ALANYA ALAADDİN KEYKUBAT UNIVERSITY

NATIONAL HYDROGEN ASSOCIATION TURKEY

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International Journal of Hydrogen Energy

IHTEC 2018

3rd International HYDROGEN TECHNOLOGIES Congress

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ABSTRACT BOOK

EDITORS
İbrahim DİNÇER
Adnan MİDİLLİ
Hilmi YURDAKUL
Kadir AYDIN

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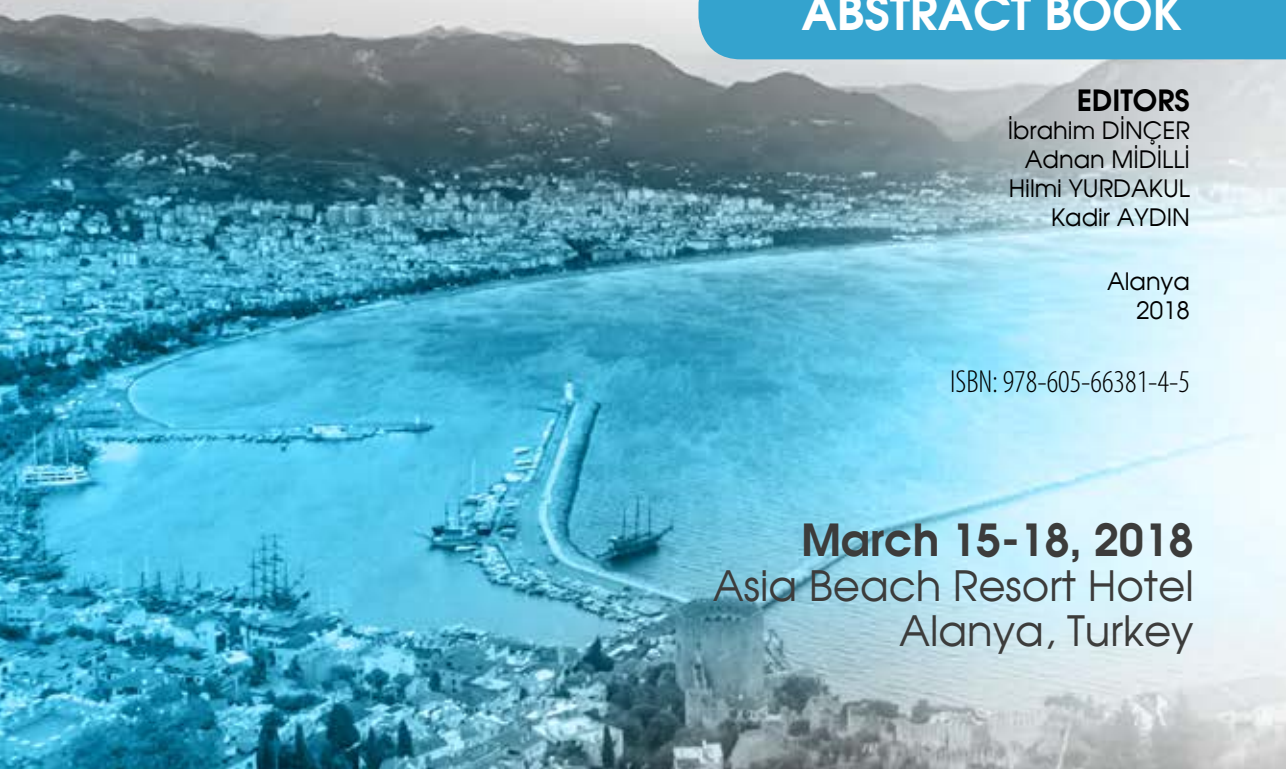

March 15-18, 2018
Asia Beach Resort Hotel
Alanya, Turkey

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FOREWORDS

WELCOMING MESSAGE

to Participants of 3nd International Hydrogen Technologies Congress

15 - 18 March 2018, Alanya, Turkey

Fossil Fuels (coal, petroleum and natural gas) are causing major environmental problems, including air pollution, oxygen depletion, acid rains, oil spills, ozone layer depletion and climate change. As a result, Earths' temperatures are rinsing, storms and hurricanes are becoming stronger, floods and droughts are increasing – all resulting in major environmental and health damages. The permanent solution to all of these problems is the conversion to the Hydrogen Energy System. Since, we have proposed this solution at the Hydrogen Economy Miami Energy Conference in March 1974, major industrial countries of the World, including Japan, South Korea, China, Europe and North America, have started conversion to the hydrogen energy system. At the market, there are hydrogen fueled cars, buses, trucks, forklifts, trams, trains, submarines, boats and drones. Airbus and Boing Companies are working on hydrogen fueled subsonic and supersonic air transports. The preferred fuel of the space programs is hydrogen. Without hydrogen, it would not have been possible to send astronauts to the Moon.

Scientists and Engineers from many countries of the world will gather at the IHTEC2018 Conference to present their papers covering the recent advances in hydrogen energy and in hydrogen technologies. All these will no doubt speed up the conversion to hydrogen economy, eliminate global environmental problems, and provide the humankind with higher living standards. I congratulate the organizers of this Congress and wish all the participants a very fruitful meeting and pleasant days in beautiful Alanya, Turkey.

T. Nejat Veziroğlu

Honorary Chair, IHTEC2018

President, International Association for Hydrogen Energy

MESSAGE FROM THE PRESIDENT

Organizing the Third International Hydrogen Technologies Congress (initially started as the National Hydrogen Technologies Congress) is another milestone in Turkey's hydrogen energy activities under the shelter of the National Hydrogen Energy Association. Due to the increasing interest in implementing carbon free economy, hydrogen energy technologies appear to become the central point to formulate the energy solutions for all sectors, ranging from industrial to transportation. During the past a few years, the climate change conferences in various parts of the World it has been made clear that the renewable energy based and carbon-free solutions will be critical in addressing both local and global environmental issues and provide clean and sustainable options for implementation. Coupling hydrogen technologies with renewable energy systems will solve many issues ranging from intermittency to storage and distribution.

It is also important to note that the National Hydrogen Energy Association was able to secure one of the next organizations of the 24th World Hydrogen Energy Congress first time to organize in 2022, in Istanbul, Turkey. This is recognized as a true achievement of the Association and the efforts of its Board. The Association is now getting ready to be one of the world's most successful societies in the area of hydrogen technologies. This is of course not easy and requires great efforts from various parties of academia, industry and government agencies, as well as individually from every one of us working in the area of hydrogen and related technologies. It is also equally important for us to primarily focus on coupling renewables and hydrogen energy technologies for implementation.

We are now getting together for our third congress in the area of hydrogen technologies, after organizing the first one in Yildiz Technical University in Istanbul, in Cukurova University in Adana, which aims to bring researchers, scientists, engineers and practitioners, who are working in the subject matter area, to provide a forum to exchange ideas, disseminate new research developments and discuss latest advances, new directions and priorities for a carbon-free future with hydrogen. We are happy to have numerous leading researchers here to share the newest ideas and latest technologies and developments. Over 140 selected technical papers will provide an ample opportunity to learn about a wide range of topics with distinguished presenters from over ten countries. Furthermore, the conference delegates will benefit from the exchange of ideas, problems and solutions with a large number of technical experts.

Many individuals have contributed in significant ways to organize this conference and make the necessary prepeartions. As the Association President, I would like to register my sincere appreciation to the Organizing Committee Members, Executive Organizing Committee Members, and the Honorary Chair, Dr. T. N. Veziroglu, the Congress Chair, Dr. Hilmi Yurdakul and Secretary General Dr. Adnan Midilli. In addition, I would like to acknowledge the assistance, support and coordination of the Bros Congress Team. Last but not least, I warmly thank the congress keynote speakers, authors, session chairs, and all attendees, whose contributions and efforts will make this conference a great success.

Ibrahim Dincer

President
National Hydrogen Energy Association

FOREWORDS

WELCOME FROM THE CONFERENCE CHAIRMAN

I am very happy to serve for "The Third International Hydrogen Technologies Congress" as conference chairman. This congress was initially held in Istanbul in December 2015 as the first one, and we are now ready to third one as hosted by Alanya Alaaddin Keykubat University in Alanya. This conference is organized as an annual event under the National Hydrogen Technologies Association

This Congress in Alanya Alaaddin Keykubat University in Alanya focus particularly on "Hydrogen Technologies", and specially on all related systems and applications to cover the entire spectrum to serve for hydrogen economy. It brings together 3 keynote speakers and over 134 participants from 8 countries for a period of four days to discuss, disseminate and network on various aspects of hydrogen production processes ranging from its performance analysis and fuel cells, transportation, distribution, security, strategies and policies and those applications, through the topics, like renewable hydrogen production and technologies, biological hydrogen production and technologies, thermochemical hydrogen production and technologies, electrolytic hydrogen production and technologies, photochemical hydrogen production and technologies, pyrolysis, gasification and plasma hydrogen production, hydrogen production and micro process technologies, hydrogen separation and cleaning technologies, hydrogen storage materials and technologies, hydrogen applications and technologies, hydrogen fuel cells, hydrogen transportation, distribution and security, hydrogen strategies and policies, modeling, energy and exergy analysis. In addition, there is a panel on the last day of the Congress with five distinguished speakers to discuss the clean energy solutions and the role of hydrogen in these solutions

I wish to formally put on record my sincere thanks to numerous key people and organizations that have been instrumental in ensuring the success of IHTEC2018 in Alanya Alaadin Keykubat University in Alanya. I would like to thank Prof. Dr. Ahmet Pinarbasi, Rector of Alaadin Keykubat University and his management for their full support

I would like to register my sincere appreciation to Professor N. T. Veziroğlu, President of International Association for Hydrogen Energy and Founding and Honorary Editor of International Journal of Hydrogen Energy (IJHE) and Professor Ibrahim Dincer, President of National Hydrogen Association and his management along with the Bros Congress Team.

Finally, I would like to thank all keynote speakers, oral and poster presenters, all participants, and the organizing committee members, as well as Bros Congress members for their exemplary contribution and support.

Hilmi Yurdakul
Congress Chair, IHTEC2018

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March 15, 2018

HALL - A	
08:00-09:00	Registration
09:00-09:30	**Opening Talks** **Hilmi Yurdakul** *(Congress Chair)* **İbrahim Dincer** *(President, National Hydrogen Energy Association)* **Ahmet Pinarbasi** *(Rector, Alanya Alaeddin Keykubat University)*
09:30-10:15	**Overview Talk-** Ibrahim Dincer **Alternative Dimensions of Hydrogen Energy and Future Directions**
10:15-11:00	**Keynote Speaker -** Richard Baker **Substituted Ceria-Based Materials for Applications in Solid Oxide Fuel Cell Electrolytes and Electrodes** **Chair:** Ibrahim Dincer
11:00-11:15	**Coffee Break**
11:15-12:00	**Keynote Speaker -** Wei-Hsin Chen **Recent Development in Hydrogen Separation and Purification through Pd-based Membrane Systems** **Chair:** Richard Baker
12:00-13:30	**LUNCH**

HALL - A	
13:30-15:00	**Session 1A: Biological Hydrogen Production** **Chair: Filiz Karaosmanoglu**
13:30-13:45	**(004) Hydrogen Production by Agar-Immobilized R. Capsulatus in Panel Photobioreactor** Kamal Elkahlout, Emrah Sagir, Siamak Alipour, Harun Koku, Ufuk Gunduz, Inci Eroglu, Meral Yucel
13:45:14:00	**(0050) Effect of Operational Variables on Biological Hydrogen Production by Dark Fermentation from Palm Oil Mill Effluent Using Response Surface Methodology** Azam Akhbari
14:00-14:15	**(0053) Multi-Objective Evolutionary Polynomial Regression Technique in Prediction of Bio-Hydrogen Production by Dark Fermentation Process** Azam Akhbari, Shaliza Ibrahim, Mohsen Vafaeifard, Isa Ebtehaj, Milad Khosravi, Hossein Bonakdari
14:15-14:30	**(0157) HHO Enrichment of Bio-Diesohol Fuel Blends in a Single Cylinder Diesel Engine** Mustafa Kaan Baltacıoğlu, Raif Kenanoğlu, Kadir Aydın
14:30-14:45	**(0154) Investigation of Optimum Hydraulic Retention Time (HRT) of Semi-batch Photofermentation Process in a Three-stage System** Melih Can Akman, Tuba Hande Erguder, Ufuk Gunduz, Inci Eroglu
14:45-15:00	**(0072) Direct Current Assisted Dark Fermentative Hydrogen Gas Production from Acid Hydrolysed Waste Paper Towel** Gulizar Onaran, Hidayet Argun
15:00-15:30	**Coffee Break**

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HALL - B	
13:30-17:30	**Workshop – Hikmet Karakoc**
	Opening Remarks
13:30-15:00	**Session-I** **Session Chair: Adnan Midilli** • Battery Technology Overview – **Fatih Mutluel, TUBITAK MAM** • Battery Thermal Management System (TMS) – **Cihad Furkan Salman, TUBITAK MAM** • Battery Module/Package Development – **Ahmet Yayli, TUBITAK MAM** • Battery Management System (BMS) – **Turev Sarikurt, TUBITAK MAM**
15:00-15:30	**Coffee Break**
15:30-17:00	**Session-II** **Session Chair: C. Ozgur Colpan** • Analysis and Selection of Effective Battery Management System Architectures for Safety – **Melih Yildiz (Atilim University), T. Hikmet Karakoc (Anadolu University)** • Electric Mobility and Li Ion Based BMS Adaptation in Bozankaya Buses – **Emrah Dal (Bozankaya), Dursun Cicek (Bozankaya)** • Electrification Options in Aviation Systems –**Nader Javani (Yildiz Tech. University)** • Maintainability and Safety Parameters for Battery Design –**Melih Yildiz (Atilim University), T. Hikmet Karakoc (Anadolu University)**

HALL - C	
13:30-15:00	**Session 1C: Renewable Hydrogen Production** **Chair: Hadi Ganjehsarabi**
13:30-13:45	**(0192) Integrating of PEM Electrolyzer for Hydrogen Production in a Kalina Cycle Driven by Low-Grade Geothermal Energy** Hadi Ganjehsarabi
13:45-14:00	**(0097) Performance of Ni Incorporated Silica and Alumina Based Catalysts in Hydrogen Production from Biomass** Birce Pekmezci Karaman, Nurbanu Çakiryilmaz, Huseyin Arbag, Nuray Oktar, Gülşen Dogu, Timur Dogu
14:00-14:15	**(0030) Investigation of a Solar Driven Integrated TEG with PEM Electrolyzer System for Hydrogen Production** Murat Emre Demir, Ibrahim Dincer
14:15-14:30	**(0060) Hydrogen Production from Water as Photoelectrochemical by using Solar Light Irradiation** Rana Muhammad Zunain Ayaz, Duygu Akyüz, Özlem Uğuz, Irem Tanışık, Cevat Sarıoğlu, Fatma Karaca Albayrak, Ali Rıza Özkaya, Atıf Koca
14:30-14:45	**(0202) A Parametric Study on Exergetic Performance of Hydropower Integrated Hydrogen Production: A Case Study for East Black-Sea Region of Turkey** Adnan Midilli and Mert Ozsaban
15:00-15:30	**Coffee Break**

SCIENTIFIC PROGRAM

HALL - A	
15:30-17:15	**Session 2A: Pyrolysis, Gasification and Plasma Hydrogen production** **Chair: Inci Eroglu**
15:30-15:45	**(0027) In–situ and Downstream Desulfurization Ability of PbO and ZnO During Pyrolysis and Hydrogenation of a High–sulfur Lignite** Arzu Kanca, Deniz Uner
15:45-16:00	**(0089) Ni Catalyzed Methane Pyrolysis for H2 Generation under Concentrated Solar Irradiation** Celal Guvenç Ogulgonen, Atalay Çalışan, Deniz Uner, Serkan Kıncal
16:00-16:15	**(0068) Energy and Exergy Analyses of an Integrated Solar and Coal Gasification Combined Cycle for Hydrogen and Ammonia Production** Ahmed Hasan, Ibrahim Dincer
16:15-16:30	**(0098) Gasification of Sewage Sludge Enriched with Virginia Mallow for Higher Hydrogen Content in Syngas** Anna Poskart, Monika Zajemska, Stanisław Szwaja
16:30-16:45	**(0021) The Effects of Equivalence Ratio on a Downdraft Plasma Coal Gasifier** Zeki Yilmazoglu, Beycan Ibrahimoglu, Onurhan Gokalp
16:45-17:00	**(0155) Electrochemical Characterization of Carbon-Supported Bimetalic Pd-Zn Nanoparticles as Anode Catalyst for Direct Borohydride Fuel Cells** Ramiz Gultekin Akay, Merve Dogan Ozcan, Cenk Celik, Ayse Nilgün Akın
17:00-17:15	**(0222) Biohydrogen Production From Fruit And Vegetable Wastes Through Dark Dry Anaerobic Fermentation Under Thermophilic Condition** Haris Nalakath Abubackar, Okyanus Yazgın, Bensu Gunay, Kubra Arslan, Tugba Keskin Gundogdu, Nuri Azbar
17:15-17:30	**Coffee Break**

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HALL - C	
15:30-17:15	**Session 2C: Hydrogen Fuel Cells** **Chair: Mehmet Suha Yazici**
15:30-15:45	**(0014) Microwave Assisted Synthesis of Pt/MWCNT Catalyst for High Temperature PEM Fuel Cell** Elif Damla Arica, Yılser Devrim
15:45-16:00	**(0085) Performance of CVD Graphene Supported PtxCoy Electrocatalysts for PEM Fuel Cell** Fatma Gül Boyacı San, Mehmet Suha Yazıcı
16:00-16:15	**(0005) A Field Application of a Fuel Cell Microcogeneration Unit** Cigdem Iyigün Karadag, Atilla Ersöz, Fatma Gül Boyacı San, Betül Erdör Türk, Emin Okumuş, Murat Kılıç, Egemen Akar, Nilüfer Topuz, Salih Obut, Özgür Can Korkmaz, Derya Aydemir
16:15-16:30	**(0153) A Labview-FPGA Based Process Control and Power Conditioning Prototype Application of a Fuel Cell Powered Range Extender for Unmanned Aerial Vehicles** Betul Erdor Turk, Mustafa Hadi Sarul
16:30-16:45	**(0174) System Design and Optimization of a Hydrogen Fuel Cell Vehicle in the Different Road Models** Yakup Hames, Kemal Kaya
16:45-17:00	**(0016) Development of Effective Cooling System for High Temperature PEM Fuel Cell** Yilser Devrim, Kubra Pehlivanoglu, Omer Erdemir, Celal Yılmaz, Huseyin Devrim
17:00-17:15	**(0181) The Impact of Boron Nitride Nanoparticles on Hydrogen Uptake Capacity over MWCNTs** Songul Kaskun, Muhammet Kayfeci
17:15-17:30	**Coffee Break**

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17:45-18:30	POSTER Session 1 Chair: Ugur Akbulut
0055	Modeling of Syngas Production from Biogas via Tri-reforming Process Reiyu Chein, Wen Hwai Hsu
0058	Active Photocatalysts Designed by Sulphurization Method for Hydrogen Production Irem Tanışık, Duygu Akyüz, Rana Muhammad Zunain Ayaz, Özlem Uğuz, Cevat Sarıoğlu, Fatma Karaca Albayrak, Ali Rıza Özkaya, Atıf Koca
0093	Comparison of LFS of H2, CH4 at Elevated Temperatures Karol Grab Rogalinski, Stanislaw Szwaja, Michal Pyrc, Michal Gruca
0095	A Low Cost, Continuous H2-CH4 Sensor Assembly Celal Güvenç Oğulgönen, Atalay Çalışan, Deniz Üner, Serkan Kıncal
0099	Optimization of hydrogen release from anaerobic thermal processing of Virginia Mallow Anna Poskart, Monika Zajemska, Stanisław Szwaja, Aneta Magdziarz, Dorota Musiał
0103	Influence of Hydrogen Addition to Diesel Fuel on Smoke and Combustion Phases in a Compression Ignition Engine Stanislaw Szwaja, Romualdas Juknelevicius, Michal Gruca, Michal Pyrc
0105	A Comparative Thermodynamic Analysis of Alternatively Proposed Different Fuel System Models using Jet A Fuel Muhammet Yilanli, Önder Altuntaş, Emin Açıkalp
0107	The Effect of Support Material on the Hydrogen Adsorption-Desorption Characteristics of Ru/SiO2 and Ru/Vulcan Catalysts Mustafa Yasin Aslan, Deniz Üner
0110	Metal-Organic Frameworks as Hydrogen Evolution Catalysts Selçuk Demir, Emine Ülker
0112	Empirical Models for the Energy Consumption of Oil-in- Water Emulsion Treatment by Electro-coagulation Process Mohamed Tir
0115	Management of Hybrid System Operating in Grid–connected and Standalone Mode Houria Boumaaraf, Billel Boumaaraf, Abdelaziz Talha, Omar Bouhali
0117	Power Generation System Control of a Hybrid Renewable System PVT-diesel with Storage Billel Boumaaraf, Houria Boumaaraf, Abdelaziz Talha, Mohamed Salah Ait Cheikh
0119	The Relationship Between Fuel Flow Rate and Pressure Drop in a Direct Methanol Fuel Cell with Parallel Channels Anil Can Turkmen, Didem Demirtas, Hatice Esen, Cenk Celik
0122	Hydrogen Permeation Characteristics Through Palladium Membrane with/without Vacuume Shang Wei Lin, Wei Hsin Chen
0069	Heat Transfer and Pressure Drop Characteristics of Different Structured Micro-Pin-Fin Reactors Evren Yilmaz Yakin, Sinan Eren Yalcin, Tahir Hikmet Karakoc
0190	The Role of Temperature on Aluminium Oxide Embedded MWCNTs for Hydrogen Adsorption Songül Kaskun, Muhammet Kayfeci

SCIENTIFIC PROGRAM

March 16, 2018

HALL - A	
09:30-10:15	**Keynote Speaker: Bruno G. Pollet** **Current Status of Hydrogen and Fuel Cells in Norway** **Chair: Richard Baker**
10:15-10:30	**Coffee Break**
10:30-12:00	**Session 3A: Thermodynamic Analysis of Hydrogen Technologies** **Chair: Güngör Tuncer**
10:30-10:45	**(0044) Thermodynamic and Economic Analyses of a Renewable Energy Based Hydrogen Production System** Fatih Sorgulu, Ibrahim Dincer
10:45-11:00	**(0047) Thermodynamic Performance Assessment of Integrated Solar Energy System with Hydrogen Production** Fatih Yilmaz, Murat Ozturk, Resat Selbas
11:15-11:30	**(0064) Geothermal and Solar Driven Multigeneration System for Sustainable Buildings: A Thermodynamic Analysis** Tahir Abdul Hussain Ratlamwala, Hamed Alimoradiyan
11:30-11:45	**(0184) Thermodynamic Analysis of a New Solar Power Tower Based Integrated System for Hydrogen Production and Liquefaction** Yunus Emre Yuksel, Murat Ozturk, Ibrahim Dincer
11:45-12:00	**(0221) Thermodynamic Analysis of a Unique Integrated Photoelectrochemical System for Multigeneration Purposes** Canan Acar, Ibrahim Dincer
12:00-13:30	**LUNCH**

HALL - B	
10:30-12:00	**Session 1B: Exergy Analysis of Hydrogen Energy Systems** **Chair: Hikmet Karakoc**
10:30-10:45	**(0096) Diagnosis and Improvement of Hydrogen Demand/Supply Processes using Combined Pinch and Exergy Analysis** Fatma Alyer, Zehra Özçelik
10:45-11:00	**(0023) Optimum Energy and Life Cycle Cost Evalautaion of an Advanced Hydrogen Liquefaction Cycle Using Geothermal Power** Ceyhun Yılmaz
11:00-11:15	**(0065) Energy and Exergy Analyses of a Novel Ammonia Combined Power Plant Operating with a Gas Turbine and a Solid Oxide Fuel Cell** Muhammad Ezzat, Ibrahim Dincer
11:15-11:30	**(0079) A Parametric Study of the Performance of a Polymer Electrolyte Membrane Electrolyzer: Energy and Exergy Analyses** Ehsan Baniasadi, Ebrahim Afshari, Faeze Moradi Nafchi, Nader Javani
11:30-11:45	**(0041) Exergoeconomic Analysis and Optimization of a Concentrated Sunlight-based Integrated Photoelectrochemical Hydrogen and Ammonia Production System** Yusuf Bicer, Ibrahim Dincer
12:00-13:30	**LUNCH**

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HALL - C	
10:30-12:00	**Session 3C: Hydrogen Fuel Combustion** **Chair: Stanislaw Szwaja**
10:30-10:45	**(0092) Analysis of the Turbocharged Internal Combustion Engine with Over-expanded Cycle Fueled with CNG and Hydrogen** Karol Grab Rogalinski, Stanislaw Szwaja
10:45-11:00	**(0102) Dilution of Fresh Charge for Reducing Combustion Knock in the Internal Combustion Engine Fuelled with Hydrogen Rich Gases** Stanislaw Szwaja
11:00-11:15	**(0147) Simulation of a Novel Alternative Fueled Hybrid Electric Vehicle (AF-HEV) with Hydrogen Enriched Internal Combustion Engine** Hüseyin Turan Arat
11:15-11:30	**(0196) A Numerical Study of Mild Flameless Combustion of Methane/hydrogen Mixtures in a Furnace** Mehmet Salih Cellek
11:30-11:45	**(0150) Colloidal Synthesis and Characterization of CuInS2 Nanoparticle for Solar Hydrogen Production** Cigdem Tuc Altaf, Nurdan Demirci Sankır
11:45-12:00	**(0131) Catalytic and Non-Catalytic Hydrogen Generation from Chemical Hydrides** Mehmet Sankir, Nazrin Abdullayeva
12:00-13:30	**LUNCH**

HALL - A	
13:30-15:00	**Session 4A: Borohydride Fuel Cells** **Chair: Ramazan Solmaz**
13:30-13:45	**(0215) Langmuir–Hinshelwood Kinetic Model to Capture the Manganese(0) Nanoparticles Supported on Ceria-catalyzed Hydrolysis of Sodium Borohydride** Sibel Duman, Saim Özkar
13:45-14:00	**(0148) Preparation And Characterization of Polyvinyl Alcohol/Chitosan Blended Anion Exchange Membranes for Direct Borohydride Fuel Cells** Tuncay Kadıoglu, Ramiz Gultekin Akay, Kursat Can Ata, Cenk Celik
14:00-14:15	**(0151) Novel Pd-Co/C Bimetallic Alloy Electrocatalyst for Direct Borohydride Fuel Cell Anode** Cem Gozlu, Cenk Celik, Ayse Nilgun Akın, Ramiz Gultekin Akay
14:15-14:30	**(0152) A Comparative Study on the Determination of Borohydride Permeability of Cation Exchange Membranes for DBFC** Kursat Can Ata, Tuncay Kadıoglu, Ramiz Gultekin Akay, Cenk Celik
14:30-14:45	**(0241) Effect of Inlet Air Temperature on Exergetic Performance of Hydrogen Production from Car Tires via Plasma Gasification** Handan Demirçay, Merve Mehan, Muhammed Emin Topal, Yildiz Kalinci, Senol Bayraktar, Ugur Akbulut, Haydar Kucuk, Hayati Olgun, Adnan Midilli, Ibrahim Dincer
15:00-15:30	**Coffee Break**

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HALL - B	
13:30-18:20	**Workshop – C. Ozgur Colpan**
	Session Chair: İnci Eroğlu
13:30-13:35	Welcoming Remarks / **C. Özgür Çolpan**
13:35-13:55	Overview of Hydrogen and Fuel Cell Related Research at CERL in UOIT / **Ibrahim Dincer**
13:55-14:15	The Development and Production of Fuel Cell from TEKSIS's Point of View / **Hüseyin Devrim**
14:15-14:35	PEM Type Fuel Cell Research at TOBB ETU / **Mehmet Sankır**
14:35-14:55	Advances in the Fuel Cell Research in Dokuz Eylul University / **C. Özgür Çolpan**
14:55-15:15	Hydrogen & Fuel Cell Research in Atılım University / **Yılser Devrim**
15:15-15:35	Advances in the Fuel Cell Research in Sen Research Group (SRG), Dumlupinar University / **Fatih Şen**
15:35-16:00	**Coffee Break**
	Session Chair: T. Hikmet Karakoç
16:00-16:20	Fuel Cell Research in Atatürk University / **Ayşe Bayrakçeken Yurtcan**
16:20-16:40	Hydrogen & Fuel Cell Research and Demonstration Activities at MAM Energy Institute / **Suha Yazıcı**
16:40-17:00	Studies on the Development of Directly Fed Fuel Cell Catalysts at Van YYU / **Hilal Demir Kıvrak**
17:00-17:20	PEMFC Studies in Recep Tayyip Erdogan University / **Adnan Midilli**
17:20-17:40	Advances in the Fuel Cell Research in Çukurova University **Ebru Erünal**
17:40-18:00	Direct Borohydride Fuel Cell Studies in Kocaeli University **Cenk Çelik and R. Gültekin Akay**
18:00-18:20	Research and Development of Microbial Fuel Cell Technology at Yildiz Technical University / **Bestami Özkaya**

