammonia is essential for food production, but ammonia production is harmful for the environment which is why green ammonia alternatives must be explored. Plasma-catalytic power to ammonia (PCP2A) synthesis has the potential to produce large amounts of ammonia globally while being environmentally friendly and operating under conditions much closer to the standard temperature and pressure (STP). However, the economic feasibility of the PCP2A system needs to be evaluated. A model to represent the system was built, consisting of a water electrolysis system to produce hydrogen, an air separation unit to generate nitrogen and a plasma catalysis reactor for ammonia synthesis. The model parameters studied were ammonia output, single pass conversion, desired N_2/H_2 feed ratio, and system efficiency. By performing a techno-economic analysis on the PCP2A system, we identified that the low rate of ammonia conversion and high cost of water electrolysis leads to high levelized cost of ammonia for PCP2A. Therefore, improvements on the catalysts for ammonia production and water electrolysis technologies are required to make PCP2A technology economically viable.

1. Hideaki Kobayashi; Akihiro Hayakawa; K.D. Kunkuma A. Somarathne; Ekenechukwu C. Okafor; Science and technology of ammonia combustion. *Proceedings of the Combustion Institute* **2019**, *37*, 109-133, 10.1016/j.proci.2018.09.029.
2. L. K. Boerner, “Industrial ammonia production emits more CO2 than any other chemical-making reaction. Chemists want to change that,” Chemical & Engineering News, vol. 97, no. 24, Jun. 2019, https://cen.acs.org/environment/green-chemistry/Industrial-ammonia-production-emits-CO2/97/i24

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-443

SURFACE WETTABILITY TUNING ON POLYMER-GRAPHITE COMPOSITE MATERIALS FOR PEMFC APPLICATION

Guanlei Zhao[1], Ruikun Geng[2], Fulin Zhang[3, 4, 5], Liangfei Xu[1*], Zunyan Hu[1], Jianqiu Li[1*], Jianguo He[4, 5, 6], Lei Liu[2], Guisheng Zou[2], Ouyang Minggao[1]

1. State Key Laboratory of Automotive Safety and Energy, School of Vehicle and Mobility, Tsinghua University, Beijing, China.
2. Department of Mechanical Engineering, Tsinghua University, Beijing, China.
3. School of Mechanical Engineering, Xiangtan University, Xiangtan 411105, China
4. Aerospace Information Research Institute, Chinese Academy of Sciences, Beijing 100094, China
5. Key Laboratory of Computational Optical Imaging Technology, Chinese Academy of Sciences, Beijing 100094, China
6. University of Chinese Academy of Sciences, Beijing 100049, China

CORRESPONDING AUTHORS

Dr. Liangfei Xu: xuliangfei@tsinghua.edu.cn

Dr. Jianqiu Li: lijianqiu@tsinghua.edu.cn

ABSTRACT

Liquid water should be effectively removed from gas flow channels of a proton exchange membrane fuel cell (PEMFC) to avoid possible blockage of channels and porous layers, which could lead to flooding and deterioration of fuel cell performance. The surface wettability of the flow channel plays an important role in water management of PEMFCs. However, the precise tuning of channel wettability is often difficult to achieve. As a result, the exact influence of channel surface wettability on fuel cell performance is still under heavy debate. In this study, we utilize ultrafast laser to prepare micro-nanostructured surfaces on polymer-graphite composite materials, which is used for the manufacturing of bipolar plates. Through carefully controlling the laser processing parameters, along with the application of hydrophobic coating, wettabilities of the surfaces can be tuned from superhydrophilic to superhydrophobic, and the corresponding mechanism is briefly described. This study paves way for investigating the effects of channel surface wettability on the performance of PEMFCs.

Keywords: Surface wettability, ultrafast laser, surface micro-nanostructuring, gas flow channel, PEMFC

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-446

LASER PERFORATED CATHODE GAS DIFFUSION LAYERS FOR DIRECT METHANOL FUEL CELLS

Abdullah Alrashidi, Hongtan Liu
Mechanical and Aerospace Engineering Department, University of Miami, Miami, United States
a.alrashidi1@miami.edu , hliu@miami.edu

ABSTRACT

Novel cathode gas diffusion layers (CGDLs) with perforation pathways are created by laser to enhance both water and oxygen transports. Such CGDLs are created by perforating PTFE treated CGDLs with laser, so that the original pores/pathways in the CGDL are hydrophobic and the laser perforation are hydrophilic, thus providing easy transport for both liquid water and oxygen gas through the CGDL to and from the catalyst layer. The overall performances of fuel cells with some of the novel CGDLs are significantly higher compared to the unperforated CGDLs. The CGDL with 100 um diameter perforations and high perforation density has shown the best performance with maximum peak power density of 88 mW cm^{-2}, an increase of about 16% compared to the non-perforated CGDL. Results of polarization curves and electrochemical impedance spectroscopy (EIS) show that the main reasons of the performance enhancement are due to the enhanced kinetics and mass transport at the cathode catalyst layer.