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HALL - C	
13:30-15:00	**Session 4C: Material Applications for Hydrogen Energy Technologies** **Chair: Emmanuel Iheanyichukwu Iwuoha**
13:30-13:45	**(0091) Wireless High-Speed Continuous Sensing of Hydrogen Leak by a Quadrotor Drone** Kazuo Matsuura, Masahiro Inoue, Yuta Segawa, Takaya Kimura
13:45-14:00	**(0216) Green Dehydrogenation of Dimethylamine Borane Catalyzed by Nickel(0) and Copper (0) Nanoparticles** Hakan Demir, Ali Ozdemİr, Sibel Duman
14:00-14:15	**(0229) Graphene Oxide/Metal Organic Framework Nanocomposite with Improved Electrocatalytic Activity for Hydrogen Evolution Reaction** Emmanuel Iheanyichukwu Iwuoha, Mogwasha Daphney Makhafola, Kabelo Edmond Ramohlola, Thabang Ronny Somo, Gobeng Release Monama, Mpitloane Joseph Hato, Kerileng Midred Molapo, Kwena Desmond Modibane
14:15-14:30	**(0228) Copper(II) Phthalocyanine/Metal Organic Frameworks (Cupc/MOF) Composite with Improved Electrocatalytic Efficiency for Hydrogen Production** Emmanuel Iheanyichukwu Iwuoha, Gobeng Release Monama, Kwena Desmond Modibane, Kabelo Edmond Ramohlola, Kerileng Mildred Molapo, Mpitloane Joseph Hato, Mogwasha Daphney Makhafola, Gloria Mashao Mashao Mashao, Siyabonga Beizel Mdluli
14:30-14:45	**(0218) Highly Effective PVP-stabilized Rh-Ru Bimetallic Nanoparticles for the Dehydrogenation of Methylamine-borane in Water** Mehmet Gulcan, Yaşar Karatas
14:45-15:00	**(0128) Investigation of Hydrogen Fuel Usage Affects On Exergetic and Exergeeconomic Performances of a Turbojet Engine** Ozgur Balli, Yasin Şöhret, T. Hikmet Karakoc
15:00-15:30	**Coffee Break**

SCIENTIFIC PROGRAM

HALL - A	
15:30-17:00	**Session 5A: Modelling and Analysis of Hydrogen Energy Technologies** **Chair: Canan Acar**
15:30-15:45	**(0070) Kinetic and Electrochemical Analyses of a CuCl/HCl Electrolyzer** Reza Soltani, Ibrahim Dincer, Marc A. Rosen
15:45-16:00	**(0119) The Relationship Between Fuel Flow Rate and Pressure Drop in a Direct Methanol Fuel Cell with Parallel Channels** Anil Can Turkmen, Didem Demirtas, Hatice Esen, Cenk Celik
16:00-16:15	**(0088) Exergetic and Sustainability Analyses of Ammonia Usage in a Gas Turbine** Suleyman Kagan Ayaz, Onder Altuntas
16:15-16:30	**(0188) Thrust Modelling for a Solid Oxide Fuel Cell and Gas Turbine (SOFC/GT) Hybrid Propulsion System** Yasin Sohret, Arif Hepbasli, T. Hikmet Karakoc
16:30-16:45	**(0124) Exergetic Comparison of Various Flow Patterns in PEMFCs** Suha Orcun Mert, Muhammed Mucahit Toprak
17:00-17:15	**Coffee Break**

HALL - C	
15:30-17:00	**Session 5C: Hydrogen Production-1** **Chair: Figen Kadırgan**
15:30-15:45	**(0028) Maturity Impact on Hydrogen Production from Natural Gas and Coal: Examples from Dadaş Shale and Zonguldak Coals** Samil Sen, Huseyin Kozlu, Ilyas Erdal Kerey, Gungor Celik
15:45-16:00	**(0031) Investigation of Hydrogen Production through Thermochemical Cycles** Fatih Yilmaz, Resat Selbas, Murat Oztruk
16:00-16:15	**(0062) Photoelectrochemical Hydrogen Production Using cd(1-x)znxs and Its Modifications with Graphene Derivatives** Ozlem Uguz, Duygu Akyuz, Rana Muhammad Zunain Ayaz, Irem Tanısık, Cevat Sarıoglu, Fatma Karaca Albayrak, Ali Rıza Ozkaya, Atıf Koca
16:15-16:30	**(0073) Hydrogen Production from Melon and Watermelon Mixture by Dark Fermentation** Savas Turhal, Mansurali Turanbaev, Hidayet Argun
16:30-16:45	**(0166) Photocatalytic Hydrogen Production with Metal Oxide Bulk Structures** Gizem Yanalak, Abdalaziz Aljabour, Emre Aslan, Faruk Ozel, Imren Hatay Patir
16:45-17:00	**(0211) Hydrogen Gas Production from Wastewater by Electro-hydrolysis** Serkan Eker, Fikret Kargi
17:00-17:15	**Coffee Break**

SCIENTIFIC PROGRAM

17:00-18:00	**POSTER Session 2** **Chair: Suha Orcun Mert**
0145	Ordered Mesoporous Carbons (OMC) Synthesized by Self-assembly Method and the Effects of Acidity and Carbon Source to Surfactant Ratio Silver Güneş, Fatma Çiğdem Güldür
0159	Bio-ethanol Reforming for Hydrogen and Methane Production Yuji Ando
0168	Electricity Generation and Wastewater Treatment with Microbial Fuel Cells Using Homemade Beer Wastewater Ömer Faruk Coşkun, Kürşat Can Ata, Ramiz Gültekin Akay
0182	Synthesis of Active and Reusable Nano Catalyst from Graphene Oxide (GO) Stabilized Pt-Ir Nanoclusters for DMAB Dehydrogenation Reaction at Room Temperature Fatih Sen, Esra Kuyuldar, Betül Sen
0183	Synthesis of Highly Active Pt-Rh Nanoclusters Stabilized on Graphene Oxide for Hydrogen Evolution Reaction Fatih Sen, Esra Kuyuldar, Betül Sen
0187	Energy and Exergy Analyses of an Integrated Hydrogen Production and Liquefaction System with Waste Material Gasification Yunus Emre Yüksel, Murat Öztürk, Ibrahim Dinçer
0191	A Comparative Study of Control Strategies for Vehicles with Hydrogen Fuel Cell/Battery/ Supercapacitor in the Electrical Grid-Independent Applications Yakup Hameş, Kemal Kaya
0200	Wood Char - Active Carbon Production for H2 Adsorption and Storage Yıldırım Tosun
0209	Biohydrogen Upgrading Towards a Cleaner Energy Production Emre Oguz Koroglu, Bestami Ozkaya, Ahmet Demir
0217	Hydrogen Generation from the Hydrolysis of Dimethylamine-borane at Room Conditions by Using Polyvidone Protected Ruthenium Nanocatalyst Mehmet Gülcan, Yaşar Karataş
0224	Optimization of Thermal Pre-treatment Conditions By Box-Wilson Method For Dark Fermentative Biohydrogen Production From Fruit and Vegetable Wastes Bensu Günay, Okyanus Yazgın, Kubra Arslan, Haris Nalakath, Tugba Keskin, Nuri Azbar
0225	Analysis of Biohydrogen Production via Dry Anaerobic Digestion of Fruit and Vegetable Waste Okyanus Yazgın, Bensu Günay, Haris Nalakath Abubackar, Tuğba Keskin Gündoğdu, Nuri Azbar
0230	Phase Transition and Photoelectrochemical Properties of Copper Oxide Photoelectrodes Fabricated by Electrodeposition İbrahim Y Erdoğan, Meral Balık, Veysel Bulut
0231	Enhanced Photoelectrocatalytic Performance of ZnO/Cu2O Photoelectrodes İbrahim Y Erdoğan, Ako Mahmood Qadir
0239	The Investigation of Three-dimensional Copper Nanodomes as Anode Materials for Direct Methanol Fuel Cells Fatih Baştürk, Handan Yüksel, Ramazan Solmaz
0240	Pt, Pd and Ag Modified NiCuZn Raney Electrodes for Alkaline Water Electrolysis Ramazan Solmaz, Ayşe Ongun Yüce, Ali Döner, Ibrahim Şahin, Gülfeza Kardaş
0104	Energy and Exergy Analysis of 1 kW Self-humidified PEM Fuel Cell Tayfun Özgür, Ali Cem Yakaryılmaz, Erdi Tosun, Mustafa Atakan Akar, Mustafa Özcanlı
0244	Mg60Ni40 Alloy Synthesis and Investigation of Hydrogen Storage Properties Gözde Bayazıt, Sefa Emre Sünbül, Sultan Öztürk, Kürşat Icin, Şadan Özcan

SCIENTIFIC PROGRAM

March 17, 2018

HALL - A	
09:00-10:30	**Session 6A: Hydrogen Energy Applications-1** **Chair: Can Ozgur Colpan**
09:00-09:15	**(0007) H_2 Adsorption on Cu(I)-ZSM-5: Exploration of Cu(I)-exchange in Solution** Ismihan Altıparmak, Busra Karakaya, Bahar Ipek
09:15-09:30	**(0082) Coke Minimization over Mesoporous Alumina Supported Ni Catalyst in Dry Reforming of Methane** Huseyin Arbag
09:30-09:45	**(0212) Electrohydrolysis Application on Metal Plating Wastewater to Produce Hydrogen Gas** Ebru Çokay, Yasin Gürler
09:45-10:00	**(0040) Bimetallic Particles for Ethanol Electro-oxidation** Hilal Demir Kivrak, Ebru Ozkan, Burak Yapıcı, Sumeyye Dogan, Shekiba Muhammady, Ozlem Sahin
10:00-10:15	**(0134) Synthesis and Characterization of Electrocatalyst with Graphene and Multi-Walled Carbon Nanotube Support Material** Guvenc Umur Alpaydin, Elif Damla Arica, Yilser Devrim, Can Ozgur Colpan
10:15-10:30	**(0108) SnS Photo-electrodes Produced by Sulfurization of Electrodeposited Sn Films for Photo-electrochemical Water Splitting** Sercan Soyoz, Bulut Sahin, Selim Demirci, Cevat Sarıoglu
10:30-10:45	**Coffee Break**

HALL - B	
09:00-10:30	**Session 2B: Hydrogen Evolution** **Chair: Kazuro Matsuura**
09:00-09:15	**(0057) The Effect of Co-catalyst and Novel Heterogeneous Active Photocatalysts for Hydrogen Evolution under Solar Energy** Duygu Akyuz, Ozlem Uguz, Irem Tanısık, Rana Muhammad Zunain Ayaz, Cevat Sarıoglu, Fatma Karaca Albayrak, Ali Rıza Ozkaya, Atıf Koca
09:15-09:30	**(0094) Water Splitting through the Pb/PbO Cycle** Atalay Calısan, Celal Guvenc Ogulgonen, Deniz Uner, Serkan Kıncal
09:30-09:45	**(0037) Comparison of Alcohol Electro-oxidation in Alkaline Medium** Ozlem Sahin, Ebru Ozkan, Hilal Demir Kivrak
09:45-10:00	**(0109) Zirconium Metal-Organic Framework Platform as a Heterogeneous Catalysts for Electrochemical Hydrogen Evolution** Emine Ulker, Selcuk Demir
10:00-10:15	**(0170) Hydrogen Evolution at the Water/DCE Interface Catalyzed by Cu2WS4** Faruk Ozel, Emre Aslan, Adem Sarilmaz, Imren Hatay Patir
10:15-10:30	**(0171) The Hydrogen Evolution Reaction Catalyzed by Metal Oxide and Metal Sulfide Catalysts at Soft Interfaces** Emre Aslan, Gizem Yanalak, Imren Hatay Patir
10:30-10:45	**Coffee Break**

SCIENTIFIC PROGRAM

HALL - C	
09:00-10:30	**Session 6C: Hydrogen Energy and Technologies-1** **Chair: Tanay Sıdkı Uyar**
09:00-09:15	**(0038) Electrocatalytic Performance of Pd Based Bimetallic Catalysts for Methanol Oxidation Reaction** Özlem Şahin, Ebru Özkan, Rabia Esra Takır,Abdullah Nadeesh, Hilal Demir Kıvrak
09:15-09:30	**(0039) Structure Sensitivity of Direct Alcohol Electro-oxidation Reaction Catalysts** Hilal Demir Kivrak, Ebru Ozkan, Ozlem Sahin
09:30-09:45	**(0013) Effect of Bipolar Plate Gas Flow Channel Pattern on Proton Exchange Membrane Fuel Cells Performance** Celal Yılmaz, Muhittin Bilgili, Yılser Devrim
09:45-10:00	**(0136) Performance Analysis of Compressor Assisted Single Effect Absorption Refrigeration Cycle Coupled with Heliostat Field** Chinedu Frank Okwose
10:00-10:15	**(0175) Integration of Renewable Energy Systems with Hydrogen Technologies** Alper Saydam, Tanay Sıdkı Uyar
10:15-10:30	**(0243) Design of Thin Film Membranes for Intermediate-Temperature Hydrogen Separation** Fatih Pişkin, Tayfur Öztürk
10:30-10:45	**Coffee Break**

HALL - A	
10:45-12:00	**Session 7A: Hydrogen Energy Policies and Strategies** **Chair: Sudi Apak**
10:45-11:00	**(0075) A Renewable Pathway Towards Increased Utilization of H_2 in Diesel Engines** Saket Verma, Abhishek Suman, Lalit M Das, Shubhash C Kaushik, Sudhir K Tyagi
11:00-11:15	**(0015) Turkey's Hydrogen Scenario and Hydrogen Production in the Thrace Basin versus Hydrogen Regulations and Standards** Erhan Atay, Sudi Apak
11:15-11:30	**(0090) Recent Trends of Hydrogen Utilization in Transportation** Kadir Aydın
11:30-11:45	**(0087) Maritime Industry and Future Hydrogen Production** Preeti Parikh, Yaqub Amani, Charles Munsch
12:00-13:30	**LUNCH**

SCIENTIFIC PROGRAM

HALL - B	
10:45-12:00	**Session 3B: Hydrogen Production-2** **Chair: Yılser Devrim**
10:45-11:00	**(0071) Steam Methane Reforming in Micro-reactors under Concentrated Solar Irradiation** Atalay Çalısan, Celal Guvenc Ogulgonen, Deniz Uner, Serkan Kincal
11:00-11:15	**(0081) Hydrogen Generation from Solid State NaBH4 by Using FeCl3 Catalyst for Portable PEMFC Applications** Inci Eroglu, Aslı Boran, Serdar Erkan
11:15-11:30	**(0100) Improvement of Operational Characteristics of Sesame Oil in a Compression Ignition Engine with Small Fraction of Hydrogen Enrichment** Tayfun Ozgur, Safak Yildizhan, Ceyla Ozgur, Kadir Aydın, Hasan Serin
11:30-11:45	**(0177) Effective TiO2 Supported Cu-Complex Catalyst in NaBH4 Hydrolysis Reaction to Hydrogen Generation** Dilek Kilinc
11:45-12:00	**(0195) Investigation of Hydrogen Generation from Sodium Borohydride Hydrolysis Reaction with Different Catalyst** Arife Saglam, Elif Damla Arıca, Yılser Devrim
12:00-13:30	**LUNCH**

HALL - C	
10:45-12:00	**Session 7C: Hydrogen Energy and Technologies-2** **Chair: Nader Javani**
10:45-11:00	**(0074) Electrochemical Impedance Modelling of a SOFC Button Cell and Parametric Analysis of the Cell Electrical / Electrochemical Performance** Yaser Mollaei Barzi, Rafat Mohammadi
11:00-11:15	**(0078) Experimental Characterization of Thin Electrolyte for Intermediate Temperature Solid Oxide Electrolysis Cell** Abdullah A. Alzahrani, Ibrahim Dincer
11:15-11:30	**(0084) Investigation of the Effect of Single Stage and Four-stage Clamping Pressure on Electrical Resistance of GDL** Mert Taş, Gülşah Elden
11:30-11:45	**(0083) Preparation of Nanostructured α-Fe2O3 Films from Electrodeposited Fe Films for Photoelectrochemical Water Splitting Performance** Selim Demirci, Cevat Sarıoğlu
12:00-13:30	**LUNCH**

13:30- 18:00	**SOCIAL PROGRAME (Damlataş Cave, Telpher Trip, Alanya Castle)**

March 18, 2018

HALL - A	
09:00-11:00	**Session 8A: Hydrogen Energy and Technologies-3** **Chair: Kadir Aydin**
09:00-09:15	**(0061) Hydrogen Storage Capacity Investigations of Pd Loading Ratio on MW-CNTs via Supercritical Fluid Deposition Method** Ebru Erunal, Fatma Ulusal, Sinan Büyükbayram, Selda Odabaşı, Bilgehan Güzel, Deniz Üner
09:15-09:30	**(0113) Enhancement of Hydrogen Charging in Metal Hydride-Based Storage Systems by Using Heat Pipe** Muhammet Kayfeci, Fawzi Elhamshri
09:30-09:45	**(0132) Artificial Neural Network Modelling of Hydrogen Storage Properties of LaNi4.75Al0.25 alloys based metal hydride vessels** Muhammet Kayfeci, Fevzi Bedir, Umran Elmas
09:45-10:00	**(0130) Gas (H2 and O2) Sensing Performance of ZnGa2O4 Thin Films Depending on Active Deep Energy Levels** Musa Mutlu Can, Shalima Shawuti, Namık Akçay, Gokhan Algun
10:00-10:15	**(0135) Axane Commitment for a Sustainable, Reliable, and Field Proven Power Source though Partnership with Laboratories and Design Efforts** Johan Andre, Marian Chatenet, Frédéric Maillard, Laetitia Dubau, Lionel Flandin, Corine Bas, Gilles De Moor, Olivier Lottin, Eric Claude, Elisabeth Rossinot, Nicolas Caqué
10:15-10:30	**(0160) A Design of Automated HHO System for Optimum Volumetric Efficiency** Mustafa Kaan Baltacioglu, Raif Kenanoglu, Kemal Kaya, Yakup Hames, Ertugrul Baltacioglu
10:30-10:45	**(0172) Effect of Channel Bend in Serpentine Flow Field Design Pattern for PEMFC** Mohammad Ziauddin Chowdhury, Yahya Erkan Akansu, Omer Genc, Serkan Toros, Yusuf Sahin
10:45-11:00	**(0234) Effects of Rice Husk Particle Size on Biohydrogen Production under Solid State Fermentation** Serpil Özmıhçı, Zülfiye Velioğlu Tosuner
11:00-12:00	**World Hydrogen Day and Closing Ceremony**

SCIENTIFIC PROGRAM

HALL - B	
09:00-11:00	**Session 4B: Applications on Hydrogen Energy and Technologies** **Chair: Johan Andre**
09:00-09:15	**(0197) An Investigation of the Mild Flameless Combustion Behaviour of Methane and Hydrogen Fuels under the Various Preheating Levels in a Furnace** Mehmet Salih Cellek
09:15-09:30	**(0173) Numerical Investigation of Conventional Flow Field Patterns in Proton Exchange Membrane Fuel Cell** Mohammad Ziauddin Chowdhury
09:30-09:45	**(0205) Metal-Schiff Base Complex Catalyst in KBH4 Hydrolysis Reaction for Hydrogen Generation** Dilek Kılınc, Ömer Şahin
09:45-10:00	**(0233) Bio-Hydrogen Production from Waste Rice Husk Using Co-Culture** Serpil Özmıhçı, Gülsün Gizem Taylan
10:00-10:15	**(0199) Mathematical Modeling of a Flowing Electrolyte-Direct Methanol Fuel Cell Using Comsol Multiphysics** Omer Faruk Atacan, David Ouellette, Deniz Yımaz, Pasa Yaman, Can Ozgur Colpan
10:15-10:30	**(0042) Development of a Mathematical Model for a HT-PEMFC Stack Based Cogeneration System** Yagmur Nalbant, Can Ozgur Colpan, Yilser Devrim
10:30-10:45	**(0125) Quasistatic Model Based Analysis of Direct Methanol Fuel Cell System for Hybrid Vehicular Applications** Mustafa Umut Karaoğlan, Alper Can Ince, Can Özgür Çolpan, Nusret Sefa Kuralay
10:45-11:00	**(0232) Turkey's Hydrogen Scenario and Hydrogen Production in the Thrace Basin versus Hydrogen Regulations and Standards** Sudi Apak
11:00-12:00	**World Hydrogen Day and Closing Ceremony in Hall A**

KEYNOTE SPEAKERS

KEYNOTE SPEAKERS

Substituted Ceria-based Materials for Applications in Solid Oxide Fuel Cell Electrolytes and Electrodes

Richard Baker

School of Chemistry, University of St Andrews

Partially substituted (or 'doped') cerium oxide materials are of great interest for applications in SOFC components. By the careful choice of dopant identity and quantity, doped cerias can be endowed with very high oxygen ion conductivity, electronic conductivity, catalytic activity for reduction-oxidation and reforming reactions, or a combination of all three. We have developed methods for the preparation of high purity doped cerias with nanoscale particles. Impurities – even a few ppm of Si – have a strongly deleterious effect on ionic conductivity at grain boundaries while high surface area nanoparticles are desirable for applications in SOFC anodes where the material must catalyse the fuel oxidation, or reforming, reaction. This presentation will review our very recent work in which two sets of ceria-based materials were prepared for application either as electrolytes or as anode materials in SOFCs. First, the effect of multiple doping of ceria with combinations of Gd, Nd and Sm on oxygen ion conductivity, materials microstructure and, therefore, suitability for use in SOFC electrolytes will be described. A composition was found which shows better performance at intermediate temperatures than singly Gd- or Sm-doped cerias. Second, the use of nanostructured doped cerias, with and without addition of an active metal function, as anode catalysts will be covered and the important effect of preparation method on ultimate performance will be highlighted.

Recent Development in Hydrogen Separation and Purification through Pd-based Membrane Systems

Wei Hsin Chen

National Cheng Kung University, Distinguished Professor, Department of Aeronautics and Astronautics

Global climate change and fossil fuel depletion have driven the need to shift energy use from the conventional carbon cycle to hydrogen cycle. One of the prime advantages of consuming hydrogen as a fuel is zero emissions of carbon dioxide and other pollutants. Hydrogen can be produced from fossil fuels, biomass, and hydrocarbons. However, in most conversion processes, hydrogen-rich gases rather than pure hydrogen are produced. When hydrogen is separated from hydrogen-rich gases using membranes, palladium (Pd) has demonstrated its excellent features of high hydrogen permeability and selectivity. In addition to hydrogen separation and purification, Pd-based membranes can also be thought of as a potential tool to fulfill CO2 capture. In this talk, recent development in hydrogen separation and purification in Pd-based membrane systems such as hydrogen permeation, concentration polarization, and membrane permeance measurement will be introduced. The interfacial and bulk mass transfer phenomena of hydrogen in Pd-based membrane system will be underlined. The presentation will also show hydrogen permeation in Pd membrane tube systems approached by computational fluid dynamics (CFD), demonstrating the potential of simulations as a tool to aid in membrane system designs.

KEYNOTE SPEAKERS

Current status of hydrogen and fuel cells in Norway

Bruno G. Pollet
Norwegian University of Science and Technology (NTNU)

Norway's strategy is structured around five closely interrelated themes addressing: (i) energy supply security, (ii) a fully-integrated energy market, (iii) energy efficiency, (iv) decarbonising the economy and (v) research, innovation and competitiveness. Climate change is one of the policy priorities of Norway. The country is a heavy producer of renewable energy and electricity generation that originate almost entirely from hydroelectric power plants (over 99%). There is also a large potential in wind power, offshore wind power and wave power, as well as the production of bio-energy from biomass. Although, Norway has limited resources in solar energy, it is one of the world's largest producers of solar grade silicon and silicon solar cells. Hydrogen Energy has been identified by Norway as an alternative fuel with the potential for a substantial contribution to reduce petroleum dependence and greenhouse gases emissions in the long term. The Norwegian government supports the potential role of hydrogen for Norway in the transition to a zero-emission society [1,2]. In line with the EU, Hydrogen and Fuel Cell Technologies (HFCTs) have been identified as a key area of research priority for Norway [1-3]. For example, the White Paper on Norway's energy policy [2] explicitly describes the national hydrogen priorities, which focus on research and development within production, storage and use of hydrogen. Indeed, among the renewable energy sources, HFCTs are considered as a key technology of the 21st century, not only because of its high efficiency in heat and electricity generation, but also because of its potential role in attaining sustainable energy system. It is also envisaged that HFCT will be integrated into "intelligent" energy networks, with conventional and distributed renewable electricity systems. Also, they enable flexible and adaptable fueling strategies, according to local resources, with fossil, bio-fuels or synthetic fuels to reduce impact on air pollution and climate change. For a few years, Norway has put significant effort in HFCT R&D through national and international projects as well as in implementing a hydrogen infrastructure. This presentation will highlight the main HFCT projects in Norway.

ORAL ABSTRACTS

ORAL ABSTRACTS

[**Abstract:0004**]

Hydrogen Production by Agar-immobilized R. Capsulatus in Panel Photobioreactor

Kamal Elkahlout[1], Emrah Sagir[2], Siamak Alipour[3], Harun Koku[4], Ufuk Gunduz[2], Inci Eroglu[4], Meral Yucel[2]

[1]Department of Biology and Biotechnology, Islamic University of Gaza, Gaza, Palestine
[2]Department of Biological Sciences, Middle East Technical University, Ankara, Turkey
[3]Department of Chemical Engineering, Faculty of Engineering, University of Maragheh, Maragheh, Iran
[4]Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Hydrogen represents an ideal alternative energy carrier that can fill all the conditions for clean, renewable and even locally produced energy resources. Intensive works were done and still on hydrogen energy systems including production methods. Biological hydrogen production is attractive since biological methods can use cheap and renewable resources for hydrogen production. Photosynthetic bacteria are balanced for hydrogen production as they can produce hydrogen by consumption of wide spectrum of substrates.

The need for elongation the working time of hydrogen production system with stability leads to introduce immobilization technology media in the process. Agar represents a good choice for immobilizing photosynthetic bacteria for hydrogen production.

In this study a novel panel photo-bioreactor was constructed from Plexiglas with a network of nylon fabric support for agar immobilized bacteria complex. The empty volume of the reactor was 1.4 liter. Two strains of Rhodobacter capsulatus DSM 1710 wild type strain and R.capsulatus YO3 (R. capsulatus MT1131 uptake hydrogenase deleted mutant strain) with a cell concentration of 5mg dcw.mL-1agar were entrapped with 4%(w/v) of agar. Four reactors (2 reactors for each strain) were operated in sequential batch mode on hydrogen producing medium containing 60mM acetate and 4mM glutamate as carbon and nitrogen sources. The reactor was illuminated from both sides with tungsten lamps with a light intensity of 200 W/m2 and thermo-stated at 30 0C by external fans. Before each batch the system was flushed with argon gas for producing anaerobic environment. The system was allowed to operate for long period of time extended around 107 days. Best hydrogen capacities were obtained by R.capsulatus YO3 strain which was continued working for 10 sequential batches for 95 days. Total hydrogen produced by this strain was calculated on the base of 10 batches as average of total hydrogen produced per one batch and it was around 4.6 liters of hydrogen per liter culture. The highest hydrogen productivity was 22.4 mL H2/L/h. The highest hydrogen productivity of 17 mL H2/L/h was obtained by DSM1710. The maximum calculated hydrogen yield was 3.6 and 2.8 mmol H2/mmol acetate based on the initial substrate concentration by YO3 and DSM1710 strains. pH was stable and around 7.5 during the process. Illumination of the reactors from both sides was observed to enhance hydrogen production capacity of immobilized bacteria in both strains.

The results demonstrate that the agar immobilized PNSB in panel photo-bioreactors can be promising systems for long-term hydrogen production.