Keywords: Direct Methanol Fuel Cells (DMFCs), Water management, Perforation, Cathode, Gas diffusion layers.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-449

EFFECT OF LEADING-EDGE DIMPLE ON THE PRE-STALL AERODYNAMIC PERFORMANCE OF A WIND TURBINE AIRFOIL

Sujit Roy[1], Agnimitra Biswas[1], Biplab Das[1*], Bale V Reddy[2]
[1]Department of Mechanical Engineering, NIT Silchar, Assam, India – 788010
[2]Department of Mechanical and Manufacturing Engineering, Ontario Tech University, Canada
Email: sujitme12@gmail.com (S. Roy), agnibis@yahoo.co.in (A. Biswas), *biplab.2kmech@gmail.com (B. Das), bale.reddy@ontariotechu.ca (BV Reddy)

ABSTRACT
The present study incorporated a dimple in the leading edge of the NACA 4415 airfoil and compared the aerodynamic performances with the plain airfoil. ANSYS Fluent 14.0 was used to carry out the present computational analysis. A spherical dimple of diameter 2% of the chord length was considered to modify the airfoil leading edge. A chord-based Reynolds number of 2×10^5 was chosen for the pre-stall region ($\alpha \leq 12°$) study. The modified airfoil produced a 7.8% lower lift than the plain airfoil at $\alpha = 12°$. The drag coefficient was increased by 48.3% in modified airfoil at $\alpha = 12°$. The maximum lift to drag ratio in plain airfoil was 37.9 at $\alpha = 8°$, whereas, modified airfoil showed 39.8% less lift to drag ratio at the same angle of attack. The modified airfoil experienced initial separation at dimple edge due to the generation of stagnation point. A secondary circulation zone was also observed near the dimple edge. The modified airfoil helped the flow to remain attached for a 40.4 % longer chord length than the plain airfoil. The modified airfoil experienced a 53% reduction in maximum pressure coefficient compared to plain airfoil at $\alpha = 12°$.

Keywords: Airfoil, leading-edge, dimple, lift coefficient, flow separation

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-452

CONVOLUTIONAL NEURAL NETWORK (CNN) OF NEUTRON RADIOGRAPHY IMAGES FOR LIQUID WATER QUANTIFICATION IN PROTON EXCHANGE MEMBRANE FUEL CELLS

Yiheng Pang, Yun Wang*
Mechanical and Aerospace Engineering, University of California, Irvine, CA, 92697-3975
yihengp@uci.edu; *yunw@uci.edu

ABSTRACT
Water is a byproduct of proton exchange membrane fuel cells (PEMFCs) operation, which causes electrode flooding if not properly managed. It is important to know the level of liquid water during fuel cell operation. Both neutron radiography and X-ray radiography have been proposed to detect the in-situ water contents in operating PEMFCs. The obtained pictures need to be post-processed by image processing to obtain water contents. Of the many deep neural network models, convolutional neural network (CNN) is commonly applied to analyze visual imagery and has achieved much success in image classification. This work presents a study on liquid water quantification by using CNN to analyze the real-time neutron radiography images obtained from PEMFC operation. In the CNN processing, each of the neutron radiography images of PEMFC was divided into 36 pieces as the input. The output of the network is the water areal mass density at a given relative humidity and current density. Compared with other image processing methods reported in the literature, the CNN method shows similar results with an accuracy of 95.1% in the test data. The study is important for machine learning applications in fuel cell research and development. In the future, the CNN will be applied to identify severe water flooding in local and the water morphology in PEMFCs.

Keywords: PEM, Machine learning, CNN, Neutron Radiography, Water management

REFERENCES
Y Pang and Y Wang, “Convolutional neural network (CNN) of neutron radiography images for liquid water quantification in polymer electrolyte membrane fuel cells”, Applied Energy, in preparation.

Mishler, Jeffrey. “Probing the Water Content in Polymer Electrolyte Fuel Cells Using Neutron Radiography.” Electrochimica acta 75.C (2012): 1–10. Web.