Keywords: Hydrogen production, Photobioreactor, Cell immobilization, Rhodobacter capsulatus

ORAL ABSTRACTS

[**Abstract:0005**]

A Field Application of a Fuel Cell Micro Cogeneration Unit

***Cigdem Karadag*[1], *Atilla Ersöz*[1], *Fatma Gül Boyacı San*[1], *Betül Erdör Türk*[1], *Emin Okumuş*[1], *Egemen Akar*[1], *Nilüfer Topuz*[1], *Salih Obut*[1], *Özgür Can Kokmaz*[1], *Osman Okur*[1], *Derya Aydemir*[2]**

[1]*TÜBİTAK Marmara Research Center, Energy Institute, Gebze/Kocaeli, Turkey*
[2]*Republic of Turkey Ministry of Energy and Natural Resources General Directorate of Renewable Energy, Çankaya/Ankara, Turkey*

In this study, the production process of hydrogen rich gas using natural gas as a feedstock has been investigated for a fuel processing system including autothermal reformer, water gas shift (WGS) (high and low temperature) and preferential oxidation reactors. The resulting gas stream has been introduced to a low temperature fuel cell unit. These two main process parts have been integrated as a 2 kWe micro cogeneration unit as a whole. In the process, the raw natural gas is cleaned, its hydrocarbon content is reformed, CO (carbon monoxide) content is shifted (via WGS reactor) and finally H2 rich stream is fed to a low temperature PEM fuel cell unit. The major challenge of this process is to decrease the CO composition to ppm levels as low as possible (10 – 20 ppm). The design of the fuel cell stack components (bipolar plate and membrane electrode assembly) has been performed. The bipolar plates with a novel flow field design have been produced. The preliminary single cell performance tests have been performed for 225 cm2 active area. The composition of hydrogen rich gas (0.95 % H2O, 44.47 % H2, 0.00065 % CO, 15.86 % CO2, 3.02 % CH4, and 35.69 % N2) has been determined as the preliminary results of the ASPEN HYSYS conceptual process simulation model. The first simulation results show that the hydrogen production rate is about 0.22 kgH2/h for a 2 kWe fuel cell unit application. The mass lower heating value (LVHmass) of the product gas before fuel cell unit has been calculated about 7115 kj/kg and the overall fuel processor efficiency has been found as ~87 %. The required parametric studies have been completed for the conceptual design of a whole micro cogeneration unit. A fuel cell based cogeneration system requires power conditioning and control units which are responsible for power DC to AC power conversion and chemical process management. This study also focuses on a real time embedded control system unit which is designed for both hydrogen reformer/fuel cell and data acquisition of the power converter. An embedded data acquisition and control system has been designed to provide a self-regulated process of the hydrogen reformer unit. The critical parameters like temperature, pressure, mass flow, etc. will be monitored in real time data acquisition and control system via a modular and flexible control platform. According to the real time output values of the sensors, the process and the power flow will be managed properly by adaptive control algorithms. This work is a part of a national project entitled "A Field Application of a Fuel Cell Micro Cogeneration Unit" supported by ETKB YEGM (Republic of Turkey Ministry of Energy and Natural Resources General Directorate of Renewable Energy).

Keywords: Reforming, hydrogen, fuel cell, PEM, micro cogeneration

ORAL ABSTRACTS

[**Abstract:0007**]

H2 Adsorption on Cu(I)-ZSM-5: Exploration of Cu(I)-exchange in Solution

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Hydrogen fuel cell vehicles has gained significant interest due to the zero carbon emmissions they result. Currently these vehicles run on compressed hydrogen that is stored at 70 MPa. Due to the volume and safety concerns, lightweight and economical onboard hydrogen storage systems are needed with a target hydrogen storage capacity of 5.5 wt.%. Adsorption onto nanoporous adsorbent materials can provide economical and safe ways of storage with increased storage capacities at moderate pressures. These materials should have high pore volumes and show optimum hydrogen binding energy to store H2 in adequate amounts and release H2 easily. The optimum H2 binding energy for maximum H2 storage at room temperature and easy desorption from adsorbents is calculated by Garrone et al. to be between 22 and 25 kJ mol/ H2. Metal organic frameworks and activated carbon show H2 adsorption enthalpies between -4 and -12 kJ mol/ H2, which results in low H2 adsorption capacities at room temperature. Cu(I)- zeolites, on the other hand, were reported to reach capacities reaching 0.4 H2/Cu (0.216 mmol H2/g) at 298 K and 1 bar pressure with isosteric heat of H2 adsorption in the range of 39–73 kJ mol/ H2.

The observed high H2 adsorption enthalpies were explained theoretically by favored Cu(I) (3dπ)→H2 (σ*) back donation on Cu(I)-zeolites. Cu(I)-exchange of zeolites are often performed using solid-state or vapour phase exchange of CuCl with H+ form of the zeolite, which is reported to result in Cl residuals inside the pores. Extra Cl content of the zeolite is not preferred since it can obstruct the zeolite pore entrances and renders Cu(I) site characterization more difficult.

In this report, we are demonstrating a solution based Cu(I) exchange using CuCl-acetonitrile solutions. The preliminary ZSM-5 samples showed that H+-ZSM-5 was successfully (Cl free) exchanged with Cu(I) with a Cu(I)/Al ratio of 0.52. Initial heat of H2 adsorption for Cl-free Cu(I)-ZSM-5 was found to be -35 kJ/ mol H2 at 323 K with H2 storage capacity of 0.235 mmol H2/g at 1 bar pressure. Cu(I)-exchange was also performed on a [B]-ZSM-5 but the diffusion of plausible Cu(I)-acetonitrile complexes through the zeolite pores were found to be limited. For this reason, Cu(I)-exchange of mesopore added ZSM-5 and [B]-ZSM-5 samples in liquid media will be optimized to achieve homogeneously distributed Cu(I) cations inside the pores without any Cl content and prepared samples will be tested for H2 adsorption at 323 K.

Keywords: hydrogen, Cu(I), zeolite, mesoporous

ORAL ABSTRACTS

[**Abstract:0013**]

Effect Of Bipolar Plate Gas Flow Channel Pattern On Proton Exchange Membrane Fuel Cells Performance

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In recent years, increasing population growth is increasing in energy consumption. The need for energy has led scientists to explore new energy sources. Fuel cell technology has been at the forefront of these energy sources. Fuel cell technology is used in many industries because it is long lasting, quiet, wide application area, zero emission and high efficiency. In this study, the bipolar plate gas flow channel design pattern, one of the parameters affecting the fuel cell performance curve, was investigated. The effect of fuel cell performance was investigated by using three-dimensional computational fluid dynamics (CFD). For this purpose, 3 different gas flow channels design (serpentine type, parallel type and custom design) has been identified. In this context, bipolar plate anode and cathode flow channel geometry on 50 cm2 active area were modeled in three dimensions and single cell solutions were made with Ansys Fluent PEMFC module. In simulation, humidification, reactant feed pressure, temperature, cell width and channel height parameters were kept constant and the effect of different gas flow channel designs on performance was investigated. Analyzes made have determined the pressure distribution, temperature, reactant concentrations and polarization curve. After, a fuel cell experiment was conducted. In the experiment, hydrogen and air were used as the reactant gas. Fuel cell experiments on 50cm2 active area were made with test station and polarization curves were plotted according to current and voltage data. The physical validity of the computational fluid dynamics model was compared and improved with the data obtained in the experiment. The model's validity, the consistency of the data, and the reliability are shown experiments result.

Keywords: Flow Channel Patterns, Numerical Solution, Ansys Fluent, Bipolar Plate Channel Geometry, CFD

[**Abstract:0014**]

Microwave Assisted Synthesis of Pt/MWCNT Catalyst for High Temperature PEM Fuel Cell

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In this study, the preparation of Pt catalyst on Multi Walled Carbon Nanotube (MWCNT) support material was prepared by Microwave Synthesis Method high temperature PEM fuel cell (HTPEMFC) applications. Prepared catalyst was analyzed with X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), BET surface area analysis and corrosion tests. 30 % Pt loading was observed on the MWCNT support material. Gas diffusion electrodes (GDE) were fabricated by an ultrasonic coating technique with Pt/MWCNT catalyst. Polybenzimidazole membrane based Membrane Electrode Assembly (MEA) was prepared for observe the HT-PEM fuel cell performance of the Pt/MWCNT catalyst. The MEA was tested in a single HT-PEMFC with a 5 cm2 active area at 160oC without humidification. A comparison of their performance with the commercial Pt/C catalyst is also presented. The experimental results suggested that the Pt/MWCNT catalyst is promising catalyst options for HT-PEMFC applications.

Keywords: Pt catalyst, MWCNT, HTPEMFC, Microwave Synthesis Method

ORAL ABSTRACTS

[**Abstract:0015**]

Turkey's hydrogen scenario and Hydrogen production in the Thrace Basin versus hydrogen regulations and standards

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Access to cheap energy is vital to economic growth. It is well known that energy will be a blade runner issue for the 2050s world. The idea of renewable energy has been a hot topic in recent years, as it has been heavily debated in both the business and investing world. But, today technological race is between volatile fossil fuels such as natural gas and renewable energy sources. Nowadays, an attractive environmental framework has been established in Turkey for the development of renewable energy. This has resulted in a strong increase of investors' interest, especially in the Thrace Basin mainly due to their renewable energy potential related to recently natural gas discovery at the Black sea region.♀

The paper aims to estimate the market share of hydrogen energy products in the economy considering the financial introducing of hydrogen energy investments at Thrace Basin-Istranca area in Turkey. Therefore, hydrogen energy and hydrogen products markets are growing rapidly. Turkey should support investments in the areas of hydrogen energy and technologies that have been developing all over the world. Thus, this research aims to analysis a comprehensive evaluation of the renewable energy in reducing CO2 emissions to environmental protection for the Thrace Basin local area in Turkey.

Renewable energy in the Thrace basin which is a risk-mitigation measure against oil price volatility by replacing conventional generation with arguments in favor of hydrogen energy applications to the local environment commonly framed in terms of economic development and energy security.

Keywords: Thrace basin, The EU, Black sea, hydrogen energy, Agriculture in Thrace.

[**Abstract:0016**]

Development of Effective Cooling System for High Temperature PEM Fuel Cell

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High-temperature Proton Exchange Membrane Fuel cell (HTPEMFC) has gained a lot of attention in recent years. It is due to a number of its unique features, such as higher CO tolerance, faster kinetics and simpler balance-of-plant design as compared to their traditional and low-temperature PEMFC (LTPEMFC). One of the most common problems in HT-PEMFC systems is to be able to produce a system that has the gas and cooling liquid leak-tightness. Effective cooling system is critical for safe and efficient operation of HTPEMFC stacks with high power. The present work is aimed at promoting the development of more effective encapsulated liquid cooling strategies for HTPEMFC stack. Special liquid cooling system was designed to safely circulate this liquid in the system without any leakage. The stack temperature was effectively regulated by the liquid cooling system based on on-off control system. The use of a 10 cell HTPEMFC is demonstrated, with a nominal power of ≈400 W at 0.5 A/cm2. A maximum power of 500 W was obtained from the stack.

Keywords: PEM fuel cell, high temperature, PBI, stack cooling

[**Abstract:0021**]

The Effects of Equivalence Ratio on a Downdraft Plasma Coal Gasifier

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In this paper, a 3D numerical simulation of a downdraft plasma gasifier was conducted. The aim of this study is to investigate the effects of the equivalence ratio (ER) on the syngas properties which is the product of the plasma coal gasification system. The boundary conditions for the air plasma inlet of the reactor were obtained from the outlet of 10 kW microwave plasma generator. The fluid-particle interaction was modeled using Discrete Phase Model (DPM) which tracks the coal particles on a Lagrangian reference frame. Chemical reactions were included using the Species Transport model with the finite-rate/eddy-dissipation turbulence chemistry interaction. The effect of the turbulent flow inside the reactor was added to simulation using standard k-ϵ model. The syngas properties, temperature distribution, and velocity vectors inside and at the outlet of the reactor were evaluated in order to understand the operating conditions and the product properties of the reactor. According to the results with ER=0.45, syngas was obtained from the outlet with a 669 kcal/m^3 heating value. Composition of the syngas, carbon conversion ratio, cold and hot gas efficiencies, and temperature distributions were presented.

Keywords: Plasma, downdraft gasifier, hydrogen, gasification, numerical, modeling

[**Abstract:0023**]

Optimum Energy and Life Cycle Cost Evalautaion of an Advanced Hydrogen Liquefaction Cycle Using Geothermal Power

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In this study, the thermoeconomic approximation is applied to the optimization of a case study a geothermal hydrogen production and liquefaction system. Objective of this application is aimed at minimizing its overall products unit costs (electricity, hydrogen production and hydrogen liquefaction). The approximation is based on the cost optimal exergetic efficieny that is obtained for a componentisolated from the remaining of the stystem components. Objective function that expresses the optimization methodology for each subcomponent of the systemaere developed. In the iterative optimization methodlogy, the variables, relative cost differances, and exergy efficieny with the corresponding optimal values are obtained. Exergoeconomically optimal values for total product cost flow rate, total cost fuel flow rate, cost of electricity, cost of hydrogen production and cost of hydrogen liquefaction are calculated to be 1820 $/h, 274.2 $/h, 0.01908 $/kWh, 1.967 $/kg and 1.095 $/kg respectively, wheras the the corresponding actual base case valus are 3031 $/h, 290 $/h, 34.34 $/h, 0.02076 $/kWh, 2.091 $/kg and 1.725 $/kg respectively.

Keywords: Geothermal energy, hydrogen production, hydrogen liquefaction, thermoeconomic optimization, life cycle cost

[**Abstract:0027**]

In–situ and Downstream Desulfurization Ability of PbO and ZnO During Pyrolysis and Hydrogenation of a High–sulfur Lignite

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This study addresses in situ and downstream sulfur capture ability of lead oxide (PbO) in comparison to zinc oxide (ZnO) during the pyrolysis and hydrogenation of high–sulfur Tuncbilek lignite. Sulfidation reaction thermodynamics of these two compounds was compared to most commonly used metal oxides i.e., FeO, MnO, and CaO. The equilibrium conversions indicated superior performance of PbO and ZnO towards sulfidation reactions at high temperatures. The experimental verification of the high temperature sulfidation ability of PbO and ZnO were performed using Tuncbilek lignite under semibatch conditions. The final compounds formed after each process were observed by X-ray diffractometer (XRD) and Diffuse Reflectance Infrared Fourier Transformation Spectroscopy (DRIFTS). Initial finding of XRD analyses revealed that PbO can be used as hot gas sulfur trap during pyrolysis and hydrogenation processes, while ZnO can hold up sulfur only in the presence of hydrogen. Furthermore, both PbO and ZnO show the superior sulfur capture performance in the presence of hydrogen when they were used as adsorbents located after the reactor (downstream) at ambient conditions.

Keywords: Pyrolysis, hydrogenation, sulfidation of PbO and ZnO

[**Abstract:0028**]

Maturity Impact on Hydrogen Production from Natural Gas and Coal: Examples from Dadaş Shale and Zonguldak Coals

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98% of the hydrogen production is made by natural gas reforming and coal gasification. Simplifed formules are CH4 + ½O2 → CO + 2H2 (+ heat), CH0.8 + O2 + H2O → CO + CO2 + H2 and CO + H2O → CO2 + H2 (+heat). Thus, carbon and hydrogen contents of the natural gas and coals are very important to hydrogen production and low carbon dioxide gas emission. According to organic geochemical studies, increase in the maturity of shale (gas source rock) and coal with Time-Temperuture Index cause to decrase of Total Organic Carbon (TOC) and Hydrogene Index (HI). For example, maturity increase in the Dadaş shale and Zonguldak coals were caused to decrease in the TOC and HI. In addition, HI has recently been used to maturity indicator of oil and gas (biogenic gas, wet gas-condensate and dry gas) generation from shale and coals.

Keywords: Maturity, Hydrogen Production, Natural Gas, Coal

ORAL ABSTRACTS

[**Abstract:0030**]

Investigation of a Solar Driven Integrated TEG with PEM Electrolyzer System for Hydrogen Production

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In this study, an integrated, solar thermal driven system is developed for hydrogen, electricity and hot water production and thermodynamically analyzed. The proposed system consists of a solar dish collector, latent heat storage subsystem, proton exchange membrane (PEM) electrolyzer, thermoelectric generator (TEG) and hydrogen storage medium. The TEG unit is sandwiched between the latent heat storage and the heat exchanger. The water is pumped from a reservoir to a heat exchanger where it is heated before electrolysis to improve the overall system performance with a novel configuration, consisting a solar dish collector and a thermoelectric generator embedded with a heat exchanger. First, as the water passes through the heat exchanger and is heated up, the electrolyzer efficiency increases and results in higher hydrogen yield. Secondly, the thermal energy storage (TES) system provides the energy supply to the system, which allows the system being operated without interruption for the period when the solar irradiance is unavailable. Thirdly, as the thermoelectric generator rejects heat to the water, a temperature gradient is created on the TEG`s legs, hence the induced thermoelectricity and heat to electricity efficiency of the TEG increases. The fourth benefit of the solar subsystem is the availability of adjusting the system`s operating range. Since the solar irradiance is not directly focused on the TEG but the latent heat storage system, the thermoelectric device is prevented from overheating which may lead burning or malfunctioning of the instrument. By arranging the type and amount of phase change material in the TES system, it is possible to regulate the working range of the thermoelectric generator. Since the phase change of a material occurs under constant temperature, the temperature fluctuations due to the variation of solar irradiance can be avoided by the presence of the PCM. Thus, the voltage variations generated by the TEG are avoided. After the water leaves the heat exchanger, it enters the PEM electrolyzer for water splitting. The electricity needed for the PEM electrolyzer is supplied by the TEG. While the produced hydrogen is sent to a storage medium, unreacted excessive hot water is sent to the residential heating subsystem. NaOH is selected as the phase change substance and Bi2Te3 is chosen for the TEG. The COMSOL Multiphysics software package is used for the numerical modelling of the thermoelectric generator. The remaining elements of the integrated system are analyzed in Engineering Equation Solver (EES). The overall energy and exergy efficiencies of each system component are determined, and H2, hot water and electric power generation capacity of the system is then calculated. Moreover, a parametric study is conducted to determine the influence of the operating temperature, environmental conditions and selected heat storage compound on the system performance.

Keywords: Hydrogen production, power production, solar energy, thermoelectric generator, thermal energy storage, efficiency

[**Abstract:0031**]

IInvestigation of Hydrogen Production through Thermochemical Cycles

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Hydrogen is one of the most promising fuel options for the future and it is considered as a green energy carrier. Clean and sustainable hydrogen production has become very important nowadays. Thus, thermochemical or hybrid cycles, one of the methods of sustainable hydrogen production, has begun to gain importance in recent years. In this study, we investigated of hydrogen production for sustainable methods. In this regard, the most commonly worked cycles in literature which are the magnesium chlorine (Mg- Cl), copper chlorine (Cu-Cl) and sulfur iodine (S-I) thermochemical cycles have been reviewed for hydrogen production. The general energy and exergy efficiencies of these cycles are presented as in the form of Tables. Also, hydrogen production with these cycle are discussed and presented in terms of the pros and cons.

Keywords: hydrogen, thermochemical cycle, Mg-Cl, Cu-Cl, S-I

[**Abstract:0037**]

Comparison of Alcohol Electro-oxidation in Alkaline Medium

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Direct alcohol fuel cells (DAFCs) are most promising renewable and clean energy devices for portable applications due to numerous advantages over similar devices fed with hydrogen. Alcohols, such as methanol, ethanol, and ethylene glycol exhibit high volumetric energy density, and their storage and transport are much easier than hydrogen. However, the oxidation kinetics of the alcohols is much slower than hydrogen fueled polymer electrolyte fuel cells. Therefore, remarkable efforts have been made to discover more effective electrocatalysts for DAFCs. In this case, numerous work has been done to study the electrooxidation of alcohol on Pt-based catalysts in alkaline medium. Palladium could be a good candidate as catalyst due to many advantages such as, less expensive, higher activity and more resistant to poisoning species than Pt. Pd-based catalysts with different structures have been investigated by many research groups to improve the activity and stability towards alcohol oxidation. These researches have shown that bimetallic catalysts could be preferred with improved electrocatalytic activies than monometallic catalysts. Moreover, core-shell structures with noble metal shells are of great importance in chemical catalysis due to their enhancing properties to substrate oxidation. In the present study, the oxidation reaction was investigated in order to compare the activity of catalysts for different alcohols. The electrocatalytic activity of the both core –shell and bulk alloy palladium-based catalysts toward oxidation reaction has been examined by electrochemical techniques such as cyclic voltammetry, chronoamperometry, electrochemical impedance spectroscopy.

Keywords: Alcohol electro-oxidation, methanol, ethanol, ethylene glycol

[Abstract:0038]

Electrocatalytic Performance of Pd Based Bimetallic Catalysts for Methanol Oxidation Reaction

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Nanotechnology can offer clean solutions about generation, storage and utilization of energy. Nanomaterials are utilized as catalysts in fuel cells being favorable sources of direct electricity generation for electronic devices and transportation. Direct methanol fuel cells (DMFCs) have the advantageous to convert chemical fuels to electricity with high efficiency. Methanol oxidation reaction is the main reaction occurring in the anode of a DMFC. It is well known that Pt is considered as the most efficient catalysts for the electro-oxidation of methanol. However, the main problem encountered in DMFCs is the loss of active sites due to CO poisoning of the catalysts and high cost of Pt would restrict their applications. Thus, development of more efficient and durable nanocatalysts is required. Therefore, a great deal of research has been focused on improving the catalyst performance for methanol electro-oxidation. Different methods have been adopted to increase the catalysts activity and reduce the Pt loadings in DMFC. Also, several non-platinum catalysts have recently been synthesized to overcome the above problems. For this aim, palladium could be utilized as electrocatalyst with significant electrocatalytic activity. Bimetallic catalysts could be preferred with enhanced electrocatalytic activies than monometallic ones. The activity of catalysts could be also improved by the core-shell structures. Moreover, core-shell nanoparticles with thin noble metal shells are of great importance in chemical catalysis due to their enhancing properties to substrate oxidation. In this study, the electrocatalytic activity of the both core-shell and alloy palladium-based catalysts toward the methanol oxidation reaction has been examined by electrochemical techniques.

Keywords: Bimetallic catalysts, methanol electro-oxidation, fuel cells

[Abstract:0039]

Structure Sensitivity of Direct Alcohol Electrooxidation Reaction Catalysts

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Over the last few decades, advanced catalysts have been extensively studied to increase the catalyst activity in fuel cell applications. Especially, bimetallic nanoparticles with core-shell structures composed of two distinct metal elements display enhanced catalytic properties due to the lattice strain formed between the core and shell regions. By changing their components and morphologies, their relevant physical, electrical, or chemical performances can be modified. Nanoparticles with different shapes and structures usually display differ¬ent activity and selectivity. Generally, these structures can improve the activity of the catalysts. Core-shell structures exhibit properties distinct from their alloy structures. Different analytical techniques can be employed to characterize the nanostructure of the core–shell particles. Comparison of different techniques is necessary in order to determine the overall structure. In this study, the structural characterization of Pd and Pt based bimetallic and trimetallic catalysts evaluated by BET, SAXS, XRD, SEM-EDS, TEM, and chemisorption analysis. Surface morphologies and particle size of these catalysts were determined and related the electrocatalytic activities. In conclusion, one could note that there is strong structure sensitivity for alcohol electrooxidation reaction for these catalysts.

Keywords: alcohol oxidation, structure sensitivity, fuel cells

[**Abstract:0040**]

Bimetallic Particles for Ethanol Electro-oxidation

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Electrocatalytic energy conversion plays an important role in the development of sustainable energy technologies for decreasing consumption of fossil fuels. The development of alternative power sources is an important issue at present. In this case, direct alcohol fuel cells (DAFCs) have attracted considerable interest for mobile applications such as electric vehicles and other portable devices. Among several fuels which can be used in DAFCs, ethanol is the most promising fuel due to its safety and high energy density. Moreover, it can be produced from agricultural products and fermentation of biomass.

Platinum (Pt) based catalysts can be utilized for electro-oxidation of ethanol due to its high activity and stability. However, it is required to develop better catalysts for ethanol oxidation due to the slow reaction kinetics and electrode poisoning. In this case, palladium (Pd) has better electrocatalytic activity than Pt. Although Pd has been known to be a suitable catalyst for electrooxidation of ethanol in alkaline media, it is required to improve the catalytic activities of the catalyst to form alloy structures. In this study, the electrocatalytic activity of the different bimetallic nanoparticles toward the ethanol oxidation reaction has been investigated by cyclic voltammetry, chronoamperometry, electrochemical impedance spectroscopy techniques in alkaline media.

Keywords: Bimetallic nanoparticles, ethanol electro-oxidation, fuel cells.

[**Abstract:0041**]

Exergoeconomic Analysis and Optimization of a Concentrated Sunlight-based Integrated Photoelectrochemical Hydrogen and Ammonia Production System

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This work presents a comprehensive study on exergoeconomic analysis and optimization of an integrated system for photoelectrochemical (PEC) hydrogen and electrochemical ammonia production. The integrated system consists of a solar concentrator, spectrum splitting mirrors, a photoelectrochemical (PEC) hydrogen reactor, a photovoltaic (PV) module, an electrochemical ammonia reactor and support mechanisms. Thermodynamic and exergoeconomic analyses are initially conducted to determine the performance of the integrated system namely; efficiency and total cost rate. The obtained performance parameters are then optimized to yield the minimum cost rate and maximum efficiency under given constraints of the experimental system. The highest capital costs are observed in photoelectrochemical hydrogen and electrochemical ammonia reactors because of high procurement costs and electricity inputs. The optimized values for exergy efficiency of the integrated system range from 5% to 9.6%. The overall efficiencies are mainly affected by the photovoltaic (PV) and photoelectrochemical (PEC) cell areas and solar light illumination. The optimum efficiencies are found to be 8.7% and 5% for the multi-objective optimization of hydrogen production and integrated ammonia production systems, respectively. When the exergy efficiency of the integrated system is maximized and total cost rate is minimized at the same time, the total cost rate of the system is calculated to be about 0.2 $/h. The sensitivity analysis results show that the total cost rate of the system is mostly affected by the interest rate and lifetime of the system.

Keywords: Hydrogen, ammonia, photoelectrochemical process, concentrated sunlight, exergoeconomics, optimization

Abstract:0042]

Development of a Mathematical Model for a HT-PEMFC Stack Based Cogeneration System

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High temperature-proton exchange membrane fuel cells (HT-PEMFC) operating between 160°C and 200°C are suitable for cogeneration applications in which electricity and hot water are produced. In this study, a mathematical model of a cogeneration system, which includes an ethylene glycol cooled HT-PEMFC stack, a heat exchanger, and a pump, is developed. The stack is fed with a reformate gas (hydrogen and carbon monoxide) at the anode side and humidified air at the cathode side. This model is based on a one-dimensional and semi-empirical fuel cell model and simple thermodynamic model for the heat exchanger. This model is validated using in-house experimental data. The effects of anode and cathode stoichiometry ratios on the electrical and cogeneration efficiencies are examined. In addition, the average temperature of hot water obtained is calculated for each month for a case study.

Keywords: High temperature-proton exchange membrane fuel cell, semi-empirical, cogeneration, mathematical model.

[**Abstract:0044**]

Thermodynamic and Economic Analyses of a Renewable Energy Based Hydrogen Production System

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We have been facing drastic issues as a result of conventional energy sources and their ultimate environmental impacts. Renewable energy sources with hydrogen as an energy carrier are considered promising alternatives to overcome such issues. Integrating hydrogen energy systems with renewable energy sources is a rational way to supply energy demand and therefore to vanquish environmental issues, such as global warming and increased CO_2 emissions. In the current study, both solar and wind energies are employed to provide the required electric power for a university campus, as included, and an electrolyzer system in order to produce hydrogen. The hydrogen produced by the electrolyzer is utilized as fuel in stationary cogeneration units and fuel cell vehicles. In this way, a renewable energy based university campus is established. Furthermore, hydrogen energy carriers such as methylcyclohexane, ammonia, and formic acid, which are proposed among promising solutions to store hydrogen are evaluated and compared technically and economically. The current integrated system is analyzed thermodynamically and economically to assess its performance. It is aimed to compare the results with the conventional systems to show its advantages through calculation of electricity cost per kWh and hydrogen cost per liter. The results show how to establish a smart university campus where the energy is provided by renewable sources in a more efficient and sustainable way.

Keywords: Hydrogen Production, Solar energy, Wind energy, Electrolyzer, Fuel cell vehicle

ORAL ABSTRACTS

[**Abstract:0047**]

Thermodynamic Performance Assessment of Integrated Solar Energy System with Hydrogen Production

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In this paper, the thermodynamic performance analysis of solar energy based integrated system with hydrogen production is investigated. This multigeneration system is consisted of seven main sub-systems, such as i-) parabolic collector system, ii-) Rankine cycle with two turbines, iii-) ORC with two turbines, iv-) hydrogen production and storage system, v-) drying process, vi-) heat pump process, and vii-) double effect absorption cooling system, for power, hydrogen, heating, cooling, drying and hot water production. In addition to that, the effects of some design parameters and reference temperature on the exergetic performance and exergy destruction rate for solar energy based integrated system with hydrogen production are investigated. The energy and exergy efficiencies of multigeneration system are calculated as 54.87% and 48.24%, respectively

Keywords: Solar energy, hydrogen, integrated system, thermodynamic analysis, design parameters.

[**Abstract:0050**]

Effect of Operational Variables on Biological Hydrogen Production by Dark Fermentation from Palm Oil Mill Effluent Using Response Surface Methodology

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In this study, batch experiments were carried out to assess the effects of four operational variables on biological hydrogen production by dark fermentation from palm oil mill effluent. Response surface methodology (RSM) was applied to investigate the effects of the studied factors on biohydrogen production. The range of the significant independent variables for the process was selected as pH (5, 5.5, and 6), temperature (30◦C, 35◦C, and 40◦C), substrate concentration (5000, 12500, and 20000 mg. L-1), and ISRs of 2, 0.8, and 0.5 with the concentration of 10000 mg. L-1 VSS. Upon seeing each interval, the results were compared. The highest COD removal, hydrogen percentage, and hydrogen yield were obtained 58.3%, 80%, and 4.83 molH2/mole consumed COD, respectively in 24 h incubation time. Monod and modified Gompertz model were studied to calculate the kinetic parameters for organic removal rate and hydrogen production.

Keywords: Biological treatment, hydrogen production, COD removal, Monod model, Gompertz model

ORAL ABSTRACTS

[**Abstract:0053**]

Multi-Objective Evolutionary Polynomial Regression Technique in Prediction of Bio-Hydrogen Production by Dark Fermentation Process

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The present study demonstrates the multi- objective evolutionary polynomial regression methodology prediction (EPR-MOGA) of the operational parameters performances on biological hydrogen production from palm oil mill effluent (POME). For each parameter, a model was considered to predict the response process values including COD removal, hydrogen percentage (H2 %) and hydrogen yield (HY). Five models were implemented and compared. The input variables were considered with the range of pH (5, 5.5, and 6), temperature (30◦C, 35◦C, and 40◦C), substrate concentration (5000, 12500, and 20000 mg.L-1), and inoculum volume (20, 25, and 30 ml with the concentration of 10000 mg.L-1 VSS). Coefficients of determination values (CoD) for models was varied between 0.21-0.96, 0.58-0.99 and 0-0.77 for COD removal, hydrogen percentage and hydrogen yield, respectively. The projected models were assessed based on root mean square error (RMSE), mean absolute percentage error (MAPE), scatter index (SI) and BIAS as well. Also, a partial derivative sensitivity analysis was employed to assess the effect of each variable in prediction of COD%, H2%, HY. The prediction uncertainty width band of COD%, H2%, HY was quantified and found to be -0.27, -0.52 and -0.09 for model 1, respectively. The experimental results indicate that the proposed EPR-MOGA model 1 is superior compared to other models.

Keywords: Biological hydrogen production, Dark fermentation, Evolutionary polynomial regression technique, COD removal, palm oil mill effluent

ORAL ABSTRACTS

[**Abstract:0057**]

The Effect of Co-catalyst and Novel Heterogeneous Active Photocatalysts for Hydrogen Evolution Under Solar Energy

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In recent years, heterogeneous photocatalysts has received much research interest because of its powerful potential applications in clean energy production and environmental remediation. The heterogeneous photocatalysts for hydrogen evolution from water by using solar energy need to decrease active and stable co-catalysts using of expensive and rare elements.Transition metals including chalcogenides (CdS, ZnS etc.) have long time been one of the most promising inorganic photocatalysts for hydrogen production[1, 2]. However, the photo-corrosion, recombination rates and efficient charge transfers of these photocatalysts are the most serious problems which constrains its development. Here, we report the design and fabrication of reduced graphene oxide (RGO) doped-cadmiumzincsulfide (RGO-Cd0.6Zn0.4S) nanocomposite by using solvothermal method. Synthesized nanocomposite loaded with different noble metals (Ru, Rh, Pt) as co-catalyst via photodeposition. The heterogeneous photocatalysts were characterized with SEM, TEM, XRD and UV-Vis diffuse reflectance spectroscopy. The obtained photocatalyst were tested in photocatalytic reactor for photocatalytic hydrogen production and investigated effect of co-catalyst on photoactivity.

Acknowledgement: We thank to The Scientific and Technological Research Council of Turkey (TUBITAK, Project Number: 116M567) for its financial support.

Keywords: Heterogeneous photocatalyst, Hydrogen production, Solar energy, Reduced graphene oxide.

ORAL ABSTRACTS

[**Abstract:0060**]

Hydrogen Production from Water as Photoelectrochemical by Using Solar Light Irradiation

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The ever increasing population and growing demand of energy, we cannot rely on exhaustible energy resources anymore. Introducing Hydrogen as a sustainable, and trustworthy energy carrier and its production through Photoelectrochemical (PEC) reactions, was an important development. The reported in literature, doping of ZnS with transition metal cations improves the absorbance of ZnS in visible region of light. Cd1−xZnxS, which is the solid solution of CdS and ZnS, has controllable band structure and excellent performance under visible light irradiation [1, 2]. But desired efficiency of Cd1−xZnxS is still a milestone to reach. On contrary, a strictly two-dimensional material, graphene oxide, possesses exceptionally high crystal and electronic quality, improved effective electron transfers and exhibits enhancement of specific surface area. We synthesized, which Cd1−xZnxS photocatalysts supported GO and/or rGO by sulphurization method for obtain photo-electrodes possess higher photoelectrochemical responses such as a higher anodic photo-current density, and a higher solar to hydrogen conversion efficiency under visible light irradiation. Obtained photo-electrodes were tested for hydrogen production from water as photoelectrochemical under solar light irradiation and photoelectrochemical hydrogen production system was optimized with respect to all system components.

Acknowledgement: We thank to The Scientific and Technological Research Council of Turkey (TUBITAK, Project Number: 116M567) for its financial support.

Keywords: Photocatalyst, Hydrogen production, Solar energy, photo-electrodes, photoelectrochemistry.

[**Abstract:0061**]

Hydrogen Storage Capacity Investigations of Pd Loading Ratio on MW-CNTs via Supercritical Fluid Deposition Method

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The high energy density and light weight of molecular hydrogen makes it an attractive alternative energy carrier against fossil fuels for mobile and static technologies. However, its storage is one of the primary problems for daily usage applications due to the poor volumetric energy density of hydrogen. Especially, the need for safe and effective hydrogen storage at ambient temperature and pressures emerge. For this purpose, carbon based materials are promising with their low densities and wide diversity in structural forms. Among them, with their high surface-to-volume ratios, high stabilities, and good gas adsorption properties, carbon nanotubes (CNT) are considered as good candidates to fulfil this need. When hydrogen adsorption on pristine CNTs at moderate temperature and pressures are investigated, it is found that hydrogen can only be captured at the surface of the materials. However, when doped with certain transition ions, the hydrogen adsorption capacity increases exponentially because of spillover process which is described in the literature as the dissociation of dihydrogen on the metal, resulting in migration of hydrogen atoms through the metal particles and diffusion on the carbon nanotube supports. Pd is known to be one of the effective transition metals to observe this effect if properly dispersed on CNT. Here deposition method of Pd gains importance since the degree of dispersion and consequently particle size distribution. Among different methods, supercritical carbon dioxide (scCO2) deposition is relatively new, environmentally friendly and powerful method to prepare well-dispersed nanoparticles among these techniques. Moreover, it enables an easy control on the nanoscale particle shape and size with desirable dispersion. The precursor and reduction conditions are as important as applied temperature and pressure during deposition. In this study, a new bipyridyl precursor that provides reduction at moderate conditions was employed for scCO2 deposition. By this way, 1% and 4% Pd doped carbon nanotubes were prepared and their temperature programmed desorption and reduction performance as a function of Pd loading were compared together with pristine carbon nanotubes. The BET surface area was determined as 176 m2/g with a pore size of 17.6 nm, 199.62 m2/g with a pore size of 21.82 nm and 205.22 m2/g with a pore size of 19.36 nm for pristine CNT, % 1 Pd/CNT and % 4 Pd/CNT, respectively. The materials will be compared in means of temperature programmed desorption (TPD) and reduction (TPR) experiments. Both TPR measurements revealed an initial Pd hydride decomposition. Moreover, the results of adsorption and desorption hysteresis at ambient temperature will be discussed.

Keywords: Hydrogen storage, multi-walled carbon nanotubes, temperature programmed reduction, temperature programmed desorption, supercritical fluid deposition

[**Abstract:0062**]

Photoelectrochemical Hydrogen Production Using Cd(1-x)ZnxS And Its Modifications with Graphene Derivatives

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Photoelectrochemical hydrogen production is one of the most trending approaches to generate renewable energy source having no hazard on the environment. In this concept, the use of semiconductors is of great importance to determine the efficiency of the overall process. To capture a large share of the solar spectrum and obtain a better output from the hydrogen production process, narrow bandgap energy, proper conduction band position, slow recombination rate and high stability are the most important characteristics to consider. Composites such as TiO2, CdS, WO3, ZnO, ZnS, and GaAs, etc. are the most commonly used materials for photoelectrochemical hydrogen production studies. Nevertheless, the efficiencies which can be obtained by utilizing these materials as semiconductors are low because of their limitations, such as stability, efficiency, electron-hole recombination and etc. Thus, different strategies are developed to achieve better efficiencies, slow recombination rate and high stability. In this regard, utilization of Cd1-xZnxS type photocatalysts can be thought to be a good solution to provide a semiconductor material with a controllable band structure by causing a higher electron mobility, and electrochemical stability [1,2].

In this study, Cd(1-x)ZnxS composites having different ratios of graphene derivatives (graphene oxide, and/or reduced graphene oxide GO/rGO) were synthesized by solvethermal methods. Prepared samples were coated on the indium tin oxide (ITO) electrodes with different coating techniques. After the samples were characterized by both structurally and morphogically by SEM, FTIR, XRD, UV-vis diffuse reflectance spectroscopy analyses, photoelectrochemical hydrogen production by water splitting were conducted under simulated solar light irradiation. The results obtained from the required analyses and hydrogen production experiments were discussed with respect to types, compositions and morphology of the semiconductor composites, electrolyte system, and electrode modification techniques. And finally the results were compared with the literate to predict technological feasibility of the active structures.

Acknowledgement: We thank to The Scientific and Technological Research Council of Turkey (TUBITAK, Project Number: 116M567) for its financial support.

Keywords: Photoelectrochemical hydrogen production,cadmium zinc sulfide, graphene oxide, reduced graphene oxide.

ORAL ABSTRACTS

[**Abstract:0064**]

Geothermal and Solar Driven Multigeneration System for Sustainable Buildings: A Thermodynamic Analysis

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The current study proposes an integrated geothermal based multi-generation system including the triple effect LiBr/water absorption system (TEAS), organic Rankin cycle (ORC), air-conditioning system (dehumidification with cooling) and an electrolyzer. The aim of this system is to supply six outputs comprising heating, cooling, dry air, hot water, hydrogen, and power. By injecting 500K geothermal water, the energetic and exergetic overall utilization factors (Ɛen and Ɛex) for the completely multi-generation cycle would be 2.467 and 1.097, respectively. A parametric study was conducted indicating that an increase in ambient temperature from 295K to 320K leads to an accumulative trend for exergetic coefficient of performance (COPex) while energetic coefficient of performance (COPen) remains constant in TEAS. Therefore, by increasing ambient temperature, Ɛen will remain constant while Ɛex will increase for all the varying geothermal mass flow. In addition, when the evaporator temperature rises from 274K to 279K, there is a downward trend for COPen and COPex (from 1.491 to 1.479 and 0.3525 to 0.3145, respectively) as well as Ɛen and Ɛex. Also, cooling load will decrease from 413.18kW to 410.4kW and condensed water in the air-conditioning system will increase. By raising the geothermal temperature from 400K to 500K, Ɛen and Ɛex will increase from 2.354 to 2.467 and from 1.055 to 1.105, respectively. Moreover, the rise in geothermal temperature will upsurge the rate of hydrogen production as well as the heat rate in hot water production from 0.004873L/s to 0.004873L/s and from 8.365kW to 112.9kW, respectively. Also, enhancing geothermal water temperature will increase the heat rate of the high temperature generator and the overall produced power. Apart from that, by increasing the air Specific humidity from 0.4 to 0.7, the dehumidification efficiency will also increase. Hence, a comparative study shows that using multi-generation cycle with higher COPen and COPex in comparison with conventional systems is more feasible to design for reaching the six outputs.

Keywords: Geothermal, absorption, Organic Rankine Cycle, Hydrogen, Power, Cooling

[**Abstract:0065**]

Energy and Exergy Analyses of a Novel Ammonia Combined Power Plant Operating with a Gas Turbine and a Solid Oxide Fuel Cell

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This study deals with a new combined power plant that is using only ammonia as a fuel for trigeneration purpose. The system comprises two main powering sources, a gas turbine running on ammonia and using hydrogen as a promoter, and an ammonia fed solid oxide fuel cell. The waste heat from the gas turbine exhaust gases will be reovered using an organic rankine cycle to generate an additional electric power, the residual thermal energy from the exhaust gases will be used to operate an absorption chiller to provide refrigeration for the industry. The electricity generated from the organic rankine cycle will be supplied to an ammonia electrolyzer to produce hydrogen, which can be stored for other application use and supplied to the gas turbine to function as a combustion promoter. The system is analysed thermodynamically using the first and second law of thermodynamics. Moreover, Exergy destruction of the different combined power plant units is determined. Furthermore, a comprehensive parametric study has been carried out to investigate the effect of varying ambient conditions, operating and design parameters on the overall performance of the combined system and subsystems.

Keywords: Ammonia, Hydrogen, Solid oxide fuel cell, Gas turbine, Energy, Exergy

ORAL ABSTRACTS

[**Abstract:0068**]

Energy and Exergy Analyses of an Integrated Solar and Coal Gasification Combined Cycle for Hydrogen and Ammonia Production

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In this study, an integrated solar and coal gasification combined cycle with a pressurized entrained flow gasifier is proposed, particularly for hydrogen and ammonia production, and thermodynamically analyzed through energy and exergy approaches. The present gasifier reduces the concentration of the carbon dioxide in the raw syngas by using solar concentrated thermal energy. The present integrated system utilizes renewable energy integrated with conventional fossil fuel sources. The developed system is thermodynamically assessed, and hence energy and exergy efficiencies are assessed and evaluated comparatively. The effects of various parameters, such as solar irradiance, gasifier temperature, gasifier pressure, on energy and exergy efficiencies of the proposed system are also parametrically studied. Furthermore, a comparative assessment is also undertaken to compare the proposed system with the one in the literature data.

Keywords: energy, exergy, solar, gasification, hydrogen, ammonia

[**Abstract:0070**]

Kinetic and Electrochemical Analyses of a CuCl/HCl Electrolyzer

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The CuCl/HCl electrolyzer is the electrochemical step of the CuCl thermochemical water splitting process for hydrogen production. In this study an electrochemical analysis is carried out on the electrolysis cell from a kinetic electrochemistry perspective. At 25℃ the activation overpotential of the anode half-reaction is found to be around 53 mV for a current density of 0.5 A.cm^(-2) while the activation overpotential of the cathode half-reaction for the same condition is about 87 mV. An increase in working temperature decreases the overpotential of the anode half-reaction and increases the magnitude of the cathode half-reaction activation overpotential. The value of the Ohmic overpotential of the cell membrane is almost 1000 times smaller than the activation overpotentials of the electrode half-reactions for the same temperature and current density. A higher working temperature results in a lower membrane ohmic overpotential. The required voltage to trigger electrolysis for a current density of 0.5 A.cm^(-2) is found to be 0.53 V at 25℃, and it increases to 0.59 V at 80℃. However, a higher temperature results in a better electrochemical efficiency for the electrolysis process examined. The cell electrochemical efficiency increases linearly with working temperature while the voltage efficiency peaks as about 75% at 60℃, respectively.

Keywords: Hydrogen production, electrolysis, electrochemical analysis, kinetic analysis, efficiency.

[**Abstract:0071**]

Steam Methane Reforming in Micro-reactors under Concentrated Solar Irradiation

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This work reports on the sequence of experimentation carried out during the summer of 2017, where continuous steam methane reforming reaction was carried out in a pilot scale solar reactor – designed, constructed and operated using in-house capabilities. One of the primary cost constraints in using solar energy for running industrial scale reactions is the requirement for large scale solar collector/concentrator infrastructure. This work evaluates the use multiple small reactors with cost effective mirror collectors, rather than a single large scale reactor.

The reaction was studied on 30x30x10mm, 200CPSI mullite monoliths, loaded with Ni or Pd catalysts. The reaction chamber was constructed from 316 grade stainless-steel components, with a 90mm diameter quartz window on one end to allow for effective energy collection. The reactor was 200mm in total length, 50mm of this is 100mm in diameter (the window side) and the rest was 60mm in diameter (the back end). This enclosure was placed in front of a 70cm diameter parabolic mirror, such that solar irradiation was focused on the 30x30mm face of the monolith. The reactor-dish assembly was mounted on a dual axis solar tracker.

An inlet provided a moist, 4%CH_4-Ar mixture to the front side of the monolith. The exhaust was located at the opposite end of the reactor. A thermocouple, embedded inside the monolith, monitored the reaction temperature. The outlet gases were analyzed in real time using SnO based solid state gas sensors and an industrial combustible gas sensor.

The Ni coated monolith was studied during August, 19-20, followed by the Pd catalyst during August, 22-24. In both sequences, measured reaction temperatures varied significantly due to weather conditions, enabling the characterization of the relationship between conversion, temperature and extent of reaction.

Peak H_2 yields of ~99% were demonstrated on both materials, with the average in the range of 50-70%. The limitation, preventing sustainable >90% yields was the discontinuity in the water supply in the feed, imposed by the the water feeding strategy. Significant differences were observed between the two catalyst materials, for instance time to steady state H_2 yield was close to an hour where as the same ramp for Pd was on the order of minutes. Significant coking was noted on both materials and yet was not enough to degrade the mean conversion levels for the duration of the study.

Hourly production rates were in the range of 0.05-0.10 moles of H_2. Differences between the two catalysts will be discussed in detail along with the possibilities of improving the average yield levels by a more efficient water feeding strategies. Advantages of running multiple micro reactors, rather than a few large scale ones, will be summarized in terms of simplification of scale-up and cost reduction possibilities.

Keywords: SMR, Concentrated Solar Irradiation, Methane, Hydrogen Production

[**Abstract:0072**]

Direct Current Assisted Dark Fermentative Hydrogen Gas Production from Acid Hydrolysed Waste Paper Towel

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One of the main constraints in batch operated dark fermentative hydrogen production is the sharp decrease of the pH due to the fast formation of volatile fatty acids. Therefore pH is generally adjusted to neutral levels using alkaline solutions. However, alkaline addition results in salt accumulation in the media limiting microbial activity. In this study, DC was applied to the dark fermentation media to control the pH as an alternative to alkaline addition. Electrical current was only applied to raise acidic pH to the neutral level. In this context, the effects of applied voltage (0.25-3 V), substrate concentration (5-40 g/L at 1 V) and electrode distance (0.3-1.3 cm at 1 V) on pH regulation and hydrogen production performance were assessed. Most convenient conditions resulting most efficient hydrogen production and pH control were obtained at 1 V, 20 g glucose/L and 0.5 cm electrode distance.

Keywords: Dark fermentation, bio-hydrogen, waste paper towel, direct current

[**Abstract:0073**]

Hydrogen Production from Melon and Watermelon Mixture by Dark Fermentation

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Fruit wastes offer a potential substrate and inoculum source for dark fermentative hydrogen gas production. Moreover, the utilization of fruit waste in dark fermentation enables waste reduction beside fuel production. In this context melon and watermelon mixture was selected as a source for hydrogen production and the effects of initial fruit mixture concentration (0.74-37 g TS/L) on hydrogen production yield and rate was studied using natural microflora and heat treated anaerobic sludge in batch experiments. Hydrogen was effectively produced by the natural microflora at 14 gTS/L (703.1 mLH2/gCOD, 3.7 mLH2/h). However, hydrogen yield and rate increased significantly by inoculating the fruit mixture with heat treated anaerobic sludge at the same substrate concentration (2062.5 mLH2/gCOD, 21.67 mLH2/h). Inoculated melon and watermelon mixture was found to be a potential source for hydrogen production however the initial substrate concentration needs to be adjusted properly for efficient hydrogen production.

Keywords: Bio-hydrogen, dark fermentation, natural microflora, melon, watermelon

ORAL ABSTRACTS

[**Abstract:0074**]

Electrochemical Impedance Modeling of a SOFC Button Cell and Parametric Analysis of the Cell Electrical/Electrochemical Performance

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The electrochemical impedance spectroscopy (EIS) is a powerful non-destructive tool for obtaining the solid oxide fuel cell (SOFC) individual losses, materials characterization, transport properties investigation and its performance optimization. Beside the EIS experimental analysis efforts, several studies are devoted to develop EIS theoretical and numerical simulation tools. The purpose of the present study is to investigate a parametric analysis of a SOFC bottom cell electrical and electrochemical performance using impedance modeling of the cell. For this purpose, a transient simulation model is developed solving the system of non-linear equations where a sinusoidal voltage excitation is imposed and the cell harmonic response is recorded and evaluated for different input parameters. In order to simulate the gas transport impedance, a set of 1D channel mass transfer model is coupled to a 1D porous electrode gas transport and electrochemical model. The obtained response is evaluated using the experimental data and is used as a base for the electrochemical impedance spectra analysis. Electrochemical model includes theoretical cell voltage using Nernst equation, the cell activation polarization (Anode and Cathode) defined by Butler-Volmer equation, Ohmic (electronic and ionic conductions) and concentration losses caused by the species concentration gradient in the cannels and porous electrodes from the gas input up to the reaction site. The influence of parameters such as inlet gas composition and temperature is investigated and the results are discussed. The results of the impedance modeling shows how the minimum diffusion and electrochemical activation polarization/impedance is achieved adjusting the cell affecting input parameters. As an example, the diffusion resistance/impedance is minimum when the input hydrogen concentration is about 50% while the oxygen concentration reduction up to 5% doesn't affect the concentration losses.

Keywords: Solid oxide fuel cells (SOFCs), transient simulation, electrochemical impedance spectroscopy (EIS), gas conversion impedance

[**Abstract:0075**]

A renewable Pathway Towards Increased Utilization of H2 in Diesel Engines

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The conventional diesel engines are widely used prime movers worldwide owing to their high performance, robust construction and versatility. The conversion of existing diesel engines to operate with alternative fuels, such as hydrogen (H2) could significantly reduce the fossil fuels requirements and improve environmental security. However, there are many technical constraints, which limit the percentage of H2 that can be utilized in a diesel engine. Due to very high auto-ignition temperature of H2, it cannot be solely used as a fuel in a diesel engine. Nevertheless, based on the dual fuel technology, H2 can be utilized in a diesel engine as the main fuel, whereas, small amount of diesel is needed as the pilot fuel. This technique has the drawback that some amount of fossil fuel is still needed, which becomes significantly high at higher loads with H2 as the gaseous main fuel. In this context, a renewable dual fuel technology can be realized with the use of biodiesel in place of diesel as the pilot fuel. In the present work, biodiesel-H2 dual fuel operation of the diesel engine has been experimentally investigated. It has been shown that the biodiesel-H2 dual fuel engines could not only achieve the renewable nature but also improve the hydrogen utilization in diesel engines.

In the present work, Jatropha Curcas biodiesel was used as the pilot fuel, which was directly injected in the combustion chamber using conventional diesel injector. The main fuel (H2) was injected in the intake manifold using a hydrogen injector and electronic control unit. The premixed mixture of hydrogen and air was inducted inside the engine cylinder, which was ignited by the pilot fuel. The engine operation was studied at varying engine loads at the maximum pilot fuel substitution conditions. The engine performance parameters such as maximum pilot fuel substitution, brake thermal efficiency and brake specific energy consumption were studied. In emission side, oxides of nitrogen (NOx), hydrocarbon (HC), carbon monoxide (CO) and smoke emissions were analysed. Based on the results, it was found that the biodiesel-H2 dual fuel engine could replace up to 80% and 25% pilot fuels at low and high loads respectively. It was also found that the dual fuel operation improves the brake thermal efficiency. In addition to that exhaust gas recirculation (EGR) has also been studied in the biodiesel-H2 dual fuel engine. It was found that EGR could improve the percentage utilization of H2 in the dual fuel engine, especially at the high loads. The effect of EGR was also found to reduce high NOx emissions from the engine and brake thermal efficiency was not significantly affected.

Keywords: Dual fuel, Hydrogen, Biodiesel, Emissions, EGR

ORAL ABSTRACTS

[**Abstract:0078**]

Experimental Characterization of Thin Electrolyte for Intermediate Temperature Solid Oxide Electrolysis Cell

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The high temperature solid oxide electrolysis is considered an important pathway to efficient and sustainable hydrogen production. However, a major limitation of high temperature solid oxide electrolysis cell is the high operating temperature and increased degradation particularly at high steam intake concentrations. This paper reports an experimental performance and characterization results of a thin electrolyte-supported solid oxide cell operating in electrolysis cell mode at temperatures of 750, and 850 C. The experiment examines the impact of high steam to hydrogen ratios including 50/50, 90/10 and as high as 95/5, respectively. Therefore, the performance parameters such as the open circuit potential and J – V curves are measured and compared with theoretical values and relative literature. In addition, the electrochemical impedance electroscopy (EIS) is performed at both operating modes electrolysis and fuel cell.

Keywords: Solid oxide cells, SOFC, hydrogen production, high temperature, cell characterization, high steam concentration

[**Abstract:0079**]

A Parametric Study of the Performance of a Polymer Electrolyte Membrane Electrolyzer: Energy and Exergy Analyses

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In this paper, an analytical model is developed to study the performance of a PEM electrolyzer. The concentration over-potential as well as resistance losses of other electrolyzer components are modeled and the effect of different parameters including temperature, pressure, membrane thickness, the width and height of channel, electro-osmotic drag coefficient and current density on the performance of the electrolyzer are investigated. In addition, the effect of these parameters on the energy and exergy efficiency of PEM electrolyzer are studied. The results indicate that by increasing current density, the voltage of the electrolyzer increases and energy and exergy efficiencies decrease. Increase of temperature, decrease of pressure, decrease of membrane thickness and increase of current density of the anode and cathode electrodes lead to decrease of voltage of the electrolyzer and increase of energy and exergy efficiencies. The results indicate that the electrolyzer voltage increases by increasing the dimensions of the channel due to increase of the ohmic over potential. Moreover, it is concluded that electro-osmotic drag coefficient has not a considerable effect on the performance of the electrolyzer.

Keywords: PEM electrolyzer, Exergy, Membrane thickness, Channel geometry, Electro-osmotic drag coefficient

ORAL ABSTRACTS

[**Abstract:0081**]

Hydrogen Generation from Solid State NaBH4 by Using FeCl3 Catalyst for Portable PEMFC Applications

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Hydrogen is considered as a promising candidate to replace fossil fuels. For implementing a hydrogen based infrastructure, hydrogen storage is the main obstacle that is needed to be overcome. Being boron based compound, sodium borohydride, NaBH4, is a convenient hydrogen storage material for applications like unmanned air vehicles. There are several issues behind commercialization of NaBH4 hydrolysis systems. This study aims to be solution of NaBH4 hydrolysis system by highlighting three main contributions. First, the usage of solid state NaBH4 enables to increase the gravimetric H2 storage capacity of the system in order to meet US DOE targets. Second, solid NaBH4 usage decreases the system's weight since it does not require a separate fuel storage tank, which is very important for practical applications. Finally, by using accessible and effective catalyst as FeCl3, it decreases the system's cost. In this study FeCl3 was added by following two methodologies: In the Case 1, solid FeCl3 was placed in a glass reactor with solid NaBH4 and water added to initiate the hydrolysis reaction. The water amount is found to be a critical parameter that should be optimized. The maximum hydrogen generation rate is 1.88L/min with a maximum yield of 1.64L H2/g NaBH4, 63.5% efficiency. In Case 2, solid NaBH4 was placed in the reactor. Solid FeCl3 was dissolved in desired amount of water to obtain catalyst solution. This catalyst solution was added into the reactor to generate hydrogen. The maximum hydrogen generation rate obtained is 2.6L/min and the yield is 1.97L H2/g NaBH4 with an efficiency of 76.3% at the most promising condition in Case 2. The novel solid NaBH4 system running at this condition is connected to a PEM fuel cell.