Wang, Yun. “A Review of Polymer Electrolyte Membrane Fuel Cells: Technology, Applications, and Needs on Fundamental Research.” Applied energy 88.4 (2011): 981–1007. Web.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-467

Intercalation Conversion Cathode Based on Mo_6S_8 for Lithium-Sulfur Batteries

Jili Xu[1],Jiayifan Liu[1], Kangfei Liu[1], Hongbin Zhao[1,*]
[1] Department of Chemistry, College of Sciences, Shanghai University
[1]99 Shangda Road, Shanghai 200444, PR China
xjl99@shu.edu.cn; hongbinzhao@shu.edu.cn

ABSTRACT
Lithium-sulfur (Li-S) batteries have been a research hotspot of energy storage system due to its high theoretical specific capacity, high theoretical energy density and low cost. Mo_6S_8 material has a faster lithium ion insertion kinetics than sulfur, and $Li_xMo_6S_8$ after lithium has a strong adsorption capacity for lithium polysulfide (LiPSs). These advantages make Mo_6S_8 material used in Li-S batteries. In this paper, we describe a kind of sulfur cathode material based on Mo_6S_8. By studying the charge discharge behavior of Mo_6S_8 in Li-S batteries and the charge discharge behavior of Mo_6S_8/carbon composite sulfur cathode material, we explore a real oxidation reduction catalytic sulfur conversion mechanism provided by Mo_6S_8, which eliminates the dissolution of LiPSs, The cycle stability of Li-S batteries is greatly improved. In addition, based on the current requirements for high bulk density Li-S batteries, we also explored the effect of low proportion of electrolyte/sulfur positive active material (E/S) on the cycle stability of the Li-S batteries. The research shows that Mo_6S_8 based materials bring excellent performance to the low E/S ratio batteries.

Keywords: Li-S batteries, Mo_6S_8, Cathode materials, Redox catalysis, E/S ratio.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-473

REASONABLE STRUCTURE DESIGN OF ZIF-DERIVED ORR CATALYST WITH DUAL-METAL ACTIVE SITE FOR FUEL CELL

Weikang Zhu, Haotian Liu, Yabiao Pei, Junfeng Zhang*, Haoyang Zhao, Yan Yin*, and Michael D. Guiver

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

To reduce Pt consumption and fabrication costs of fuel cells, numerous non-precious group metal (non-PGM) catalysts have been developed. The kinetic activity of non-PGM catalyst for the oxidation reduction reaction (ORR) has been recently improved significantly, especially for Co or Fe-based single atom catalysts. [1] However, the relatively low metal content of single atom catalyst limits its application in the fuel cell catalyst layer. In this work, multi-metal elements were introduced into a zeolitic imidazolate framework (ZIF) precursor to obtain non-PGM catalyst with high active site density. The obtained catalysts were investigated by rotating disk electrode (RDE) and systematic physical-chemical analysis to identify the active site type and microstructure. Firstly, the role of Zn element was investigated by adjusting the ratio of Zn and Co elements. As a sacrificial template, Zn element vaporizes during the pyrolysis process, thus forming abundant micropores, which enlarge the specific surface area of catalyst. By careful adjustment of the pore size distribution of ZIF-derived catalyst, the mass-transfer resistance and charge-transfer resistance can be further optimized to obtain better ORR performance. [2] Based on the porous structure investigation, CoFe nanoalloy particles were formed by introducing Co and Fe elements into the Zn-based ZIF precursor. Density functional theory (DFT) was also employed to investigate the performance of different active sites. Our theoretical and experimental research indicates that the synergistic effect of CoFe alloy particles and $M–N_4$ (M = Co or Fe) can significantly improve the performance for ORR in both acid and alkaline environments.

Keywords: CoFe alloy; Oxygen reduction reaction; non-PGM; Polymer electrolyte fuel cell

REFERENCES

[1] Zhang, J., Zhu, W., Huang, T., Zheng, C., Pei, Y., Shen, G., Nie, Z., Xiao, D., Yin, Y. and Guiver, M. D., 2021, Recent insights on catalyst layers for anion exchange membrane fuel cells. *Advanced Science* 2100284.
[2] Zhu, W., Pei, Y., Liu, Y., Zhang, J., Qin, Y., Yin, Y. and Guiver, M. D., 2020, Mass Transfer in a Co/N/C catalyst layer for the anion exchange membrane fuel cell. *ACS Applied Materials & Interfaces* 12:32842.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-482