Keywords: Sodium borohydride, hydrogen generation, PEM Fuel Cell

[**Abstract:0082**]

Coke Minimization over Mesoporous Alumina Supported Ni Catalyst in Dry Reforming of Methane

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Biogas can be converted to hydrogen rich syngas by dry reforming of methane. In fact, CO2 reforming of methane can be considered as one of the important steps of production of valuable chemicals from biogas. Syngas with a H2/CO molar ratio of one is suitable to produce liquid hydrocarbons via Fischer-Tropsch synthesis and/or direct synthesis of dimethyl ether. In the present study, activity of mesoporous alumina supported nickel catalysts was tested in dry reforming of methane. Mesoporous alumina was synthesized following a hydrothermal route. Ni was incorporated into the structure of alumina materials by impregnation method. Mg was co-impregnated or sequentially impregnated into the Ni based catalyst. The synthesized catalysts were characterized by XRD, N2 adsorption/desorption, TPR, SEM-EDX, CO2-TPD and TG techniques. Nitrogen adsorption/desorption analysis showed that these catalysts had uniform mesoporous size distribution. The TPR analysis of the catalysts showed that Mg incorporation changed the reduction temperature of the Ni catalysts. All catalysts showed stable activity during 4 h activity test. Mg impregnation decreased the activity of the Ni based catalyst in terms of methane and carbon dioxide conversion. The result of TG analysis showed that impregnation Mg onto the Ni based catalyst did not help to decrease the coke deposition over Ni catalyst. However, co-impregnation of Mg and Ni decreased the coke deposition significantly due to the formation of a Ni and Mg mixed oxide.

Acknowledgements: Gazi University Research Fund (06/2016-12 and 06/2017-03) grants are acknowledged

Keywords: Hydrogen, Mesoporous Alumina, Ni, dry reforming

[**Abstract:0083**]

Preparation of Nanostructured α-Fe2O3 Films from Electrodeposited Fe Films for Photoelectrochemical Water Splitting Performance

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Hematite (α-Fe_2O_3) has been extensively studied for photoelectrochemical (PEC) water splitting. The aim of this study is the fabrication of α-Fe_2O_3 photoanodes in order to apply in the hydrogen production area. In this study, nanostructured α-Fe_2O_3 photoanodes structures were prepared on indium-doped tin oxide (ITO) coated glass by thermal oxidation of electrodeposited Fe films at different temperature in the air atmosphere. The effect of electrodeposition parameters of Fe such as duration, current etc. on photoelectrochemical water splitting was investigated. The crystal phase structure, surface morphology, and optical properties of the α-Fe_2O_3 photoanodes were characterized using an X-ray diffractometer (XRD), scanning electron microscopy (SEM) and UV–VIS spectrophotometer, respectively. PEC performances of the α-Fe_2O_3 photoanodes were determined in the 0.1 M NaOH electrolyte solution. The results showed that electrodeposition parameters influenced the PEC performances of α-Fe_2O_3 photoanodes. Electrodeposition method could be good candidate for production of efficient α-Fe_2O_3 photoanodes for enhancement of PEC performance.

Keywords: Electrodeposition, Fe film, Hematite, Hydrogen generation, thermal oxidation, Photoelectrochemical Properties (PEC)

[**Abstract:0084**]

Investigation of the Effect of Single Stage and Four-stage Clamping Pressure on Electrical Resistance of GDL

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Polymer electrolyte membrane fuel cells which generate power have a very wide application area such as portable, transport and stationary systems. The generating power with electrochemical reactions by fuel cell is directly related to the cell performance that changing with the properties of cell compenents. Gas diffusion layer (GDL) which is one of the cell compenents provides electron, water, fuel and oxidant transport with anisotropic porous structure. The anisotropic electrical resistances occurring due to structure of GDL can cause low cell performance. The purpose of this study is to investigate experimentally the effects of single stage (8 bar) and four-stage (2, 4, 6 and 8 bars) clamping pressure on the electrical conductivity of GDL. To achieve this purpose, the anistopic electrical resistances were separately measured for gas diffusion layer and its with micro porous layer using four probe conductivity measurement system. The electrical conductivities were calculated from the obtained values and these conductivities were integrated into three dimensional numerical models to analyze fuel cell performance and the distrubiton of electrical current density over GDL. It was observed that the electrical resistance values under gradual clamping pressure were more stable than directly one.

Keywords: PEM fuel cell, micro-porous and porous gas diffusion layer, Electrical resistance measurement, 3D anisotropic modeling

[**Abstract:0085**]

Performance of CVDGgraphene Ssupported PtxCoy Electrocatalysts for PEM Fuel Cell

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Catalyst support materials play an important role for the fuel cell performance. Graphene is attractive candidate due to superior properties such as good electronic conductivity, large surface area, high durability, mechanical and chemical stabilities. Platinum/cobalt (Pt/Co) nanoparticles have emerged as one of the most promising electrocatalyst in polymer electrolyte membrane (PEM) fuel cell. In this study, chemical vapor deposition (CVD) grown graphene was utilized as catalyst support after nickel foam was removed and graphene was transferred onto the membrane. Graphene supported PtxCoy electrocatalysts (Pt3Co,Pt2Co, PtCo,PtCo2,PtCo3) were prepared by sodium borohydride reduction method at room temperature. Anode (graphene supported PtxCoy)/membrane (nafion)/cathode (Vulcan XC-72 supported Pt) unit is compressed to prepare to membrane electrode assembly. Fuel cell performance tests indicate activity increase in the following trend: Pt3Co < Pt2Co < PtCo < PtCo2 ≤ PtCo3. The PtCo3 electrocatalyst was shown minimum 2 times higher performance than that of Pt3Co electrocatalyst at 0.55V. Further details of the study will be discussed.

Acknowledgements: Financial support provided by the TUBITAK-ARDEB through 1003 program under contract #215M302 (Developing Cobalt-Boron-Nitrogen doped Oxygen Electrode (Cathode)) is greatly acknowledged.

Keywords: CVD graphene, PtCo catalyst, PEM fuel cell

[**Abstract:0087**]

Maritime Industry and Future Hydrogen Production

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The impact of global warming is clear from the unfolding events witnessed worldwide. The world needs a new accelerated approach to meet the energy demand and reverse the processes that cause further instability in the earth's atmosphere. The objective of this paper is to introduce a novice idea for production of hydrogen. In 1962, NS Savanah, a nuclear-powered cargo ship, was commissioned by Maritime Administration with a total power generating capacity of seventy-five megawatts. The ship was not welcomed to dock in any port, due to fears that radiation from nuclear-powered ship may cause problems related to human health. Recognizing this fact, we offer to utilize a class of vessels for production of hydrogen, assuring all safety measures are applied, far away from population centers. The transfer of hydrogen produced will be done by smaller hydrogen powered ships using the nonvolatile, non-combustive hydrogenated liquid organic hydrogen carrier to shore platforms, where Marine Power Platforms deliver combined heat and power to coastal areas around the world. The proposed scenario for such a scheme is based on the latest technological advances made in the fields of hydrogen production and autonomous cargo ships for hydrogen transfer to designated platforms. The economic viability of this process, comparative emission of greenhouse gases and production capacity of a platform similar to NS Savanah will be presented in this paper.

Keywords: hydrogen, power generation, shipping, maritime, climate change, energy

[**Abstract:0088**]

Exergetic and Sustainability Analyses of Ammonia Usage in a Gas Turbine

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The world surface temperature increased by 0.6 °C in the 20th century and in the literature, there is a wide consensus that the temperature increase of 2 °C is an irreversible point. Low carbon economy is of great importance in decreasing global warming effects of energy systems. Ammonia, if produced in a sustainable way, can be used in energy systems in an environmentally benign way, producing only water vapour and nitrogen. This carbon free fuel can be stored and transported more easily than hydrogen or methanol and can be found easily since it is extensively used in agricultural industry. This study focuses on effects of using ammonia in a general gas turbine engine used for ground operations. The gas turbine model have been developed using the sotware EBSILON® Professional. Effects of ammonia fraction in compared to other fuels such as methane, hydrogen and kerosene is the main concern of this paper. Energetic, exergetic and sustainability analyses have been carried out for optimising power generation utilising ammonia fuel blends.

Keywords: Ammonia, gas turbine, exergy analysis, sustainability

[**Abstract:0089**]

Ni Catalyzed Methane Pyrolysis for H2 Generation under Concentrated Solar Irradiation

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This work reports on the sequence of experimentation carried out during the summer of 2017, where a cyclic methane pyrolysis and coke burning reaction sequence was carried out in a pilot scale solar reactor – designed, constructed and operated using in-house capabilities. One of the primary cost constraints in using solar energy for running industrial scale reactions is the requirement for large scale solar collector/concentrator infrastructure. In this work, the proposal is to use multiple small reactors with cost effective mirror collectors, rather than a single large scale reactor.

The reaction was studied on 30x30x10mm, 200CPSI mullite monoliths, blank or loaded with 1.645g Ni. The reaction chamber was constructed from 316 grade stainless-steel components, with a 90mm diameter quartz window on one end to allow for effective energy collection. The reactor was 200mm in total length, 50mm of this is 100mm in diameter (the window side) and the rest was 60mm in diameter (the back end). This enclosure was placed in front of a 70cm diameter parabolic mirror, such that solar irradiation was focused on the 30x30mm face of the monolith. The reactor-dish assembly was mounted on a dual axis solar tracker.

An inlet provided either a 4%CH_4 or a 4.2%O_2 mixture to the front side of the monolith. The exhaust was located at the opposite end of the reactor. A thermocouple, embedded inside the monolith, monitored the reaction temperature. The outlet gases were analyzed in real time.

The pyrolysis and de-coking reactions were implemented in various sequences. The measured reaction temperatures varied significantly due to weather conditions, allowing the capture the relationship between conversion, temperature and the extent of coking.

Repeatable, peak H_2 yields of ~95% were demonstrated, falling to <50% within approximately an hour due to coking. The removal of coke also took place on the order of an hour. The recovery of the high initial yields was seen to be dependent on the effectiveness of the coke removal sequence. As expected, the same sequence on the blank monolith yielded two orders of magnitude lower conversion. The results were also validated through the closure of the material balance – comparing the amount of coke burned to the H_2 produced.

Hourly, peak production rates were around 100mmol of H_2. The demonstration of the cyclic pyrolysis/de-coking sequence over the same Ni catalyst hints at the possible feasibility of running multiple small reactors in an integrated cyclic sequence to ensure continuous H_2 production. Advantages of running multiple micro reactors, rather than a few large scale ones, will be discussed in terms of simplification of scale-up and cost reduction possibilities.

Keywords: methane pyrolysis, microreactor, Concentrated solar irradiation

[**Abstract:0090**]

Recent Trends of Hydrogen Utilization in Transportation

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Today's transportation sector depends almost entirely on fossil fuels, emits more than 20% of all CO2 emissions – and is almost certain to grow significantly in the years ahead. Latest predictions show that CO2 emissions will increase by about 35% by 2050. Hydrogen usage is one of the solutions for the reducing of the emissions created by transportation. In the transport sector hydrogen is now used almost exclusively in fuel cells. Hydrogen fuel cell systems are suitable for virtually all means of transport. Passenger cars, buses and material handling vehicles have tech¬nically reached series-production readiness, are not far off that point, or are already in the early stages of commercialisation. Fuel cell passenger cars now offer the same features as those powered by internal combustion engines. Buses have undergone more intensive testing with hydrogen and fuel cells than any other form of transport. Light rail and road vehi¬cles for the transport of goods may benefit from bus technology. Of all modes of transport, industrial trucks have the largest numbers of fuel cell electric vehicles. Commercial aircraft and merchant ships can use fuel cells as an efficient and clean energy provider for auxiliary power units.

Keywords: Hydrogen, fuel cell, transportation, renewable energy, ammonia

[**Abstract:0091**]

Wireless High-Speed Continuous Sensing of Hydrogen Leak by a Quadrotor Drone

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Continuous hydrogen sensing by a quadrotor drone is presented. The present system consists of a drone, semiconductor-type hydrogen sensor, wireless microcontroller module, boot converter and batteries. After investigating the relationship between leak amount and the spatial distribution of hydrogen concentration in the absence of the drone, sensing experiments are conducted with the drone hung above the leak source. The rotational speeds of the blades are also varied. The results show that the present system can successfully detect leaked hydrogen in spite of the downwash of the quadrotor drone.

Keywords: hydrogen safety, hydrogen sensor, drone, wireless, continuous sensing

ORAL ABSTRACTS

[**Abstract:0092**]

Analysis of the Turbocharged Internal Combustion Engine with Over-expanded Cycle Fueled with CNG and Hydrogen

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Nowadays one of the major challenges regarding internal combustion (IC) engine operation is to reduce exhaust toxic emission at higher engine loads. There are several technologies and methods as eg. exhaust gases after-treatment systems, applying alternative fuels and modifications to engine combustion systems by applying an over-expanded cycle system, that was under investigation and results are presented in this paper. It is especially important in high power stationary gas fueled engines working for heat and power generation (CHP). Hydrogen is crucial component in syngas and hythane (H2-CH4) is considered as a component which significantly reduces CO2, THC and CO in exhaust gases from the IC engine. However, on the other hand, hydrogen as secondary fuel blended primary gas is willing to generate engine knock, that might lead to damage the engine in short-term future. Knock combustion affects not only for engine reliability but also emissions, efficiency and performance, what can be observed in analysis of the combustion parameters. In this work results from investigation on knock intensity in the IC engine with the over-expanded cycle system and fueled with hydrogen rich gases is presented. The test engine used for investigation worked as a classical Otto cycle based engine and after modifications, it worked with over-expanded cycle system. In these both cases two fuels were used: CNG (Compressed Natural Gas) and hydrogen. Moreover, the engine was equipped with charging system to increase its performance as well as to compensate losses caused by use of the over-expanded cycle. The over-expanded cycle in this case was done through applying early intake valve closure before BDC (Bottom Dead Centre). The boost positive pressure was varied from 0 to 0.6 bar. On the basis of the performed tests parameters as follows: IMEP, COVIMEP, knock intensity and engine efficiency were obtained. The results confirmed that running the engine with over-expanded cycle makes it possible to reduce intensity of the knock from both these fuels by approximately 50% with increase in engine efficiency of nearly 1.5%.

Keywords: gas engine, hydrogen, over-expanded cycle, knock combustion

[**Abstract:0094**]

Water Splitting Through the Pb/PbO Cycle

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This work reports the studies conducted on the feasibility of the Pb/PbO cycle for the splitting of H_2O for H_2 production. The reaction cycle

$Pb(s) + H_2O(g) \rightarrow PbO(s) + H_2(g)$

$2PbO(s) \rightarrow 2Pb(s) + O_2(g)$

was studied in several different experimental set-ups. Despite its relatively high vapor pressure and toxic nature, Pb is a good candidate for this cycle, owing to the thermodynamic feasibility of the Pb/PbO cycle and cost – compared to other possible metals.

The fundamental reaction kinetics were studied by flowing moist Ar gas over a small molten Pb surface, demonstrating the feasibility of reaction kinetics.

In the next set of trials, a 30x30x10mm, 200CPSI mullite monolith, coated with 1.665g Pb was taken to a concentrated solar irradiation driven pilot scale reactor. The reaction chamber was constructed from 316 grade stainless-steel components, with a 90mm diameter quartz window on one end to allow for effective energy collection. The reactor was 200mm in total length, 50mm of this is 100mm in diameter (the window side) and the rest was 60mm in diameter (the back end). This enclosure was placed in front of a 70cm diameter parabolic mirror, such that solar irradiation was focused on the 30x30mm face of the monolith. The reactor-dish assembly was mounted on a dual axis solar tracker. Unfortunately no measurable H_2 production was detected as the Pb coating quickly evaporated from the monolith surface due to the high temperature levels.

The final sequence of experimentation was carried out in a molten Pb bath. A 56mm ID, 300cm tall cylindrical reactor was constructed and placed inside a 2kW radiatively heated furnace. A stainless steel bubbler and a thermocouple was installed inside this reactor before ~2kg of lead was heated and melted – resulting in a molten Pb column about 80mm in height. An Ar+H_2O mixture was fed into this molten Pb bath. The exhaust gas was analyzed for H_2 content from temperatures of 600°C to 950°C. Some cyclic behavior was seen in conversion at the lower temperatures, likely due to the limitations of the water feeding strategy, they were stabilized post 900°C.

The resulting kinetic data from the molten surface and column experiments were analyzed using appropriate reactor transport models, comparing the data with the limiting thermodynamic conversion levels. Possibilities of extending this approach to economically viable larger scale reaction schemes will be discussed. The fundamental limitations to be addressed are the high temperature required for PbO reduction and handling of high temperature molten Pb.

Keywords: H2O splitting, Pb/PbO cycle, H2 production

[**Abstract:0096**]

Diagnosis and Improvement of Hydrogen Demand/Supply Processes using Combined Pinch and Exergy Analysis

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Hydrogen occur a renewable energy source and alternative energy to the fossil fuels all over the world. Hydrogen production technologies have a crucial importance for industries. Hydrogen is a clear energy and provides the clean eco system. Except for production of hydrogen, there is another way to obtain hydrogen source that is management of hydrogen in the industries which is used to hydrogen as a feed stock and/or raw material. When hydrogen management applies to the any system, it is clearly seen that, operating cost and hydrogen stock usage is reduced. Because of the much hydrogen consumption in refineries with respect to such industries, in this study refinery process have examined. Refinery process hydrogen network management is an integration process in which apply pinch analysis technology.

In this study, by using graphical method of pinch technology, hydrogen surplus of the network has determined. 277,2 mol/s feed stock is decreased to the 196,8 mol/s. Excess hydrogen is recycled to the inlet and is used as a feedstock after purification. Purification unit has added to the available system than is called retrofit design.

Secondly, the objective is to calculate the efficiency of each system component and to understand hydrogen integration effect on the energy. Hydrogen network units are classified as consumer units and/or producer units. Hydrocracking unit, Diesel Hydro-treating unit, Cracked Naphtha Hydro-treating unit, and Naphtha Hydro-treating unit are hydrogen consuming units and called as sink. Fresh feed, Catalytic Reforming unit, and Steam Reforming unit are hydrogen producing unit and called as source. By exergy analysis around the each unit, exergy efficiency has determined for overall system as available and retrofit cases. Exergy is useful energy for system and provide to determine real energy loss of the whole system. Retrofit system which minimum hydrogen usage has become high exergy efficiency approximately 30% with respect to available system by calculation unit by unit. That is, retrofitting system has provided us minimum energy loss and maximum exergy efficiency by using process integration.

Keywords: Hydrogen Pinch, Energy, Exergy, Efficiency

ORAL ABSTRACTS

[**Abstract:0097**]

Performance of Ni Incorporated Silica and Alumina Based Catalysts in Hydrogen Production from Biomass

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One of the most promising alternative fuel is hydrogen because of its high energy content and reduced greenhouse gas emissions as compared to fossil fuels. Biomass-based hydrogen production is recognized as promising resources for hydrogen production. In this study, steam reforming of acetic acid, as a model compound of biomass source, was performed over silica and alumina based mesoporous materials. Silicate structured mesoporous SBA-15 was synthesized following a hydrothermal procedure and mesoporous alumina (MA) catalyst was prepared by using EISA method. Nickel was incorporated into the structure of catalysts by impregnation method. The physical and structural properties of these catalysts were investigated by characterization methods such as X-ray diffraction (XRD), N2 adsorption-desorption, Transmission electron microscopy (TEM) and thermal analysis (TGA-DTA) techniques. Multipoint BET surface area values of SBA-15 and mesoporous alumina were 652 and 229 m^2/g, respectively. TEM images of the 5Ni@SBA-15 catalyst are consistent with the nitrogen adsorption/desorption analysis and proved the presence of ordered cylindrical mesopores. XRD pattern of silica and alumina based catalysts showed that Ni particles were rather well dispersed on catalysts structure. The performances of the SBA-15 and MA supported Ni based catalysts were highly stable and highly active in steam reforming of acetic acid. Both 5Ni@MA and 5Ni@SBA-15 catalysts showed complete acetic acid conversion with a similar hydrogen selectivity (% 58) values. However, TGA result of the spent catalysts showed that coke deposition over the 5Ni@MA catalyst (% 46) was higher than the 5Ni@SBA-15 catalyst (% 8).

Acknowledgements: Financial support of Gazi University Researcher Fund (BAP 06/2015-05 BAP-06/2016-08) TUBITAK 214M578 are gratefully acknowledged.

Keywords: Hydrogen, Acetic acid, Steam reforming, SBA-15, Alumina, Nickel

[**Abstract:0098**]

Gasification of Sewage Sludge Enriched with Virginia Mallow for Higher Hydrogen Content in Syngas

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The article presents results from investigation of gasification of sewage sludge enriched with biomass from Virginia Mallow in order to obtain a hydrogen-rich syngas. In the analysis, the content of hydrogen in the syngas produced during gasification of dried sewage sludge and Virginia Mallow in a mass ratio of 50/50% was determined. Sewage sludge contains about 50% organic compounds, however, it is a substance difficult to further energy utilization. The dried sludge can be subjected to thermal processing of gasification at temperature above 800°C. However, there are some difficulties in obtaining this temperature due to high content of mineral substances transforming into large amounts of ash during gasification. Thus, it has been proposed a solution based on mixing a high energy component with the sewage sludge in order to improve the gasification parameters. Due to the restrictions on the use of fossil fuels, it was decided to apply for this purpose a dried Virginia Mallow, which is considered as an energy plant with fast and high annual weight gain. The analysis was carried out as an experiment and also as modeling using the Chemkin program. The analysis was based on a 0-dimensional simulation model. A detailed chemical mechanism developed by the CRECK Modeling Group, "Biomass mechanism", has been implemented for the calculations. The mechanism is dedicated to the chemical analysis of processes occurring during thermal biomass conversion. The calculations were carried out for a gasification temperature of 850°C. Obtained results showed that hydrogen content in syngas can increase up to approximately 12%. Furthermore, calculations performed for the case of gasification of the sewage sludge without biomass enrichment showed a three times smaller content of hydrogen than in syngas produced from gasification of sewage sludge with Virginia Mallow.

Keywords: syngas, hydrogen, gasification, Virginia Mallow, sewage sludge, modeling

ORAL ABSTRACTS

[**Abstract:0100**]

Improvement of Operational Characteristics of Sesame Oil in a Compression Ignition Engine with Small Fraction Of Hydrogen Enrichment

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Methods of the improvement of performance and emission characteristics of the internal combustion engines such as biodiesel and hydrogen (H2) usage particularly for compression ignition engines are widely investigated by many researchers all over the world with the awareness of depletion of fossil sources and environmental issues. Also, to eliminate the drawbacks of biodiesel usage such as lower performance and higher carbon dioxide (CO2) and oxides of nitrogen (NOx) is one of the most important popular studies recently. Hydrogen enrichment to biodiesel is a promising alternative method since H2 molecules do not contain carbon atoms. Also the high energy content of H2 (120 Mj/kg) makes it a signifant candidate for the enriching the bio-based renewable fuels. This study explores the effect of small fraction of H2 (5 litre per minute) enrichment to sesame oil biodiesel (SOB) on the performance and emission characteristics of an unmodified compression ignition engine. In the study, fatty acid composition of sesame oil was determined by using gas chromatography (GC) prior to convert it to biodiesel by two stage transesterification. GC measurement results showed that sesame oil has Palmitic acid (C16:0), Stearic acid (C18:0), Oleic acid (C18:1), Linoleic acid (C18:2), Linolenic acid (C18:3), Eicosenoic acid (C20:1), 12.54, 6.09, 44.10, 35.11, 1.02, 1.14 by wt%, in its composition, respectively. The most significant property of SOB was its pour point and measured as -15 oC. Also, calorific value of SOB was 9.71% lower than conventional diesel fuel. The engine experiments showed that operating engine with SOB (100%) increased brake specific fuel consumption (BSFC), CO2 and NOx emissions. But enriching the SOB with H2 gas improved BSFC up to 8.34% while decreasing CO2 emissions up to 16.29%.

Keywords: Hydrogen, Biodiesel, Sesame, Compression ignition engine

[**Abstract:0102**]

Dilution of Fresh Charge for Reducing Combustion Knock in the Internal Combustion Engine Fuelled with Hydrogen Rich Gases

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Although, trend for pure hydrogen use as the only fuel for internal combustion (IC) engines in vehicles is decreasing, but hydrogen is commonly burnt in high power stationary engines for heat and power generation. Hydrogen can appear either as a single gas or as a component in processing gases eg. syngas, hythane and coke gas. Hence, problems concerning effective hydrogen combustion in the IC engines is still current. The most crucial is problem with so-called hydrogen combustion knock, which is harmful to the engine. Paper presents results from experimental investigation focused on dilution of air-fuel mixture for reducing the combustion knock. Dilution can be realized by both exhaust gas recirculation (EGR) and making the combustible mixture lean. It is known that both lean mixtures and EGR can be successfully applied not only for reducing NOx content in exhaust gases but also for reduction of combustion knock in SI engines. From this point of view, both these techniques can be also effective for knock elimination in the internal combustion engine fueled with hydrogen rich gases. Results from this investigation show that applying EGR is more effective than making combustible air-gas mixture lean. Comparison between EGR and lean mixture impact on knock intensity was possible after recalculating these parameters from mass percentage to molar percentage of diluent. Then, it was found that EGR is approximately twice more effective in knock reduction than lean mixtures.

Keywords: hydrogen, syngas, coke gas, IC engine, knock, EGR

[**Abstract:0108**]

SnS Photo-electrodes Produced by Sulfurization of Electrodeposited Sn Films for Photo-electrochemical Water Splitting

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Recently SnS has become attractive for photovoltaic absorber as well as photo electrodes for solar water splitting because of their promising high electron (2.37x104cm2V-1s-1) and holes (7.35x104cm2V-1s-1) mobility and suitable band gap (Eg: 1.2-1.7 eV). In this work,SnS photo-electrodes were investigated for photo-electrochemical splitting of water. They were prepared on indium-doped tin oxide (ITO) coated glass by sulfurization of electrodeposited Sn films at different temperature (300-500oC) in the sulfur vapor atmosphere The effect of electrodeposition parameter (thickness of the film) and sulfurization temperature on photo-electrochemical (PEC) water splitting were investigated. The crystal structure, surface morphology and optical properties of the SnS photo-electrodes were characterized using an X-ray diffractometer (XRD), scanning electron microscopy (SEM) and UV–VIS spectrophotometer, respectively. PEC performances of the SnS photo-electrodes were determined in the 0.1 M NaOH electrolyte solution. The results showed that electrodeposition parameter (thickness of the Sn films) and sulfurization temperature influenced the PEC performance of SnS photo-electrodes. The photo current and efficiency increased as the SnS became the major phase with decreasing temperature and the thickness of the SnS layer decreased.

Keywords: "SnS, Photo-electrode, Electrodeposition, Sulfurization, Hydrogen generation, Water splitting"

[**Abstract:0109**]

Zirconium Metal-Organic Framework Platform as a Heterogeneous Catalysts for Electrochemical Hydrogen Evolution

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Large-scale hydrogen production requires development of alternative low-cost electrocatalysts to be used instead of platinum for hydrogen evolution reaction (HER). Metal-organic frameworks (MOFs) have been attracting great attention because of their porosity, high surface area and modular structural properties. Herein, we prepared a zirconium based MOF using 4,4′,4″,4‴-benzene-1,2,4,5-tetrayltetrabenzoic acid (H_4TBA) and zirconium(IV) chloride. The prepared MOF (Zr-TBA) has high chemical and thermal stability that allows post metalation with cobalt acetate to obtain Zr-TBA@Co via solvothermal deposition method. Zr-TBA@Co thin film has been used as a scaffold for the deposition of sulphur. HER activity of the prepared Zr-TBA@Co_S hybrid material was investigated on both FTO and GC working electrodes in acidic solution. Consequently, the GCE_Zr-TBA@Co_S electrode displayed better activity than the FTO_Zr-TBA@Co_S electrode. Furthermore, two hours chronopotentiometry measurements (CP) significantly increased the catalytic activity of GCE_Zr-TBA@Co_S hybrid materials with an onset potential of 171 mV (vs RHE) and 347 mV for current density of 10 mA cm^{-2}.

Keywords: Hydrogen evolution reaction, Metal-organic frameworks, Heterogeneous electrocatalysis

[**Abstract:0113**]

Enhancement of Hydrogen Charging In Metal Hydride-Based Storage Systems by Using Heat Pipe

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Hydrogen as an energy has come to the forefront within the scope of new energy technologies as being a storable and transportable energy source with high calorific value. Many challenges are remains to store and to use hydrogen efficiently. Metal hydride absorbing material is applied in hydrogen storage because it has features such; generating a large amount of heat with hydrogen absorbing and storing hydrogen compactly. Heat transfer from/to the metal hydride bed is a significant factor affecting the performance of metal hydride storage reactors. In this study, the hydrogen charge process in metal hydride reactors is investigated experimentally in order to explain the influence of heat pipe on the metal hydride process. The enhancement of heat transfer in metal hydride bed is studied under various hydrogen pressure supplies in the range of 2 to10 bar. Three configurations of metal hydride reactors are considered and consisted of tubular cylindrical reactors with same base dimensions. The first one is a closed cylinder that exchanges heat through its lateral and base surfaces by means cool with natural convection. Heat pipe is made of copper–ethanol combination and situated along the axis of the second reactor. The third reactor is similar to the second reactor with additional of aluminum circular fins are manufactured around the heat pipe in order to enhance the heat transfer rate between the hydride powder and the exterior environment. The temperature evolution data on the surface of a cylindrical LaNi5 metal hydride reactor at several locations are recorded under all applied charging pressures. The use of heat pipe can be a good choice to increase hydrogen storing performance (capacity and storage time). The finned heat pipe reactor confirms the less temperature increased in the fastest charging time under all specific amounts of charging pressures investigated. The experimental results showed that the charging of hydride reactors is mainly heat transfer management and the better performance of reactor can be achieved by the configuration which provides successful heat removal.

Keywords: Hydrogen storage, heat transfer, heat pipe, reactor cooling, charging improvement

[**Abstract:0120**]

The Relationship Between Flow Channel Geometry and Pressure Drop in a Direct Methanol Fuel Cell with Parallel Channels

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In this study, the relationship between the pressure drop on the channels due to the methanol flow and the geometry of the flow channels on the anode side of a direct methanol fuel cell has been investigated. Parallel type channels are used as flow channels. The active area of the fuel cell is 5x5 cm^2. The system consists of channels that are optimally placed in the active area, with channel widths and distance of the channels kept constant. Combinations of 1, 1.5, 2, 2.5, 3 mm measurements were used for flow channel width and distance between channels. The ratio of the area created by the prepared geometries to the active area (percentage of contact area) is defined as a new parameter. There was a statistically significant difference between the flow channel widths and the distance between the channels and the pressure.

Keywords: methanol fuel cell, flow channel geometry, pressure drop

[**Abstract:0124**]

Exergetic Comparison of Various Flow Patterns in PEMFCs

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Energy need of the civilized world is ever increasing, and as such, the subject of energy production from renewable energy sources is gaining popularity in scientific studies. Amongst these studies are the researches on fuel cell systems. In this study, the flow channels of the "proton exchange membrane" (PEM) type fuel cell were designed, modelled, and studies were conducted on three-dimensional channels of various designs via Comsol Multiphysics simulation software, with hopes to contribute to the renewable energy solutions. Proposed fuel cell designs and geometries of flow channels were compared to existing fuel cells' with exergetically efficient designs, in terms of total exergy efficiency. Exergy efficiency analysis was conducted on the membrane surfaces of the proposed flow channels. Anode and cathode side exergy analyses, polarization curve of the system, voltage, current and produced power parameter results were also inspected.

Keywords: Fuel Cell, PEM, Comsol Multiphysics, Modeling and Simulation, Flow Plates, Exergy

[**Abstract:0125**]

Quasistatic Model Based Analysis of Direct Methanol Fuel Cell System for Hybrid Vehicular Applications

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Different operating scenarios can be used in a hybrid system based on a direct methanol fuel cell (DMFC) and a battery. In this paper, a DMFC system model is integrated into a model formed for a hybrid vehicular system which consists of a battery, a DMFC stack and its auxiliary equipments, and the model is simulated in MATLAB/Simulink environment using quasistatic approach. An algorithm for the energy managent of the system is also developed considering the state of charge of the battery. In the DMFC system model, DMFC current and empirical data for the polarization curves, and methanol crossover and water crossover rates are taken as the input parameter; whereas the stack voltage, the remaining methanol in the fuel tank and the power demand of auxiliary equipments are taken as the output parameters. In this model, the methanol consumption, and the water and CO2 production are found applying mass balances for each component of the system. The results of the simulations helped to give more insights in the operation of both DMFC system and hybrid system.

Keywords: DMFC, fuel cell system, quasistatic model, vehicular application

[**Abstract:0128**]

Investigation of Hydrogen Fuel Usage Affects On Exergetic and Exergeeconomic Performances of a Turbojet Engine

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In the present paper a comprehensive exergetic and exergoeconomic analyses of a turbojet engine is performed to determine how the hydrogen fuel usage affects the exergetic and exergoeconomic performances of the engine. According to this study, by hydrogen fuel burnt in the turbojet engine, the product exergy rate decreases from 4.06 GJ/h to 4.02 GJ/h because the exhaust gases mass flow rate decreses from 9.21 kg/s to 9.108 kg/s. The exergy efficiency of the engine deduces from 15.40% to 14.33% while the waste exergy rate increases from 22.31GJ/h to 24.01 GJ/h. Hovewer, the fuel cost rate increases from 264.38 US$/h to 1143.72 US$/h while the specific fuel exergy cost rises dramatically from 10.03 US$/GJ to 40.81 US$/GJ. The high increase in the fuel cost rate and specific fuel exergy cost with the hydrogen fuel causes that the specific product exergy cost rises up from 134.69 US$/GJ to 355.11 US$/GJ.

Keywords: turbojet engine, exergetic analysis, exergoeconomic analysis, hydrogen fuel, aircraft

[**Abstract:0130**]

Gas (H2 and O2) Sensing Performance of ZnGa2O4 Thin Films Depending on Active Deep Energy Levels

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We focus on zinc gallate (Zn,Co)Ga2O4 oxide semiconductors, which have limited study on. (Zn,Co)Ga2O4 are direct band gap semiconductors with value 4.4 – 4.7 eV (at room temperature), transparent to the visible light and high refractive index materials. The physical properties make (Zn,Co)Ga2O4 semiconductors be suitable for applications in solar cells, gas sensors, chemical sensors. The aim of this study is to show the point defects dependent gas (H2 and O2) sensing ability above the room temperature and opto electronic behavior of ZnGa2O4 thin films, fabricated via RF magnetron sputtering system. The sensing ability were performed with temperature dependent I-V and C-V curves. The active energy level of (Zn, Co)Ga2O4.to gas sensing were investigated employing DLTS (deep level transition spectrometer) measurements.

Keywords: Gas sensing, Oxide semiconductors, Active Deep Energy Levels

[**Abstract:0131**]

Catalytic and Non-Catalytic Hydrogen Generation from Chemical Hydrides

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Hydrogen is one of the most promising clean energy carriers of future and is a key component in several areas such as carbon dioxide removal, hydrogenation reactions and fuel cells. An extensive research has been conducted in order to find inexpensive and efficient ways to generate and store H2. One of the most widely studied methods of hydrogen generation developed in recent years is the hydrolysis of chemical hydrides (NaBH4, NaAlH4, LiH, LiBH4). Among them, sodium borohydride is a solid hydrogen carrier that has been broadly studied for its high content of hydrogen capacity, non-toxicity and easy-controlled hydrogen generation rate. However, hydrolysis reaction itself has a slow kinetics requiring the presence of a catalyst to accelerate the reaction. Various catalysts have been used in the area of hydrogen generation which were generally noble-metals, non-noble metals, metal-free systems and alloys. Catalysts with various morphologies such as particle forms or film forms have also been investigated. In this study, three different methods of hydrogen generation have been reported. Among them, one is based on catalyst free hydrogen generation while the rest are systems using catalyst. Catalyst involved hydrogen generation systems are the alloys of precious and nonprecious metals cosputtered simultaeously. The process includes dealloying the nonprecious metal from substrate and leaving a nanoporous noble metal behind with large surface area and high catalytic activity. In this study, different combinations of Ru-Al, Pt-Al, Ru-Cu were tested at various process conditions. The highest amount of hydrogen generated by particulate catalysts of Ru-Al alloys was found as 110 L.min-1gcatalyst-1. Catalyst free systems, in comparison, consist of directly disulfonated copolymers at various degrees of disulfonation. The highest obtained hydrogen generation rate in catalyst free system was 235 mL.min-1 for BPSH 45 evaluated in a two-compartment reactor containing acid and NaBH4 solutions separated via proton exchange membranes.

Keywords: Hydrogen generation, catalysts, catalyst morphologies, catalyst free hydrogen generation

[**Abstract:0132**]

Artificial Neural Network Modelling of Hydrogen Storage Properties of LaNi4.75Al0.25 alloys based metal hydride vessels

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Heat transfer is an important factor affecting the performance of metal hydride based hydrogen storage vessels. In the present work an artificial neural network (ANN) model has been created for prediction of the hydrogen storage capacity in finned and non-finned vessels. The ANN was trained and tested by using MATLAB toolbox on a personal computer. As ANN input parameters, time, temperature and hydrogen charge pressure were used, while absorbed hydrogen mass was the output parameter. The model was used to study their influence on the performance of the reactor geometry and hydrogen charging parameters in hydride vessels using LaNi4.75Al0.25 as the storage media and comparing vessels with and without fins as named Vessel 1 and Vessel 2. It was found that the maximum mean absolute percentage error (MRE, %) is less than 7.658%. R2 (%) values for testing were found 99.90 and 99.99 in Vessel 1 and Vessel 2 respectively. The predicted results agreed well with experimental values, verified the applicability of the network model in the estimation of hydrogen storage capacity of non-finned and finned vessels. And also results show that this ANNA models more useful for Vessel 2.

Keywords: Hydrogen storage, metal hydride, ANN, vessel design

ORAL ABSTRACTS

[**Abstract:0134**]

Synthesis and Characterization of Electrocatalyst with Graphene and Multi-Walled Carbon Nanotube Support Material

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Proton exchange membrane fuel cells (PEMFC) have the characterstics of high efficiency, quick start-up, high power density and simple design. PEMFC variants include low temperature PEMFC (LT-PEMFC), high temperature PEM fuel cells (HT-PEMFC). Among the types of PEMFC, there has been recent focus on Polybenzimidazole (PBI) based HT-PEMFC. The higher operating temperatures enable high electrode kinetics, simple water management and easy heat removal. Increased working temperature provides high CO tolerant with concentration up to 5 vol. % and it possible that an HT-PEMFC can be easily connected with a reformer fuelled with hydrocarbon. The carbon supports play an important role in HT-PEMFC applications. Among all kinds of carbon supports, carbon black (CB) has been commonly used due to its high mesoporous distribution and graphite like characteristics. However, CB can be electrochemically oxidized under PEMFC conditions and decrease PEMFC performance. MWCNT and GNP are used instead of using carbon black (CB) which is frequently encountered in the literature as support material. Because MWCNT and GNP provide high thermal and electrical conductivity, chemical stability, high surface area as well as a mechanical durability.

The aim of this study is to investigate the effect of graphene nano pellets (GNP) and multi-walled carbon nanotubes (MWCNT) based carbon supports on PBI based HT-PEMFC under simulated reformate gases. Pt-Ru/GNP-MWCNT (50:50 wt/wt) was synthesized by microwave (MW) irradiation method. Thermal gravimetric analysis (TGA), X-ray diffraction (XRD) and high resolution transmission electron microscope (HRTEM) were used to investigate the microstructure and morphology of the as-prepared catalysts. Electrochemical characterization of the catalysts were carried out by cyclic voltammetry (CV) analysis using a conventional three electrode electrochemical cell connected to a potentiostat. The corresponding electrochemical surface area (ECSA) of the catalyst layers are 55 m2/g and 47.7 m2/g for Pt-Ru/GNP-MWCNT and commercial Pt-Ru/CB catalysts, respectively. Pt-Ru/GNP-MWCNT has a larger ECSA which was directly related to the number of available catalytic sites. The performance tests were done in a single HT-PEMFC hardware with a 5 cm2 active area via the HT-PEMFC test station with H2/CO2/CO reformate gas mixture with 75/22/3 ratio at 160oC without humidification. A comparison of their performance with the standard, commercial Pt-Ru/CB PEMFC catalyst is also presented.

Keywords: HT-PEMFC, fuel cell, cyclic voltammetry studies, carbon nanotubes, graphene

ORAL ABSTRACTS

[**Abstract:0135**]

Axane Commitment for a Sustainable, Reliable, and Field Proven Power Source Though Partnership with Laboratories and Design Efforts

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Axane is a fuel cell system supplier of the Air Liquide group, located in Sassenage. Through the development of systems dedicated to niche markerts and powering of telecom antennas on remote sites, Axane had to cope with technical hurdles to reach ambitious targets in terms of performance, lifetime, availability and system cost. Thanks to a 3-year project dedicated to a better understanding of MEA degradation mechanisms and a 7-year project promoting new technologies for stationary applications and forklift markets, Axane has developed close relations with expertise laboratories to address lifetime and performance issues.

A better understanding of MEA degradation appeared as a priority for the PEMFC industry in order to develop more resistant materials and efficient mitigation strategies. Furthermore, degradations mechanisms are closely linked to operating conditions and as a consequence some damages are specific to the systems in which the MEAs are used.

In this work, detailed post-mortem analyses of different commercial MEAs aged in test benches as well as commercial systems have been carried out. Most of the ageing has been realised in Axane's commercial hardware in order to observe the corresponding specific degradation mechanisms. Multi-scale techniques were involved, giving complementary RESULTS: leak detection with infra-red camera, physic-chemical characterisation of catalyst layers, local performance measurement. This showed that degradations were heterogeneous on the active area: membranes appeared more damaged near the air channels outlet while the cathodic active layers underwent faster degradation in the outlet region of the H2 channels.

The results of this work have been helpful to select MEAs, adapt operating parameters, then optimise hardware geometry (flow-field). Following presentation will detail the key features and benefits of this special partnership, from experience feedback from the field to local analyses and new cell design.

Keywords: fuel cell, lifetime, MEA, degradation, ageing

ORAL ABSTRACTS

[**Abstract:0136**]

Performance Analysis of Compressor Assisted Single Effect Absorption Refrigeration Cycle Coupled With Heliostat Field

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Single effect absorption refrigeration system are usually used for producing cooling and heating by using low and medium heat temperature. In this study a combined cycle consisting of two sub cycles; a Rankin cycle as the top cycle and a compressor assisted single effect absorption cycle with LiBr-H2O working pair as the bottom cycle, the two sub- cycles are coupled together by the turbine-compressor combination and the excess heat from the turbine is used to supply heat to the generator and part of the work from the steam turbine is used to drive the compressor which is placed between the absorber and the evaporator. This added feature is used in the absorption cycle to provide the compression needed in enhancing the cycle performance. The whole system is powered from the solar tower.

To evaluate the thermodynamic performance of the combined cycle, energy and exergy analysis is carried out to study the effect of some parameter mainly the generator heat source and the compression ratio on the performance of the combined cycle. The simulation results show that as the heat input to the generator increases from 50 – 200 kW, the COP decreases from 0.7- 0.43 and exergetic efficiency decreases from 0.65-0.59 respectively. Also by adjusting the compression ratio from 1-1.8 increases the COP from 0.36-0.75 and exergetic efficiency from 0.32- 0.56 respectively.

This cycles are therefore good in providing refrigeration using energy sources such as solar thermal energy in rural areas and places with no access to the grid.

Keywords: Absorption cycle, refrigeration, compressor, Rankin cycle, solar tower

[**Abstract:0147**]

Simulation of a Novel Alternative Fueled Hybrid Electric Vehicle (AF-HEV) with Hydrogen Enriched Internal Combustion Engine

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There are new issues with very little research on the usage of alternative fuels on internal combustion engines (ICE) used in hybrid electric vehicles (HEV). The use of hydrogen, which has perfect combustion and engineering properties gas fuel, as an additional/enriched fuel on an ICE that used for HEV will be investigated in this simulation study for the first time. In this work, the performance and emission values of the internal combustion engine of a hybrid electric vehicle resulting from hydrogen enrichment are simulated. In the simulation, the energy, performance and emission values are given comparatively in comparison with a driving cycle of model vehicle realized with AVL Cruise and AVL Boost programs. The ICE's experimental results used in this study were compiled from authors' other publications for validating the modelled ICE which was computed with AVL Boost. Then it is placed as ICE of HEV in AVL Cruise. The electric machine, battery and transmission of parallel configuration HEV modelled, determined and compared with the basic model. Increasing performance gained with hydrogen enrichment, beside ICE has become more environmentally friendly with hybrid mode. The Model HEV has delivered promising results both as performance and emission values. Addition of hydrogen showed 3,56 % improvement in ICE torque and 2,37% ICE power. Sum of the total fuel consumption and emission pollution decreased by 12,6% and 27% respectively with hybrid mode.

Keywords: Alternative Fuelled Hybrid Electric Vehicles, Hydrogen Enrichment, Emissions, AVL Cruise & Boost.

ORAL ABSTRACTS

[**Abstract:0149**]

Preparation and Characterization of Polyvinyl Alcohol/Chitosan Blended Anion Exchange Membranes for Direct Borohydride Fuel Cells

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Development of liquid based fuel cells for particularly portable applications which are the clean and efficient substitutes for the batteries such as li-ion became more important in the recent years. Direct borohydride fuel cells (DBFC) is a promising sub-class of fuel cells because an alkaline solution of sodium borohydride (NaBH4) as fuel offers the ease of storage and transportation and oxygen, air or hydrogen peroxide as oxidant could be used. DBFCs have the advantages of having a higher theoretical open circuit voltage (OCV), higher energy density (theoretical energy density for a DBFC using oxygen is 9.3 kW h kg-1) and safety compared to proton exhange membrane fuel cells (PEMFC) and direct methanol fuel cells (DMFC). Since sodium borohydride doesn't have any carbon in it CO can not be formed in the cell preventing CO poisioning occuring in cell's anode. Anode, cathode and overall reactions and the potentials (in strongly alkaline media) are as follows:

Anode (Oxidation): BH4- +8OH− → BO2-+ 6H2O+8e− E0=1.24 V (1)

Cathode (Reduction): O2 +2H2O + 4e− → 4OH− E0=0.40 V (2)

Overall Cell Rxn: NaBH4 + 2O2 → NaBO2 + 2H2O E0CELL=1.64V (3)

As in other types of fuel cells, electrolyte membrane is one of the most important component for the commercialization of DBFCs. Both anion-exchange membranes (AEMs) and cation-exchange membranes (CEMs) can be used for DBFCs. AEMs can transport OH- from cathode to anode side with efficient way and naturally suitable for an alkaline DC but BH4- crossover is higher than that of CEM. Alkaline stability of AEMs is limiting their use for long-term operation in DBFCs. The fuel-cell operation conditions, temperature, basicity of environment directly effect stability. Moreover, increasing of temperature or pH value accelerate the degradation of the AEM. Another factor is the ion exchange capacity (IEC) which depends on the degree of swelling ratio and water uptake, or number of the cationic sites of the membrane.

In this study, PVA/CS AEMs were prepared by a modified solution casting method and glutaraldehyde is used as a cross-linking agent. The amount of glutaraldehyde was investigated on the membrane performances. Another investigated parameter is the preparation METHOD: AEMs were prepared by direct and indirect chemical cross-linking. The membranes were studied in their OH- forms and characterized for their ion conductivity with electrochemical impedance spectroscopy (EIS), IEC with titration, mechanical stability by tensile tests, chemical stability with fenton's tests,water uptake, chemical characterization by FTIR. The permeability tests were also performed in a lab made permeability cell with a potentiometric electrochemical method. Results showed that these membranes have a potential if the balance between the crosslinking and the other needed properties could be balanced. Further single fuel cell tests will be performed in the near future.

Keywords: direct borohydride fuel cell, anion exchange membrane, polyvinyl alcohol, chitosan

ORAL ABSTRACTS

[**Abstract:0150**]

Colloidal Synthesis and Characterization of CuInS2 Nanoparticle for Solar Hydrogen Production

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Photoelectrochemical (PEC) solar cells are of great interests ever since the shortage of fossil sources has been alarming scientists to get alternative energy sources such as hydrogen. Hydrogen production by PEC water splitting is considered to be an attractive in view of energy and environmental issues. Solar cells containing thin films prepared by I-III-VI ternary semiconductors are being under investigation as their primary advantage is low production cost. Among them, CuInS2 is one of the most important materials due to its optimum band gap energy for sunlight absorption. The aim of this research is to develop beneficial CuInS2 thin films for solar cells by practical knife coating (so called doctor blade) technique on flurine doped tin oxide (FTO) coated glass substrate. For this purpose, chalcopyrite, zincblende and wurtzite crystals of CIS nanoparticles as well as polytypic crystal form were prepared via facile hot-injection process. All the nanocrystals have been characterized by XRD, EDS and TEM analysis. As one of the most practical non-vacuum deposition techniques, doctor blade, is very promising as it offers a number of combined advantages to lower the manufacturing costs: reduced machine investments, lower maintenance costs, and faster coating capabilities over larger areas, compatibility with roll-to-roll processes for high throughput production, and patterning possibilities for semi-transparent devices. In addition, multiple coatings may be applied to fabricate thin films coatings with suitable thickness. Thus, as-synthesized nanoparticles were redispersed in N, N-dimethylformamide to form ''nanoinks'' which could directly be applied on glass substrate. In doctor's blade method, finding a suitable solvent is crucial for the application since it can directly affect the crack free and uniform surface formation. In this study, we observed that the use of DMF is highly efficient to form suitable thin films having 6.72 % illumination and 0.91% photoconversion efficiencies.

Keywords: Copper indium sulfide, nanoink, hydrogen, photoelectrochemical solar cell

[**Abstract:0151**]

Novel Pd-Co/C Bimetallic Alloy Electrocatalyst for Direct Borohydride Fuel Cell Anode

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In the recent decades, with the increase in the number and variety of portable electronic devices demand in power for these has also increased. Fuel cells and particularly liquid fuel based ones are becoming alternatives of conventional batteries with being clean,their high efficiency and energy/power density promises. H_2-O_2 polymer electrolyte membrane fuel cells (PEMFC) and direct methanol fuel cells (DMFC) are vastly studied. But, fuel cells such as direct borohydride fuel cells (DBFC) are also very good candidates and needs more improvements. Also, they have some advantages over PEMFC and DMFC. Since sodium borohydride doesn't have any carbon in it CO can not be formed in the cell preventing CO poisioning occuring in cell's anode. Also DBFC uses borohydride ion directly as fuel, meaning no H_2 is formed, removing the need of a reformer and the problem of H_2 storage.

With these motivations a Pd-Co/C bimetallic alloy anode electrocatalyst for DBFC was being developed and researched to investigate its activity towards borohydride oxidation reaction (BOR). The electocatalyst was prepared via a modified Polyol method using ethylene glycol as the reducing agent and acetate salts of Pd and Co as precursors. Vulcan XC-72 was used as catalyst support material. The catalyst was prepared at 210 °C, and pH value of 10 at a continuously stirred pressured reactor under the pressure of 20 bars in nitrogen media. The electrocatalyst preparation reaction lasts 2 hours. The catalyst was characterized using X-ray diffractometer (XRD), Transmission Electrone Microscope (TEM), Energy Dispersive X-ray Spectroscopy (EDX) and Inductive Coupled Plasma Optic Emission Spectroscopy (ICP-OES) to determine its physical and structural characteristics. To study its activity towards BOR; Cyclic Voltammetry (CV), Linear Sweep Voltammetry (LSV) and Chronoamperometry electrochemical methods were used. These methods were used to determine the selectivity of the catalyst towards BOR, its electrochemically active surface area (ECSA), stability and number of electrons produced as a result of BOR.

XRD results showed no oxidation peaks for Co and Pd oxides. ICP-OES results showed the metal loading of the catalyst was %12 by weight and the ratio of Pd:Co by weight is 1:1. CV results showed a good selectivity towards BOR and ECSA value calculated was 71,0 cm^2/mg. According to chronoamperomety study, compared to Pd/C prepared via the same method under same conditions Pd-Co/C catalyst showed more current density and stability.

Keywords: Direct Borohydride Fuel Cells, Pd-Co Nanoparticles, Anode Catalyst

ORAL ABSTRACTS

[**Abstract:0152**]

A Comparative Study on the Determination of Borohydride Permeability of Cation Exchange Membranes for DBFC

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Direct borohydride fuel cell technology is a promising technology for especially protable applications because of the high theoretical energy density and for the advantageous liquid fuel. For Turkey in particular, technologies utilizing boron containing compounds are important since a vast share of world boron sources are located in the country. However, there are a number of technical obstacles to be solved. One of them is the borohydride crossover to the cathode which will cause a mixed potential as a result of the oxidation at the cathode part.

Similar to the other classes of fuel cells, membrane is one of the key components to the commercialization of DBFCs. A good polymer electrolyte membrane must have the impermeability for the reactant and oxidant used (problem in particular for liquid reactant systems). Membrane properties affects all the system performance and electro-catalyst choice and preparation method at first. Nafion® still seems to be the membrane used mostly for DBFCs also because of its teflon like fluorinated backbone and related high chemical-mechanical- thermal stabilities for both PEMFCs and DMFCs. But Nafion® has also well-known drawbacks such as being very expensive (an important barrier for commercializaton), being dependent on full hydration (sharp decrease at temperatures over 80 °C) and high permeability to reactants especially methanol because of its well separated channels and the dependence of water. One of the difficulties in the research on borohydride-based systems is related to the determination of the borohydride concentration particularly for permeability determination.

For this purpose, there are a number of methods are avaliable but it must be fast, non-destructive and should not change the concentration. Therefore, a potentiometric electrochemical method seems to be a good choice. When immersed in sodium borohydride alkaline solutions, different electrode materials give very different responses to the borohydride presence. So the choice and comparison of the electrode materials are very important.

Another technique that we choose includes the combined usage of the acid-base and iodometric titration methods. The acid-base titration method, which simultaneously uses the technique of differentiation and computer simulation of titration curves, allows one to determine the contents of hydroxide and total "borate +borohydride" content. The iodometric titration method allows one to selectively determine borohydride. The average determination error depends on the number and ratio of compounds in a mixture. In this study both the gold and platinum electrode responses for portentometric measurements were investigated and the results are compared with combined acid-base and iodometric method. The two membranes fort he comparison of permeability results are CEM membranes which are commercial Nafion 117 and sulfonated polyether ether ketone (SPEEK) produced in laboratory. Specific details of the both analysis' of two different techniques will be discussed.

Keywords: dbfc, crossover, permeability, borohydride, ocp, titration

ORAL ABSTRACTS

[**Abstract:0153**]

A Labview-FPGA Based Process Control and Power Conditioning Prototype Application of a Fuel Cell Powered Range Extender for Unmanned Aerial Vehicles

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This paper will focus on an embedded Labview-FPGA based data acquisition and control system, which was designed to provide a self-regulated process of the hydrogen generation and power conditioning systems of a fuel cell powered small unmanned aerial vehicle. The hydrogen generation system utilizing sodium borohydride solution is able to produce 4 L/min of hydrogen with the aim of extending the range of the UAV. The critical parameters for on-site hydrogen production like temperature, pressure, mass flow, chemical sensor's output signals and voltage were monitored in real time via the NI sbRIO-9626 control card and Labview FPGA toolkit software. On the power conditioning side, according to the real time output values of the sensors; the required analog and digital signals were evaluated to actuate valves and drive the brushless DC motor and the MOSFETs to manage the power properly. In this study, the combined hardware-software implementation of the experimental and prototype control set-ups will be introduced and performance test results will be given as well.

Keywords: Fuel cell, Embedded process control, Power Conditioning, Range extender, UAV, Sodium borohydride

[**Abstract:0154**]

Investigation of Optimum Hydraulic Retention Time (HRT) of Semi-batch Photofermentation Process in a Three-stage System

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Hydrogen is a promising energy carrier and important player in future energy systems. It has not only higher conversion efficiency to usable power, but it also can play a substantial role for reduction of greenhouse gas emissions. Biological hydrogen production (biohydrogen), which can be produced by direct biophotolysis, indirect biophotolysis, dark fermentation and photofermentation processes, is one of the hydrogen production methods. Within this scope, biological hydrogen production is considered as the most environmentally friendly route of producing hydrogen gas.

This photofermentation research study investigates the third-stage of an integrated three-stage system, which consists of dark fermentation, methanogenesis and photofermentation, to improve the total energy of the integrated system. To that purpose, a set of semi-batch photofermentation reactors were operated. It was aimed to determine the optimum hydraulic retention time (HRT) of photofermentation stage leading to the optimization of energy production in three-stage system. In this direction, three different HRT values of 2, 4 and 6 days were studied. Thus, it was planned to investigate hydrogen production rate and hydrogen yield of semi-batch photofermentation reactors. The photofermentation process was followed by using pure strain of purple non-sulfur (PNS) bacteria, *Rhodobacter capsulatus* DSM1710. Results indicated that, under the studied conditions, HRT value which provided the highest hydrogen production rate was determined as 4 days. The highest production rate was observed as 0.041 mmol/L.hour at that condition. When hydrogen yields were examined, HRT value of 6 days provided the highest hydrogen yield of 0.622 mol H2/mol HAc (0.0194 g H2/g COD-HAc). It was expected that higher hydrogen production yield could provide higher total thermal energy in three-stage system. Therefore, the optimum HRT value for photofermentation process operated in semi-batch mode was determined as 6 days.