INFLUENCE OF DISPERSION SOLVENT ON THE ANODE PERFORMANCE FOR ANION EXCHANGE MEMBRANE FUEL CELL

Di Xiao, Haoyang Zhao, Shuoyao Yin, Xintian Li, Yabiao Pei, Chenyang Zheng, Junfeng Zhang*, Yan Yin*, Michael D. Guiver
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
Water management in the anode is of importance to the performance of anion exchange membrane fuel cells (AEMFC).[1, 2] Until now, controlling external conditions and adjusting other components like the gas diffusion layer (GDL) have been proved to have a significant effect for optimizing water behavior of the anode catalyst layer (ACL).[3, 4] However, few methods are reported for directly regulating water content within the ACL. This study investigates the influence of dispersed solvent on the microstructure of the ACL and the performance of the anode. It is observed that the hydrodynamic diameter of aggregates in the dispersion state is similar to the agglomeration tendency of aggregates in the consolidated ACL. A catalyst ink prepared by using tetrahydrofuran solvent having the smallest dielectric constant,[5] resulted in an ACL with a small hydrodynamic diameter and a uniform, dense microstructural texture. It exhibits promising drainage capacity shown by dynamic water vapor sorption, and good electrochemical properties for hydrogen oxidation. The research results provide an insight into the preparation of high-performance ACLs.

Keywords: Dispersion solvent; AEMFC; Anode catalyst layer; Water Mangement

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-485

CROSSLINKED QUATERNARY AMMONIUM POLY(N-METHYL-PIPERIDINE-CO-P-TERPHENYL) FOR ANION EXCHANGE MEMBRANES

Zixi Nie, Chenyang Zheng, Tong Huang, Jiandang Xue, Junfeng Zhang, Yan Yin*, Michael D. Guiver*
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); guiver@tju.edu.cn (M. D. Guiver);

ABSTRACT
The performance of anion exchange membranes (AEMs) determines the efficiency and lifetime of anion exchange membrane fuel cells (AEMFCs). Crosslinking is an effective approach to optimize the AEM performance. Herein, a series of crosslinked quaternary ammonium poly(N-methyl-piperidine-co-*p*-terphenyl) (QAPPT) membranes were designed to study the influence of crosslinking. A long flexible crosslinker, a long rigid crosslinker (with the same length as the long flexible crosslinker) and a short rigid crosslinker were compared to crosslink QAPPT. For each type, the ion mobility and conductivity were calculated and analyzed through molecular dynamics (MD) simulation. The results indicate that the conductivity of polymer membrane crosslinked by long flexible crosslinker has the best performance. This study provides technical guidance and research ideas for the development of high-performance electrolyte membranes.

Keywords: Anion exchange membranes; Crosslinking; Molecular dynamics simulation

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-488

S-Doped Fe/N/C with Hierarchical Porosity for Efficient Oxygen Reduction Reaction

Muhammad Arif Khan[a,b], Rida Javed[a,b], Yanmei Gong[a], Cai Jian[a], Daixen Ye[a], Hongbin Zhao[a*]
a School of Material Science and Engineering, Shanghai University, Shanghai 200444, P. R. China
b College of Sciences & Institute for Sustainable Energy, Shanghai University, Shanghai 200444, P. R. China
(Email: hongbinzhao@shu.edu.cn)

Abstract
The replacement of Precious metal catalysts for ORR with non-precious metal catalysts is a hot topic. Reasonable design and synthesis of Fe/N/C based catalysts is one of the most promising way for developing precious metal-free oxygen reduction reaction (ORR) catalysts. Here, nitrogen and sulfur doped catalyst were synthesized (Fe-N-C-S) using ferric chloride hexahydrate ($FeCl_3.6H_2O$) as Fe source, Potassium thiocynate (KSCN) as Sulfur (S) source and Polyvinylpyrrolidone (PVP) as Carbon and nitrogen source. The obtained catalyst shows three dimensional macroporous structure. SEM images revealed graphene like structure for the obtained catalyst, while the formation of isolated single atomic sites are conformed through HAADF-STEM analysis. The enhancement in the ORR activity is attributed to the 3D graphene like structure and to the presence of isolated single atomic sites. This method has the advantage of using Potassium thiocynate as Sulfur source during the synthesis process, which resulted in high doping of sulfur (about 5.4 %). The optimal catalyst shows high ORR activity with a half wave potential of 0.880 V, vs RHE and limiting current density of 6.5 mA cm^{-2}. The stability of the catalyst was tested through i-t test, retention in the current density after 12 h was 93%. In the acidic medium catalyst shows high ORR activity with a half wave potential of 0.80 V, vs RHE and limiting current density of 5.2 mA cm^{-2}. The synthesized Fe-N-C-S catalyst showed stability in both acidic and basic media.
Keywords: oxygen reduction reaction, three dimensional macroporous structure, zinc-air batteries