Keywords: Biohydrogen, hydraulic retention time (HRT), photofermentation, Rhodobacter capsulatus, solid retention time (SRT)

ORAL ABSTRACTS

[**Abstract:0155**]

Electrochemical Characterization of Carbon-Supported Bimetalic Pd-Zn Nanoparticles as Anode Catalyst for Direct Borohydride Fuel Cells

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The demand for new and clean energy supply systems is increasing due to the increasing environmental concern of emissions derived from the use of fossil fuels. Hydrogen based fuel cells are one of the alternative technologies providing highly efficient energy conversion systems, in which electrical energy is produced directly from the chemical energy of hydrogen. However, hydrogen storage and handling problems must be resolved for successful commercialization of fuel cells. Energy can be obtained simply by an electrochemical reaction between hydrogen and oxygen in the fuel cells (Liu et al. 2015). Direct borohydride fuel cells (DBFC) differ from conventional fuel cells as aqueous solution of sodium borohydride is fed to DBFC. In addition, DBFC has many advantages such as high energy density (9300 Wh kg-1), high theoretical open cell voltage (1.64 V), easy start-up and low toxicity. (Li et al. 2013). Therefore, one approach for solving the problem of hydrogen production and storage by using high-pressure cylinders is the use of DBFC for portable applications

In this work, Vulcan XC-72 carbon supported bimetallic PdZn nanoparticles catalyst with a fixed molar ratio of Pd:Zn (3:1) was prepared by NaBH4 impregnation-reduction technique with ultrasound irradiation. The catalyst was prepared with 20 wt% metal loading on the support. Physical properties of the catalyst were described by using X-ray diffraction (XRD), Transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS) technologies. Electrochemical characterization of PdZn nanoparticle catalyst was performed by cyclic voltammetry (CV), chronoamperometry (CA) and Linear Sweep Voltammetry (LSV). The catalytic activity of the Pd3Zn/C catalyst for borohydride electrooxidation was investigated by CV. Hydrogen oxidation and direct oxidation of borohydride peaks are observed in the positive-going sweep. In the reverse potential sweep, the oxidation peak is attributed to the electrooxidation of absorbed BH3OH- formed as a byproduct in the process of the BH4- electrooxidation. The peak current density of direct oxidation of borohydride is 22.5 mA/cm2.The electrochemical surface area (ECSA) were determined from the areas of the peaks in voltammograms obtained by CV. The calculated ECSA of Pd3Zn/C catalyst is 987 cm2/mg. Chronoamperometry was used to interpret on the overall electrocatalytic performance of the catalyst for the desired reaction. Linear Sweep Voltammetry was used in a rotating disc electrode system to calculate the number of electrons. The results show that the bimetallic catalyst can be utilized for the DBFC system.

Keywords: Direct borohydride fuel cells, Pd-Zn nanoparticles, Anode catalyst,

[**Abstract:0157**]

HHO Enrichment of Bio-Diesohol Fuel Blends in a Single Cylinder Diesel Engine

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One of the primary aims of this experimental investigation is to examine hydroxy-gas enrichment effects on environmentally friendly but performance-reducing alternative fuels such as ethanol and biodiesel. Entire HHO system has integrated into engine test rig for this purpose. Two different fuel mixtures were prepared and named by their volumetric compositions which are Biodiesohol (10/5/85) and Biodiesohol (15/5/80). Biodiesohol was used to describe biodiesel, ethanol and standard diesel blends. Specific fuel properties are measured and ensured to be in EN590 and EN 14214 standards. Experiments were conducted on a single cylinder diesel engine which was fuelled with diesel-biodiesel-ethanol fuel blends whose enriched by 1 liter per minute HHO gas fuel during the entire tests. All the experiments were performed under full load condition within the range of 1200 to 3200 rpm and graphical points were selected at intervals of 100 rpm. From the view of performance; brake power, brake specific fuel consumption and thermal efficiency results were discussed; additionally carbon monoxide and nitrogen oxides as exhaust emission results were also measured and presented. Standard diesel fuel outputs were determined as the reference line to compare experimental results. A number of studies have been conducted with fuels used in this experimental study and their mixture in different ratios as well, but an examination of the HHO addition to biodisohol is performed for the first time in this research area of the literature.

Keywords: Hydroxy gas enrichment, single cylinder diesel engine, ethanol, biodiesel, performance, emission

[**Abstract:0160**]

A Design of Automated HHO System for Optimum Volumetric Efficiency

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As demonstrated in scientific studies; hydrogen which is produced by electrolysis method can be a supplementary fuel for diesel engines. On the other hand, it has been determined that the adaptation of the HHO system to the operating principles of internal combustion engines is highly necessary in terms of total energy efficiency and it is aimed to be solved by this study. For this purpose, a control unit was designed to control the amount of HHO production automatically by adjusting the current drawn from the engine's battery so that the stable volumetric efficiency could be sustained at any determined engine speed ranges.The continuous constant volumetric flow rate of produced hydrogen as HHO and variable mass airflow rate related to engine speed has provided without degrading the volumetric efficiency, thus can lead better combustion. Amount of necessary HHO can be produced interdependent to the low, medium and high engine speeds by the aid of designed HHO control system which is designed to control with the current automatically. HHO control system is designed in MATLAB/ Simulink. The flow chart and the structure of the generated electronic control mechanism are presented with figures.

Keywords: HHO Control System, volumetric efficiency, hydrogen, engine speed

[**Abstract:0166**]

Photocatalytic Hydrogen Production with Metal Oxide Bulk Structures

***Gizem Yanalak*[1], *Abdalaziz Aljabour*[2], *Emre Aslan*[1], *Faruk Ozel*[3], *Imren Hatay Patir*[4]**

Three types of metal oxide catalysts (NiO, Co3O4, Mn3O4) have been synthesized by solid state method and characterized by using Scanning Electron Microscopy (SEM) and X-ray Powder Diffraction (XRD). These structures have been used as catalysts for the photocatalytic hydrogen evolution from water without using any co-catalyst under the visible light irradiation by using triethanolamine as an electron donor and Eosin-y dye as a photosensitizer. It is found that the photocatalytic hydrogen evolution activities follow the order as: Mn3O4<Co3O4<NiO (135 μmolg-1h-1, 901 μmolg-1h-1, 937 μmolg-1h-1, respectively). These results demonstrated that NiO and Co3O4 catalysts have been showed approximately 7 times higher photocatalytic hydrogen activities than Mn3O4. This is thought to be due to the difference in the electronegativity, charge carrier separation and transport efficiency of metals.

This study has been supported by TUBITAK-1003 project (215M309), UNESCO-Loreal "For Women in Science" program scholarship and Turkish Academy of Sciences GEBIP fellowship.

Keywords: Metal oxide, hydrogen evolution, co-catalyst free

[**Abstract:0170**]

Hydrogen Evolution at the Water/DCE Interface Catalyzed by Cu2WS4

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A novel inorganic highly crystalline ternary electrocatalyst for the hydrogen evolution reaction (HER) is reported as cheap and active. Ternary cubic and cubiclike Cu2WS4 have been synthesized by simple and low-cost hot-injection method to minimize the reaction time and required pressure. The synthesized Cu2WS4 have been characterized by XRD, SEM, TEM, Raman spectra methods. The catalytic activity of Cu2WS4 has been investigated at water/DCE interface by two-phase reactions and 4-electrode methods. Kinetic study of HER has been carried out by integrated rate law. The rate of hydrogen evolution reaction in the presence of Cu2WS4 catalyst results in the enhanced catalytic activity by about 1000-fold, when compared to that in the absence of Cu2WS4 catalyst [1].

This study has been supported by TUBITAK-1003 project (215M309), UNESCO-Loreal "For Women in Science" program scholarship and Turkish Academy of Sciences GEBIP fellowship.

Keywords: hydrogen evolution, liquid/liquid interfaces, metal sulfide catalyst

ORAL ABSTRACTS

[**Abstract:0171**]

The Hydrogen Evolution Reaction Catalyzed by Metal Oxide and Metal Sulfide Catalysts at Soft Interfaces

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Cheap, active, and consisted of abundant element catalysts are crucial for the development of efficient hydrogen evolution. Electrocatalytic hydrogen evolution reaction has been usually working with modified solid electrodes. Electrochemistry at the interface between two immiscible electrolyte solutions (ITIES) is also known as another approach to study electrocatalytic reactions. Hydrogen evolution reaction (HER) at the liquid/liquid interface by organic electron donor decamethylferrocene (DMFc) is taken place very slow rate [1]. For this reason, some catalysts are needed to increase the reaction rate. In this study, HER at the water/DCE interface have been investigated by metal oxide and metal sulfide catalysts such as NiO, Co3O4, WS2, MoS2 and Cu2WS4 [2-4]. Catalytic activities of these catalysts have been also compared to each other.

This study has been supported by TUBITAK-1003 project (215M309), UNESCO-Loreal "For Women in Science" program scholarship and Turkish Academy of Sciences GEBIP fellowship.

Keywords: hydrogen evolution, liquid/liquid interfaces, metal sulfide catalysts, metal oxide catalysts

[**Abstract:0172**]

Effect of Channel Bend in Serpentine Flow Field Design Pattern for PEMFC

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Proton exchange membrane (PEM) fuel cell becomes more viable for fulfilling growing demand of alternative energy. For this reason, it is very important to develop an efficient system for PEM fuel cell. Numerical analysis facilitates better technical tools to analyze suitable and optimal design criteria with an understanding into the internal phenomena of PEM fuel cell instead of experimental measurements, which are highly expensive and time consuming. Flow field design is one of the major research parameter of the system since the appropriate flow field design can improve the cell performance significantly. Among the different types of flow field design patterns, serpentine flow field is one of the most suitable design for better PEM fuel cell. However, one of the biggest drawback of serpentine flow field is high channel pressure drop. In this study, a mathematical model including computational fluid dynamics, electrochemistry and species transport is developed. The model is first solved for traditional serpentine design and the mathematical model is validated with experimental results. Channel bend effect on single serpentine channel is numerically analyzed with consideration of channel pressure drop as well as cell performance. The aspect ratio of bipolar plate with different number of channel bend is taken into account for more effective serpentine flow field design.

Keywords: Aspect ratio, Bipolar Plate, Flow field design, Pressure drop, Proton exchange membrane fuel cell.

[**Abstract:0173**]

Numerical Investigation of Conventional Flow Field Patterns in Proton Exchange Membrane Fuel Cell

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Flow field pattern intricately facilitates reactive species transport along the reactive zone in the proton exchange membrane fuel cell (PEMFC). Every flow field pattern has its own distinctive flow characteristics having pros and cons. Therefore, a suitable flow field pattern can enhance the cell performance significantly. In this study, the most common flow field patterns (parallel, pin, serpentine and interdigitated) are comparatively studied investigating the transport phenomena and cell performance to identify the pros and cons of the conventional flow field patterns. A validated three dimensional numerical model of an active area of 2 cm2 is considered analyzing the mass transport, pressure drop and water concentration. The predicted results showed that cell performance as well as transport phenomena are highly dependent on the cathode side of the flow field. The model predicted better mass transport and water management especially of the cathode compartment for the interdigitated, serpentine and pin flow fields through a descendant order where severe mal-distribution of mass transport and excessive water accumulation indicated in the parallel flow field. As a whole outcome of the study, interdigitated flow field has the best cell performance, while parallel has the least.

Keywords: parallel serpentine interdigitated pin flow field design, mass transport, water distribution, pressure drop, cell performance.

[**Abstract:0174**]

System Design and Optimization of a Hydrogen Fuel Cell Vehicle in the Different Road Models

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With the acceleration of the development process of hydrogen fuel cell vehicles, it has become very important to maximize the energy stored in the vehicle and to use the vehicle with high efficiency. The fuel cell, which is located within a hydrogen fuel cell vehicle, is inadequate to require at the first working time and high power demands. For the solution of this, the battery and supercapacitor technologies are used to supply the extra power and energy demands of the fuel cell. These demands vary according to the road conditions of the region. In this study, the system design and optimization of a hydrogen fuel cell vehicle that improves fuel economy and energy efficiency in various road conditions have realized.

Keywords: Fuel cell, battery, supercapacitor, fuel economy, road models

[**Abstract:0175**]

Integration of Renewable Energy Systems with Hydrogen Technologies

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Renewable energy systems becomes more important as conventional energy generation methods gets more expensive and less reliable. This will lead a transition to 100% renewable energy systems from the current situation which will require smart grid technologies. The excess energy generated from renewable energy sources needs to be stored in a convenient way in order to use when one or some of the renewable energy source is not available. Fuel cells and hydrogen can play a big role in the smart grid area.

There is already applications of co-production of hydrogen and electricity such as DFC-H2 plants in California. This technology can be used with all renewable energy sources and Turkey has a huge potential for producing hydrogen and electricity from wind energy. There are many possibilities for a wind – hydrogen smart grid as Turkey is only beginning the transition to renewable energy systems.

Keywords: Smart grid, hydrogen cell, wind energy

[**Abstract:0177**]

Effective TiO2 Supported Cu-Complex Catalyst in NaBH4 Hydrolysis Reaction to Hydrogen Generation

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Hydrogen and fuel cell technology are currently in an intense development phase and many improvements have been accomplished, however the set-up of appropriate hydrogen storage technologies still represents a challenge (Bennici, 2011)

Between the most suitable and safe technologies for H2 storages metal borohydrides have a potential for portable and portable and stationary applications due to their high energy density storage at room temperature and atmospheric pressure (Demirci, 2009).

NaBH4 can be utilized as sources of a high purity hydrogen generatedby the hydrolysis reaction which is easily controlled by catalyst.

In this study, Cu-Schiff Base complex which we synthesized before (Kilinc.2012) was used to support TiO2 for getting TiO2 supported-Cu-Schiff Base complex. And this complex was used as a catalyst for hydrolysis of NaBH4 to H2 generation. TiO2 supported-Cu(II) complex catalyzed NaBH4 hydrolysis reaction was researched based on several parameters. Also the catalyst were caracterized with some analysis techniques like XRD, FT-IR, BET, SEM. As a result it seen that TiO2 supported-Cu(II)-Schiff Base complex was highly efficent catalyst in NaBH4 hydrolysis to H2 generation.

Keywords: NaBH4, Hydrolysis, Schiff Base Complex, H2 Generation.

[**Abstract:0181**]

The Impact of Boron Nitride Nanoparticles on Hydrogen Uptake Capacity over MWCNTs

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In this present study, Hydrogen uptake capacity of purified multiwalled carbon nanotubes (MWCNTs) and hexagonal boron nitride (h-BN) decorated multiwalled carbon nanotubes (h-BN/MWCNTs) were investigated at room temperature and under pressures of 25 bar. The purification of MWCNTs was performed by using KMnO4/H2SO4 oxidizing agents. After oxidative treatment, h-BN nanoparticles successfully embedded on purified MWCNTs by wet chemical method. Characterization and morphology analyses of h-BN/MWCNTs were performed using X-ray diffraction (XRD), Energy Dispersive X-ray (EDX), Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) analyses to determine the structure of the obtained h-BN/MWCNTs. The hydrogen uptake capacity of purified MWCNTs and h-BN/MWCNTs were measured under room temperature and pressures of 25 bar. It was observed that h-BN nanoparticles supplementation drastically enhanced the hydrogen storage capacity over MWCNTs.

Keywords: Hydrogen storage, hexagonal boron nitride, carbon nanotubes

[**Abstract:0184**]

Thermodynamic Analysis of a New Solar Power Tower Based Integrated System for Hydrogen Production and Liquefaction

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In this paper, thermodynamic analysis of a solar power tower based integrated system with hydrogen production and liquefaction is investigated for better environmentally-benign operation. The proposed integrated system is consisted of mainly eight sub-systems; a solar power tower, a high temperature steam electrolysis, a steam Rankine cycle with two turbines, a hydrogen liquefaction process, a quadruple effect absorption cooling system, a drying process, a membrane distillation unit and a domestic hot water tank to supply hydrogen, electrical power, heating, cooling, dry products, fresh water and hot water production for a community. The energy and exergy efficiencies of the integrated system are found as 65.17% and 62.35%, respectively. The parametric studies are carried out to investigate the impact of various system design parameters on the sub-systems exergy destruction rates and exergy efficiencies. In addition, the effect of ambient temperature on exergy destruction rate and exergy efficiency for the integrated system components and whole system.

Keywords: Solar energy, hydrogen, energy, exergy, multigeneration

[**Abstract:0188**]

Thrust Modelling for a Solid Oxide Fuel Cell and Gas Turbine (SOFC/GT) Hybrid Propulsion System

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The economical crisis and depletion of conventional fuel resources are major concerns of the 21st century. Facing these challenges are the main drivers of the researches and studies in the field of energy associated with science and engineering. In aerospace science, one of the prominent energy consuming fields, it is required to achieve either more efficient or alternative energy conversion systems. However, efficiency improvement in conventional propulsion systems is considered to be reached limits as more as possible depending on materials science limitations. That implication leads to development of novel and alternative propulsion systems. The mostly preferred system is electric motor driven propulsion system. Additionaly, the main goal of all these researches is to realize all electric arcraft concept. In the light of these considerations, all energy demand of an aircraft, including thrust, should be supplied by an electric power generator. Thermal batteries were used at first to partially supply energy to the aircraft systems. But over the last decade, numerous new generation propulsion systems have been studied. The main objective of this study is to provide a basis for future researches on Solid Oxide Fuel Cell and Gas Turbine (SOFC/GT) hybrid propulsion systems. In this regard, a SOFC/GT hybrid system is studied and thrust generated by a SOFC/GT is parametrically modelled.

Keywords: Aircraft, hybrid propulsion, more electric aircraft, propulsion, SOFC/GT, thrust

[**Abstract:0192**]

Integrating of PEM Electrolyzer for Hydrogen Production in a Kalina Cycle Driven by Low-grade Geothermal Energy

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The possibility of utilizing low temperature heat source systems for producing electricity has been significant due to increasing energy demand. The Kalina cycle is a power generation cycle which uses ammonia-water mixture as working fluid. In this study, Kalina cycle integrated with proton exchange membrane (PEM) electrolyzer is analyzed thermodynamically through exergy method. In addition, the effect of key parameters such as concentration at the turbine inlet and turbine inlet temperature is discussed. An analysis based on the first and second laws of thermodynamics and basic heat transfer relations is used to illustrate the operational limits and performance characteristics of these power plants.

Keywords: PEM electrolyzer, Kalina cycle, Geothermal energy

[**Abstract:0195**]

Investigation of Hydrogen Generation from Sodium Borohydride Hydrolysis Reaction with Different Catalyst

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In this study, hydrogen gas (H_2) was generated from sodium borohydride ($NaBH_4$), a chemical compound that stores significant amount of H_2 and plays a role in H_2 generation, at the moment of need for portable fuel cells, thereby eliminating all the risks and difficulties of H_2 storage to obtain high efficiency of generation H_2. Based on Proton Exchange Membrane Fuel Cell (PEMFC) which is the most suitable for portable fuel cell applications, $NaBH_4$ weight (2.582 %, 3.823 % and 5.033 %), the effects of different temperatures (27°C, 47°C and 67°C) and the different types of catalysts (platinum/carbon (Pt/C), platinum/grafen (Pt/G) and platinum/multiwall carbon nanotube (Pt/MWCNT)) experiments was carried out by keeping the Pt mass constant were studied experimentally and kinetic study was made. An on-demand H_2 generation system for portable PEMFC has more than 90% conversion rate was developed.

Keywords: Hydrogen generation, hydrolysis, catalyst, sodium borohydride

[**Abstract:0196**]

A Numerical Study of Mild Flameless Combustion of Methane/Hydrogen Mixtures in a Furnace

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This numerical study focuses on the mild flameless combustion of methane and hydrogen fuels in a laboratory-scale pilot furnace based on the experimental study of Ayoub et al. at various preheating levels. The combustion emissions of both fuels under the mild flameless condition at various preheating levels are presented. The results show that the mild flameless combustion regime is achieved with the combustion of both fuel with and without preheating. Additionally, increase of the preheating level of the oxidizer causes to increase the NOx emissions for two fuels.

Keywords: mild flameless combustion, preheating, furnace

ORAL ABSTRACTS

[**Abstract:0197**]

An Investigation of the Mild Flameless Combustion Behaviour of Methane and Hydrogen Fuels under the Various Preheating Levels in a Furnace

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This numerical study focuses on the mild flameless combustion of methane and hydrogen fuels in a laboratory-scale pilot furnace based on the experimental study of Ayoub et al. at various preheating levels. The combustion emissions of both fuels under the mild flameless condition at various preheating levels are presented. The results show that the mild flameless combustion regime is achieved with the combustion of both fuel with and without preheating. Additionally, increase of the preheating level of the oxidizer causes to increase the NOx emissions for two fuels.

Keywords: mild flameless combustion, preheating, furnace

[**Abstract:0199**]

Mathematical Modeling of a Flowing Electrolyte-Direct Methanol Fuel Cell Using Comsol Multiphysics

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Direct methanol fuel cell is a promising candidate for portable applications because fuel is liquid at low temperatures, easily stored and cheap. However, the problem of methanol crossover from anode to cathode, is the main problem for the commercialization of this fuel cell due to performance degradation. In order to prevent methanol crosover, the flowing electrolyte-direct methanol fuel cell (FE-DMFC) is considered as a potential solution. In this type of fuel cell, the anode and the cathode are separated by the porous flowing electrolyte channel, where a liquid electrolyte (for example, sulfuric acid) flows. Membranes are placed on both sides of this porous channel and the methanol crossover is mostly prevented by the flowing electrolyte. Many researchers have modeled this fuel cell, however the majority of these studies are single phase and developed using 1D or 2D techniques. In this study, a three dimensional and two phase FE-DMFC model has been modelled to examine the baseline condition of this fuel cell to obtain more realistic modeling predictions. Main equations such as continuity, momentum, charge, and transport of methanol, water and oxygen species are combined with basic mixture equations and auxiliary equations using the commercial software Comsol Multiphysics.

Keywords: Comsol Multiphysics, DMFC, FE-DMFC, simulation, two phase

[**Abstract:0202**]

A Parametric Study on Exergetic Performance of Hydropower Integrated Hydrogen Production: A Case Study for East Black-Sea Region of Turkey

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The main objective of this study is to perform a parametric study on exergetic performance of the run-of-the-river hydropower integrated hydrogen production via high-pressure-PEM electrolyser in terms of the second law of thermodynamics. For this purpose, the following parameters are taken into consideration: i) Gross head (=50-300m), ii) Discharge (=0.2-0.4 m3/s), iii) Pure water flow. In this regard, in order to determine the exergetic performance of the run-of-the-river hydropower integrated high-pressure-PEM electrolyser, the hydrogen production rates have been calculated based on the power generated from this hydropower plant. It is determined that run-of-the river mini hydropower plant generates power between 75.5 kW and 905 kW based on the gross head, ranging from 50 m to 300 m, and the discharge, ranging from 0.2 m3/s to 0.4 m3/s. Depending on these values, it is estimated that the PEM electrolyser produces hydrogen gas ranging from 1.325 kg/h (=14.928 Nm3/h) to 15.966 kg/h (=180 Nm3/h) at 30 bar and 70 °C. Moreover, exergy efficiency is found to be 0.543 at 0.4 m3/s for 50 m and 0.545 at the discharge of 0.2m3/s for 300 m of gross head. Accordingly, it can be said that exergetic efficiency of the process decreases with the rise of the discharge at a constant gross head while the hydrogen production rate increases with the rise of electricity generation.

Keywords: Exergy efficiency, Hydrogen, PEM electrolyzer, run-of-river mini hydropower, discharge, gross head.

[**Abstract:0205**]

Metal-Schiff Base Complex Catalyst in KBH4 Hydrolysis Reaction for Hydrogen Generation

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Hydrogen is often presented as one of the potential, sustainable alternatives to fossil fuels as it has the highest energy per mass. Hydrogen storage is a major obstacle in the way of the development of a near-future hydrogen economy. A number of potential solutions have been investigated so far (Demirci, 2017).

Among others, potassium borohydride (KBH4) appears to be a promising candidate because of its hydrogen storage capacity exceeds 7.4 wt. % H2 and similar to that of NaBH4 (hygroscopicity, self-hydrolysis, exothermic hydrolysis with -220 kJ/mol, better stability in basic medium, accelerated kinetics in the presences of Co catalysts (Zhu, 2008)

In this research, the new Co-Schiff Base complex that prepared 5-Amino-2,4-dichlorophenol-3,5-ditertbutylsalisylaldimine ligand (Kilinc, 2017) was synthesed. This complex was used as a catalyst to hydrolysis of KBH4 for H2 production. KBH4 hydrolysis reaction which catalyzed with Co-Schiff Base complex was investigated depend on concentration of KBH4, concentration of NaOH, temperature, percentage of Co complex and amount of catalyst. In addition the catalyst and products were caracterized with some analysis technique like XRD, FT-IR, BET, SEM. As a result it seen that Co-Schiff Base complex was effective catalyst in KBH4 hydrolysis for H2 production.

Keywords: KBH4, Co-Complex, H2 Production

[**Abstract:0211**]

Hydrogen Gas Production from Wastewater by Electro-hydrolysis

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Hydrogen gas production was obtained from organics present in wastewater by electro-hydrolysis. Electrical current generated by a using photovoltaic cells and was applied to wastewater using electrodes. Stainless steel electrode was used in a well-sealed and mechanically mixed reactor. Control experiments with electrical power application to water and wastewater were also performed to determine hydrogen gas production. Hydrogen gas production from electrolysis of pure water was less than 15% of that obtained from wastewater indicating that the major fraction of hydrogen gas was generated by electro-hydrolysis of organic compounds. Hydrogen gas yields up to 7.14 L H2 g-1 TOC were obtained. Hydrogen gas fraction in the gas phase varied between 75 and 99%. Hydrogen gas production from electro-hydrolysis of wastewater using electrical power from photovoltaic cells was proven to be an inexpensive, fast and energy efficient method with TOC removal.

Keywords: Electro-hydrolysis, hydrogen gas production, wastewater

[**Abstract:0212**]

Electrohydrolysis Application on Metal Plating Wastewater to Produce Hydrogen Gas

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Hydrogen gas production was investigated by electrohydrolysis method using metal plating washing wastewater due to high metal concentration in wastewater. Wastewater contains chrome, copper and nickel metals which can accelerate the hydrogen gas production. Different voltages generated by DC power supply were applied to metal plating wastewater in order to produce hydrogen gas. Effects of the voltage, reaction time and kind of metal on percent hydrogen gas production were investigated. After application of different DC voltages on each metallic wastewater, cumulative hydrogen gas volume and total organic carbon removal with different reaction times were also evaluated. Cumulative hydrogen gas volume increased up to 4V and then decreased with increasing voltages above 4V. Percent hydrogen gas in the gas phase also varied during the course of experiments and reached to nearly pure H2 gas (95-99% H2) at 4 V. The optimum DC voltage maximizing cumulative hydrogen gas volume (3500 ml), H2 production rate (866 ml H2 d-1) and hydrogen percentage (100%) in the gas phase was obtained with chromic wastewater at 4V. Nearly pure hydrogen gas formation in the gas phase is a significant development since the produced hydrogen gas can directly be used in fuel cells.

Keywords: Electrohydrolysis, Metal plating wastewater, Hydrogen gas production, TOC removal,

[**Abstract:0215**]

Langmuir–Hinshelwood Kinetic Model to Capture the Manganese(0) Nanoparticles Supported on Ceria-catalyzed Hydrolysis of Sodium Borohydride

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Because of depletion of fossil fuel resources, environmental pollution and global warming caused by a steep increase in carbon dioxide and other greenhouse gases in the atmosphere, there has been an increasing demand for the renewable energy sources, on the way towards a sustainable energy future. Hydrogen has been considered as a clean and environmentally benign new energy carrier for heating, transportation, mechanical power and electricity generation. Long term exploration has shown that the most effective and safest way of storing hydrogen is to use solid media such as sorbent materials or hydrides. Among the chemical hydrides considered as hydrogen storage material, sodium borohydride (NaBH4) has received the most extensive attention owing to its combined advantages of: (i) the high hydrogen storage capacity (10.8wt%); (ii) the high stability and no flammability of its alkaline solutions; (iii) the optimal control on hydrogen generation rate by supported catalysts; (iv) the acceptable hydrogen generation rate even at low temperature; (v) the availability and easy handling; (vi) an efficient hydrogen source which releases hydrogen gas in the amount double of its hydrogen content upon hydrolysis in water.