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-491

Biomass derived M-N-C/P catalyst use as an active electro catalyst for Zn-air battery

Rida Javed[a]*, Muhammad Arif Khan[a], Yanmei Gonga[b], Cai Jiana[b], Daixin Ye[b] , Hongbing Zhao[b],
a School of Material Science and Engineering, Shanghai University,
b College of Sciences & Institute for Sustainable Energy, Shanghai University, Shanghai 200444, P. R. China
(Email: ridajaved617@yahoo.com)

ABSTRACT
In this work, we design an improved strategy to create an ORR catalyst by using sustainable biomass as a self-source of carbon, iron, nitrogen and phosphorus. This method is proceeded by; chemical activation with KOH, intrinsically doped with nitrogen, iron as well as phosphorus, while extrinsically doped with cobalt in order to get a catalyst with enhanced ORR catalytic performance. The SEM images revealed 3D hierarchically graphitic micro and mesoporous structure with high surface area of about 1571.86 m²/g. The EDX, mapping and XPS confirms the formation of Fe/Co-N-C/P catalyst. The synthesized Fe/Co-N-C/P displays excellent ORR activity with a half wave potential of (0.86 V versus RHE), and limiting current density 5.30 mA cm^{-2} in 0.1 M KOH solution. This work will be surely helpful for the design and synthesis of biomass resource as facile route to change renewable bio mass materials to a valuable electro catalyst for Zn-air batteries.

Keywords: biomass, sweet potato, oxygen reduction reaction and phosphorus.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-494

EX-SITU EXPERIMENTAL STUDY ON EXTRACTION OF DROPLET DYNAMIC PARAMETERS BASED ON DROPLET SHAPE IN PEMFC

Mengjie Li, Yanzhou Qin*, Zhizhao Che
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT
In this paper, an ex-situ visualization experimental system for the proton exchange membrane fuel cell (PEMFC) is used to study the dynamic characteristics of a droplet in a square channel. The extraction of droplet dynamic contact angles based on droplet shape is performed by a home-made image processing method. The best double circle fitting is found by comparing different fitting methods. The accuracy of double circle fitting is improved by the relationship between droplet shape and data analysis. Compared with manual measurement, they have good consistency. The droplet size and removal time as well as the vibration degree before droplet detachment are found to decrease with the increase of gas velocity.

Keywords: visualization, parameter extraction, dynamic characteristics.

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-497

EFFECT OF LIQUID WATER PRESENCE ON GAS DIFFUSION LAYER EFFECTIVE THERMAL CONDUCTIVITY

*Shibo Cao, Yanzhou Qin**
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT
The process of gas diffusion, discharge of reaction product water and heat conduction occurs in the gas diffusion layer(GDL), which has an important impact on the water and thermal management and output performance of the polymer electrolyte membrane fuel cell (PEMFC). The microstructure of GDL is reconstructed, and a two-phase simulation of the water transport process in the GDL is carried out by water injection from the macroscopic cracks on the surface of the microporous layer. The change of water injection pressure affects the liquid water content, and the increase in saturation increases the effective thermal conductivity of the GDL. The presence of liquid water has a more significant effect on the effective thermal conductivity in the through-plane direction.

Keywords: Gas diffusion layer, Permeability, Water transport, Thermal conductivity

Proceedings of the 13th International Green Energy Conference
July 15-18, 2021, Tianjin, China
Paper No.: IGEC2021-500

EFFECTS OF CLAMPING FORCE AND MEMBRANE SWELLING ON STRUCTURAL DEFORMATION AND PERFORMANCE OF PROTON EXCHANGE MEMBRANE FUEL CELL

*Yuwen liu, Yanzhou Qin**
State Key Laboratory of Engines
Tianjin University, Tianjin, 300350, China
*Authors' contact e-mail: qinyanzhou@tju.edu.cn

ABSTRACT
The change of relative humidity (RH) will lead to the expansion and shrinkage of the membrane, resulting in hygrothermal stress, performance degradation and mechanical damage of polymer electrolyte membrane (PEM) fuel cell. In this study, two-dimensional PEM fuel cell deformation model and three-dimensional computational fluid dynamics (CFD) model are coupled to study the performance of fuel cell. Emphasis is placed on the influence of membrane swelling and clamping force on the performance of fuel cell. It was indicated membrane swelling can lead to change in membrane electrode assembly (MEA) structure and increase of stress in the MEA. Moreover, the performance after membrane swelling is slightly lower than that of the undeformed membrane. This study can improve the simulation accuracy of PEM fuel cell.

Keywords: Relative humidity, Clamping force, Deformation, Stress, Performance