The present study focused on kinetics of hydrogen release through hydrolysis of sodium borohydride NaBH4 in the presence of manganese(0) nanoparticles supported on ceria. From the hydrogen evolution curves, the reaction constant versus the NaBH4 concentration, apparent activation energy, rate constant were determined. It was noticed that the hydrolysis kinetics depends on temperature of reaction (i.e. 20–40°C) and NaBH4 concentration (1.0-5.0 mmol). Hence, the kinetic constants were analyzed using existing kinetic models. The bimolecular Langmuir–Hinshelwood model satisfactorily captured the behavior of our catalyst consisting of manganese(0) nanoparticles supported on ceria. Herein, the kinetic data, the kinetic model, the hydrolysis mechanism and the issues still to be addressed are reported and discussed.

Keywords: Ceria, hydrolysis mechanism, manganese, sodium borohydride

ORAL ABSTRACTS

[**Abstract:0216**]

Green Dehydrogenation of Dimethylamine Borane Catalyzed by Nickel(0) and Copper (0) Nanoparticles

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The synthesis of metal nanoparticles (NPs) by a sustainable technology is very important to solve many challenges in modern materials science. "Top-down" approach which utilizes physical methods and the "bottom-up" approach which employs solution-phase colloidal chemistry are traditional methods of synthesis of metal NPs. Size distributions of NPs obtained by top-down methods are very broad and typically large (>10 nm) and are giving irreproducible catalytic activities. In contrast, bottom-up method is the most widely used approach and provides more convenient ways to control the size of the NPs than top down methods. However, preparation of monodisperse NPs on large scales, which can be used in practical applications, is very difficult to obtain via both of these methods. Therefore, in recent years, atom-economy and solvent-free approaches have attracted the attention for a permanent solution to this problem. Moreover, solvent-free approaches have drawn considerable attention and popularity, both from an environmental point of view and for synthetic advantages in terms of yield, selectivity, and simplicity of the reaction procedure.

Herein, DMAB that has low melting point (~35°C) was used as both reducing and stabilizing agent for synthesis of Ni(0) and Cu(0) NPs. We report that Ni(0) and Co(0) NPs are normally obtained by decomposition of NiCl2 and Cu(acac)2, respectively, during the solvent-free dehydrogenation of DMAB under inert gas atmosphere at room temperature. The solvent-free dehydrogenation of DMAB in the presence Ni(0) and Cu(0) NPs corresponding to an initial turnover frequency of 21 and 19 h-1, respectively. The Ni(0) and Cu(0) NPs were characterized by TEM, HRTEM, TEM-EDX, UV-Vis. and XRD techniques. The heterogeneity of the in situ generated Ni(0) and Cu(0) NPs in the solvent-free dehydrogenation of DMAB were identified by carbon disulfide poisoning experiments. Also, the detailed kinetics in the solvent-free dehydrogenation of DMAB was studied by varying catalyst and substrate loadings and temperature.

Keywords: Copper, dimethylamine-borane, green dehydrogenation, hydrogen storage, nickel

[**Abstract:0218**]

Highly Effective PVP-stabilized Rh-Ru Bimetallic Nanoparticles for the Dehydrogenation of Methylamine-borane in Water

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Methylamine-borane (CH3NH2-BH3, MeAB) is an ammonia-borane derivative and it has been studied in hydrolysis reaction over the past years due to its very high hydrogen density of 11.1%. According to the eqn (1), 3 moles of hydrogen can be obtained from the dehydrogenation of MeAB in water per mole MeAB in the presence of a suitable catalyst, which is considered to be a more advantageous method when compared to other systems that produce hydrogen using MeAB such as thermolysis and non-aqueous catalytic dehydrogenation (Gülcan and Karataş, 2017; Staubitz et al. 2010; Yang et al. 2012).

In the current work, we aimed to prepare and characterize PVP-stabilized Rh-Ru bimetallic nanoparticles and to use them as an highly effective catalyst for dehydrogenation of MeAB in water at room temperature. The PVP-stabilized Rh-Ru bimetallic nanoparticles were synthesized using a classical alcohol reduction method (Gülcan and Karataş, 2017) and characterized by using TEM, HR-TEM, TEM/EDX, P-XRD, UV/Vis and XPS techniques.

Keywords: Nanoparticles, methylamine-borane, PVP, dehydrogenation, rhodium, ruthenium

[**Abstract:0221**]

Thermodynamic Analysis of a Unique Integrated Photoelectrochemical System for Multigeneration Purposes

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Hydrogen is a highly versatile energy carrier that may become one of the key pillars to support the future CO2-free energy infrastructure. When used in fuel cells, H2 is converted to water and it gives little or zero exhaust of greenhouse gases. For H2 economy to succeed, it needs to be produced in a clean, sustainable, reliable, and feasible way. The main objective of this study is to develop and investigate a continuous type hybrid photoelectrochemical-chloralkali H2 production reactor that converts the by–products into useful industrial commodities (i.e., Cl2 and NaOH). This system maximizes solar spectrum use by taking advantage of photocatalysis and PV/T. Furthermore, by using electrodes as electron donors to drive the photochemical reaction, the potential of pollutant emissions are minimized. The final products of this novel integrated system can be listed as H2, Cl2, NaOH, heat, and electricity. In this study, the effects of operating temperature on H2, Cl2, heat, and electricity production, energy and exergy efficiencies, and exergy destruction rates are presented.

Keywords: Exergy, efficiency, hydrogen, multigeneration, sustainability, solar energy

ORAL ABSTRACTS

[**Abstract:0222**]

Biohydrogen Production From Fruit And Vegetable Wastes Through Dark Dry Anaerobic Fermentation Under Thermophilic Condition

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Anaerobic digestion (AD) is considered as an alternative technology to treat organic waste along with generation of clean energy such as biohydrogen. Depends on the amount of total solid content of waste used in the process, the AD is classified into dry (> 10 %) and wet anaerobic digestion. Dry fermentation is a promising technology due to its several advantages like requirement of smaller reactor volume, easiness in handing digestate and lesser water wastage. Although many studies have performed for the biogas production through dry fermentation still not much studies on biohydrogen using this process. In this studies dry fermentation were performed under thermophilic condition to understand the effect of pre-treatment (autoclaving) of fruit and vegetable wastes (FVWs) on biohydrogen production in a 55 L costume made reactor (DF). A fully automated stirred tank single walled reactor (13 L, INFORS HT Labfors 5 reactor, Switzerland) was also used, as percolation tank, where inoculum was maintained actively by feeding the collected leachate as the sole source of carbon. During the experimental run, the leachate from the DF was drained through the leachate collection tube and the respective volume of liquid from the percolation tank was removed and introduced to DF periodically. Two experiments were conducted to compare autoclaving and non-autoclaving pretreatment on enhancing the biohydrogen production. 6.48 kg wet FVWs were chopped and grinded, and were mixed with pre-treated inoculum and filled inside the DF. A volumetric gas flow meter (µFlow, Bioprocess Control AB, Sweden) which used to monitor the total gas production was connected at the outlet of both reactors. Gas samples of 2 mL were taken from the outlet of the reactors to measure the hydrogen percentage using a GC-6890N (Agilent technologies). 2 mL liquid samples were withdrawn during the feeding days from the reactors in order to measure the soluble metabolites (VFAs) produced, total sugar, soluble COD and ammonia concentrations. From the analyses, it was found that maximum hydrogen % obtained for autoclaved study was 41% whereas, for non-autoclaved was 21%. In terms of total hydrogen produced, around 30% higher production was observed with autoclaved waste compared to the non-autoclaved waste. The metabolites (VFA) preferentially produced were acetic acid and butyric acid. It can be concluded that although thermophilic autoclaved improved the overall hydrogen productivity, further optimization studies are warranted for commercialization of this process.

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Keywords: Biohydrogen, dry fermentation, fruit and vegetable wastes, bioenergy

[**Abstract:0228**]

Copper(II)Phthalocyanine/Metal Organic Frameworks (Cupc/MOF) Composite with Improved Electrocatalytic Efficiency for Hydrogen Production

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The hydrogen evolution reaction (HER) of CuPc/MOF composite was investigated for hydrogen production. The SEM and EDS analyses showed that CuPc was incorporated into MOF through impregnation method. The electrochemical measurements were studied using cyclic voltammetry (CV) and it was found that CuPc/MOF composite exhibited favourable catalytic activity for HER. The Tafel slope value of the CuPc/MOF composite was found to be 185.3 mV.dec-1 and noticeably lower than that of the bare MOF (236.7 mV.dec-1) at 0.30 M of the acid, and the charge transfer coefficients are all close to 0.5, suggesting the Volmer reaction coupled with either Heyrovsky or Tafel reaction for hydrogen production. The exchange current density, (i0) of all the samples increased with increasing the concentration of the hydrogen source. Nonetheless, the CuPc/MOF composite showed a higher i0 as compared to bare MOF. These observations provide a platform to synthesize promising low-cost CuPc/MOF electrocatalyst with high efficiency and excellent electrocatalytic performance for HER.

Keywords: Metal organic framework, Phthalocyanine, Hydrogen evolution reaction

[**Abstract:0229**]

Graphene Oxide/Metal Organic Framework Nanocomposite with Improved Electrocatalytic Activity for Hydrogen Evolution Reaction

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In this study, a composite of graphene oxide (GO) and HKUST-1 type of metal organic framework (MOF) was synthesized by impregnation method, and its application as electrocatalyst for hydrogen production via hydroge evolution reaction (HER) was studied. X-ray diffraction (XRD), Fourier Transform Infrared spectroscopy (FTIR), Scanning electron microscopy (SEM) and Transmission electron microscopy (TEM) were used to characterize GO, MOF, and GO/MOF catalysts. The XRD and FTIR results of the composite showed the phases and characteristic bands for both parent materials as indicative of the composite. The SEM and TEM images revealed the presence of octahedral structure of MOF in the GO sheet-like structure. The performance of the proposed electrolytic system for electrochemical HER was studied by cyclic voltammetry and Tafel plots. The results showed that the addition of GO/MOF in the electrolytic system reveals better catalytic characteristics such as highest catalytic activity and lowest onset potential.

Keywords: Hydrogen evolution reaction, HKUST-1-type Metal organic framework, Graphene oxide

[**Abstract:0232**]

Turkey's Hydrogen Scenario and Hydrogen Production in the Thrace Basin Versus Hydrogen Regulations and Standards

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Access to cheap energy is vital to economic growth.It is well known that energy will be a blade runner issue for the 2050s world. The idea of renewable energy has been a hot topic in recent years, as it has been heavily debated in both the business and investing world. But, today technological race is between volatile fossil fuels such as natural gas and renewable energy sources. Nowadays, an attractive environmental framework has been established in Turkey for the development of renewable energy. This has resulted in a strong increase of investors' interest, especially in the Thrace Basin mainly due to their renewable energy potential related to recently natural gas discovery at the Black sea region.The paper aims to estimate the market share of hydrogen energy products in the economy considering the financial introducing of hydrogen energy investments at Thrace Basin-Istranca arae in Turkey. Therefore, hydrogen energy and hydrogen products markets are growing rapidly. Turkey should support investments in the areas of hydrogen energy and technologies that have been developing all over the world. Thus, this research aims to analysis a comprehensive evaluation of the renewable energy in reducing CO 2 emissions to environmental protection for the Thrace Basin local area in Turkey. Renewable energy in the Thrace basin which is a risk-mitigation measure against oil price volatility by replacing conventional generation with arguments in favour of hydrogen energy applications to the local environment commonly framed in terms of economic development and energy security.

Keywords: Hydrogen energy Thrace basin, The EU, Black sea

[**Abstract:0233**]

Bio-Hydrogen Production From Waste Rice Husk using Co-Culture

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Research of clean energy alternatives accelerate after the growing energy demand such as biohydrogen production. Hydrogen gas is a clean fuel and an important energy carrier with a high energy content of 122 kJ g−1. Replacement of fossil fuels with bio-hydrogen gas would overcome air pollution problems and helps to reduce global warming. It's eco-friendly, has high gravimetric energy, waste materials such as rice husk may be used as substrates.

The aim of this study is to investigate the best ratio of co-cultures (*Clostridium termitidis*, *C. intestinale*) for batch dark bio-hydrogen fermentation with 5 g/L rice husk. *C. termitidis* is a celluloytic microorganism that has the ability to hydrolize both cellulose and hemicellulose and *C. intestinale* was used in the fermentation media to fasten the hydrogen production yield and rate. 6 different co-culture ratios (1:1,2:1, 5:1, 10:1, 15:1, 20:1, *C. termitidis*:*C. intestinale*) were tested in submerged dark fermentation at 37°C for 14 days.

The highest CHF (29.15 mL) was detected with a ratio of 5:1 at the end of the fermentation period. The hydrogen production yield and specific hydrogen production rates at the same ratio were 5.83 mL H2/ gr rice husk and 0.28 mL H2/ gr biomass.h, respectively.

Keywords: Biohydrogen, submerged fermentation, rice husk

ORAL ABSTRACTS

[**Abstract:0234**]

Effects of Rice Husk Particle Size On Biohydrogen Production under Solid State Fermentation

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The search for eco-friendly, economical, alternative energy sources has begun due to the insufficient fossil fuels to meet the energy demand. As a renewable energy source bio-hydrogen production from lignocellulosic wastes is a novel and promising approach which can produce clean fuel with no CO2 emissions. Utilization of agro-industrial residues in solid state fermentation (SSF) known as an eco-process with its lower energy requirements, low wastewater production and offering a solution to solid wastes disposal; provides an economical production process of value-added products such as hydrogen. *Clostridium* sp. (*Clostridium termitidis* and *Clostridium intestinale*) which have the ability to produce hydrogen in anaerobic conditions can be subjected to waste lignocellulosic substrates such as rice husk with high carbon content.

In this study three different particle size of rice husk (crude, below 50 mesh, below 200 mesh) was subjected to batch dark fermentation with a *Clostridium termitidis*: *Clostridium intestinale* ratio of 5:1. *C. termitidis* is a cellulolytic microorganism that has the ability to hydrolyze both cellulose and hemicellulose. Therefore, combined fermentation of *C. termitidis* and *C. intestinale* is appropriate for the production of hydrogen in fermentation media where various lignocellulosic wastes are used as the substrate. 5 g rice husk with 75% humidity was used as substrate. The highest CHF (29.26 ml) and the highest yield (5.9 ml H2 g-1 substrate) were obtained with the smallest particle size (below 200 mesh). The second best production yield (3.99 ml H2 g-1 substrate) was obtained with the middle particle size (below 50 mesh) rice husk with a CHF of 19.71 mL.

Keywords: Biohydrogen, solid state fermentation, rice husk

ORAL ABSTRACTS

[**Abstract:0241**]

Effect of Inlet Air Temperature on Exergetic Performance of Hydrogen Production from Car Tires via Plasma Gasification

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In this study, exergetic performance of hydrogen production from car tires via air plasma gasification is parametrically investigated. The required data are taken from the literature studies for testing the exergy balance equation developed for the air plasma gasification process. In order to estimate the exergetic efficiency of this process, some important data including the results of ultimate and proximate analyses, air flow rate and specific power input for plasma gasification, yield of steam, etc. are used. In terms of the Second Law of Thermodynamics, the variation of exergetic hydrogen production efficiency as a function of exergetic efficiency is discussed. Furthermore, during the plasma gasification process, the effect of air inlet temperature on hydrogen gas production efficiency is investigated. Consequently, under the selected operating conditions, exergetic hydrogen production efficiency increases linearly with the rise of exergetic efficiency ranging from 0.781 to 0.821 while it increases parabolically with the rise of the air inlet temperature ranging from 298 K to 1023 K. The minimum and maximum hydrogen production efficiencies are calculated to be 0.179 and 0.188 respectively. It is concluded that it is necessary to increase the hydrogen production yield a higher air inlet temperature.

Keywords: Car tires, plasma gasification, hydrogen production, exergetic performance evaluation

[**Abstract:0243**]

Design of Thin Film Membranes for Intermediate-Temperature Hydrogen Separation

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Separation membranes allow purification of hydrogen from gas mixtures that could be generated by various production methods such as steam reformation of hydrocarbons, coal gasification or biomass-based fermentation process. Here, each production method sets conditions for separation membranes in terms of operating conditions. Thus, the separation membranes are required to meet different process temperatures varying from ~600 °C to as low temperature as possible. The temperature intervals for hydrogen separation processes might be expressed into three categories such as; low temperature, RT-200 °C, intermediate-temperature, 300-450 °C, and high temperature, ≥450 °C.

The current study concentrates on intermediate-temperature separation membranes, i.e. temperature 300-450 °C which are applicable to steam reformation of natural gas including the water gas shift reaction. Metallic membranes used for this purpose are quite attractive due to their high permeability together with a selectivity that is exceptional among other alternatives. The study adopts a membrane design methodology based on combinatorial material science. This approach makes use of magnetron sputtering whereby a library of thin film membranes are produced in a single experiment each membrane with a different composition. The library is then screened by four-probe resistivity measurements so as to identify compositions that react with hydrogen. A map of reactive index is prepared in the compositional field from which candidates were identified for hydrogen separation. The membranes were then fabricated in the form of foils and tested for hydrogen permeability. Using the above methodology, three ternary alloy system were evaluated, namely Nb-Pd-Ti, Pd-Ag-Ti, and Pd-Ag-Ni.

Keywords: Hydrogen separation membranes, combinatorial approach, Pd-based membranes, Nb-based membranes, resistivity measurements.

POSTERS

[Abstract:0055]

Modeling of Syngas Production from Biogas via Tri-reforming Process

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The tri-reforming (TR) process was employed for syngas production from biogas at elevated pressures in this study. In the TR process air and H2O were added simultaneously as the reactants in addition to the main biogas components. The effects of various operating parameters such as pressure, temperature, and reactant composition on the reaction performance were studied numerically. From the simulated results it was found that CH4 and CO2 conversions can be enhanced and higher H2/CO ratio can be obtained by increasing the amount of air. However, decreased H2 yield could result due to the reverse water-gas shift (WGS) reaction. Higher CH4 conversion and H2/CO ratio can be obtained with the increased H2O addition. However, negative CO2 conversion could result due to WGS and reverse CO2 methanation reactions. The dry reforming reaction resulting in positive CO2 conversion can only be found at high reaction temperature. For all cases studied, low or negative CO2 conversion was found because of CO2 production from methane oxidation, water-gas shift, and reverse CO2 methanation reactions. It was found that the CO2 conversion can be enhanced in the TR process by a small amount of added H2O. It was also found that the first-law efficiency increases with the increased reaction temperature because of higher H2 and CO yields. The second-law efficiency was found to decrease with increased temperature because of higher exergy destruction due to more complete chemical reaction at high temperatures.

Keywords: Biogas, tri-reforming process, CH4/CO2 conversion, H2/CO ratio, first-law/second-law efficiency.

[Abstract:0058]

Active Photocatalysts Designed by Sulphurization Method for Hydrogen Production

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Hydrogen is the most abundant element in the nature. Since hydrogen can be transported into a renewable and non-polluting energy resource, it is considered as the future energy. Hydrogen is produced mostly from the fossil fuels. Since the sun is primary and renewable energy source, photocatalytic hydrogen production becomes a current issue[1, 2]. For photocatalytic hydrogen production from water, several photocatalysts have been tested. In order to increase hydrogen energy efficiency, it is known that CdxZn(1-x)S is an efficient photocatalyst for hydrogen production. Therefore, in here, we synthesised CdxZn(1-x)S nanoparticles on graphene derivatives by using thermal sulphurization method by using elemental sulphur as the sulphur source. Then, characterization of compounds for determining crystal systems, lattice parameters, band gap and surface morphologies, was done by various techniques including X- Ray diffractometer, scanning electron microscopy and UV-VIS-NIR spectrophotometer. Finally the GO/ CdxZn(1-x)S and RGO/ CdxZn(1-x)S composites were tested as active photocatalysts for hydrogen evolution reactions and basic photocatalytic parameters were analysed.

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Keywords: Photocatalyst, Hydrogen production, Solar energy, Graphene and graphene derivate, Sulphurization.

[**Abstract:0069**]

Heat Transfer and Pressure Drop Characteristics of Different Structured Micro-Pin-Fin Reactors

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Proton Exchange Membrane Fuel Cells (PEMFC) are potential power sources when compared with internal combustion engines and conventional batteries due to several reasons such as low emissions, low costs, low operating temperatures, high efficiency, high energy density, quick start up, and compactness. Without any combustion, electricity can be generated, and water and heat can be the only products. However the need for hydrogen supply is a critical factor for reliable operation of the PEMFC. One of the most attractive approach is to overcome the hydrogen production limitation is to use microstructured reactors. Thus the optimal design of the micro reactor is a key factor for PEMFC development.

Although significant improvements have been made in the microreactor flow systems, its thermal management still remains the challenge. Its cooling rate can be improved by increasing coolant flow rate and surface heat transfer area, but this also increases the pumping power. Recently, micro structured reactors have gained an increasing interest due to its large surface area, energy density, high heat and mass transfer, and short reaction time.

Here in this study, we aim to perform several numerical experiments to study the heat transfer and pressure drop rates of different micro pin fin structured reactor configurations. Based on the results, the pin-fin structures' thermofluidic characteristics will be obtained and a better one will be proposed.

Keywords: micro-pin-fin reactor, pressure drop, heat transfer, optimal design

[**Abstract:0093**]

Comparison of LFS of H2, CH4 at Elevated Temperatures

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The paper presents results of case studies on laminar flame speed (LFS) of different gaseous fuels such as hydrogen, methane and mixture of hydrogen and methane in percentage share by volume 20%/80% (hydrogen/methane). LFS is one of the parameters which describes properties of flame propagation during combustion process. On the basis of the LFS analysis at various temperatures the conclusions of the behavior for the tested fuel can be stated, what in consequence can be used to explain phenomenon called combustion knock which might occur during combustion in the spark ignited reciprocating piston engine. The experiment was performed at temperature range from 25 to 100°C, as it is typical for fresh air-gas mixture in the intake manifold of both a naturally aspirated and a boosted engines. The test stand used for the experiment consists of the following: a one side open tube equipped with a spark plug which initiates combustion, a mixing system for feeding the tube with homogeneous air-fuel mixture and measuring system which allows to measure LFS of the flame along the tube. Modeling LFS was done with aid of Chemkin program. Results from both experiment and computer calculations were used to present LFS vs. temperature and tube length. As observed, hydrogen addition to methane dramatically shorten ignition delay, what contributes to faster flame development and increases LFS. These properties are used in methods for knock prediction in the piston engine fueled with hydrogen rich gases.

Keywords: laminar flame speed, hydrogen, knock prediction

[**Abstract:0095**]

A Low Cost, Continuous H2-CH4 Sensor Assembly

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A very significant cost item for studying reaction pathways for H_2 production from hydrocarbons, mainly but not limited to CH_4, is the capability to monitor the composition of the effluent gases to keep track of conversion and yield as a function of reaction conditions.

A widespread approach is gas-chromatography (GC) equipment installed with multiple sensors, does not provide the capability for real time analysis as the separation of the gas mixture takes in the order of tens of minutes – in addition to the cost on the order of a few $10K. Particularly when one desires the capability to take the equipment to the field in order to study pilot scale reactors, the costs climb even higher.

Another approach is to use field tested standalone sensors, widely implemented in the petroleum refining industry. Unfortunately relatively low cost such sensors operate based on the combustion of the sample gas and cannot differentiate between the different species of the flammable components in the mixture. Modifying this approach a little further, one may implement a flammable gas sensor along with an IR sensor and perhaps a standalone thearmal conductivity detector – providing for different sensitivity levels for the various gas components. However the combined cost of such a system easily runs into the same level as a GC.

The approach detailed and demonstrated in this study takes this idea of using multiple sensors of varying sensitivity levels and implements it using solid-state (SnO) based detectors. 3 different such sensors, namely the MQ-4 (methane), MQ-6 (propane) and MQ-8 (hydrogen) models manufactured by Hanwei Electronics, China – the gas in parenthesis referring to the highest but not exclusive sensitivity.

The sensors were imbedded into a gas flow chamber constructed from a block of polyimide, the gas flow volume was minimized to ensure fast response. Sensors were supplied by a 5V signal from an independent power supply and the response was monitored by Arduino boards, digitazing the analog sensor response to a USB port on a logging and monitoring PC. The sensor assembly was placed on a portable frame that allowed for easy transportation for field measurements.

The whole sensor assembly along with the data acquisition hardware is below $100. The limitations and capabilities of the set-up are reported with extensive calibration experiments. Sensor signals are a strong function of total gas flowrate – as there is no internal temperature control capabilities integrated into the sensors. There is good repeatability for individual sensors but a large sensor to sensor variation. The sensing circuit can be modified by different load resistors to adjust the sensitivity range. The approach can potentially sense as many different gases as there are sensors.

Keywords: gas sensor, H2 and CH4, real time gas composition monitoring

[**Abstract:0099**]

Optimization of Hydrogen Release from Anaerobic Thermal Processing of Virginia Mallow

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This article presents investigation of the temperature and residence time influence on hydrogen content in processing gas (torgas, pyrolysis gas and syngas) obtained from the thermal processing of Virginia Mallow heated from ambient temperature to 800°C with temperature rise rate of approximately 40°C/min along the tube length of 1 m. The thermogravimetric tests were carried out in order to determine parameters of torrefaction and pyrolysis processes. As part of the TGA analysis, the weight loss over time was determined. Based on the designated data, computer simulations were carried out using the CHEMKIN-PRO computer software. A detailed chemical mechanism including 137 compounds and 4533 chemical reactions was implemented for the calculations. The hydrogen content in the torgas was analyzed for a variable temperature range between 200÷325°C and residence time from 1 to 60 minutes. Hydrogen content in the pyrolysis gas was analyzed for a temperature profile up to 800°C and a residence time of up to 60 minutes. Results from simulations have shown that the content of hydrogen increased with increasing either residence time in the reactor or the torrefaction temperature. The highest value equaled 0.6% was recorded for a residence time of approx. 19 minutes and a temperature of 250°C. The further increase in temperature and extension of residence time of the sample in the reactor leads to a decrease in the hydrogen content in torgas below 0.1%. This is because significant hydrogen amounts were released during torrefaction in which hydrogen appeared in PAH compounds.

Keywords: hydrogen, thermal processing, Virginia Mallow, torrefaction, pyrolysis, TGA analysis

[**Abstract:0103**]

Influence of Hydrogen Addition to Diesel Fuel on Smoke and Combustion Phases in a Compression Ignition Engine

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Paper presents results from analysis of combustion progress in the internal combustion engine fueled with diesel fuel and hydrogen. Hydrogen was used in amounts up 40% by energy share. The main objective of this study was to examine impact of hydrogen on combustion phases and ignition delay in the diesel engine as well as smoke in the exhaust gases. Literature review shows in general hydrogen in those cases is used in small amounts below lower flammability limits. In this study, the test bench consisted of a single cylinder diesel fueled engine with common rail injection system. Hydrogen was injected into the intake manifold, where it created homogeneous mixture with air. Tests were performed at both fixed and optimal injection timings at full engine load. Results from experiments show that increasing amounts of hydrogen into the engine contribute to shorten ignition delay time that also affect main combustion phase. Complete analysis for heat release rate was presented in the paper. Moreover, decrease in smoke (mainly soot) in the exhaust gases was observed with increase of hydrogen amounts to the engine.

Keywords: hydrogen, diesel fuel, IC engine, combustion, emission

[**Abstract:0104**]

Energy and Exergy Analysis of 1 kW Self-humidified PEM Fuel Cell

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Fuel cells are new power generation systems that convert chemical energy into electrical energy. A proton exchange membrane (PEM) fuel cell promises clean energy conversion with nearly zero emission. Since PEM fuel cells have high efficiency and zero emissions levels, many researchers make a lot of investigations on them. PEM fuel cell uses hydrogen as a fuel and oxygen that is generally taken from air. Then, converts these reactants to water and electricity. In this study thermodynamic analysis of a 1 kW self-humidified PEM fuel cell which was produced by Horizon Fuel Cell Technologies was experimentally investigated. The aim of this study is to obtain better performance and better efficiency from the PEM Fuel Cell. A testing apparatus was established to analyze the system efficiencies based on first and second laws of thermodynamics. In this system, pure hydrogen was directly used as a fuel from compressed gas storage tank. Purity of hydrogen was 99.99% and operating pressure was set to 0.5 bar. The effects of different dead state temperature values on system performance were observed at constant operating pressure.

Keywords: PEM fuel cell, dead state, efficiency, energy, exergy.

[**Abstract:0105**]

A Comparative Thermodynamic Analysis of Alternatively Proposed Different Fuel System Models using Jet A Fuel

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As a baseline model an aircraft fuel system and alternatively proposed different type of aircraft fuel system models analysed in order to assess energy and exergy interactions between fuel system components using Jet A fuel as a working fluid. The aim of this study is to examine and compare energy and exergy changes of four different fuel systems and its components, which are considered to be related to the departure, acceleration, horizontal cruising and landing phases of the aircraft under the same conditions.

Keywords: Aircarft fuel system, energy, exergy, diffirent type of aircraft fuel systems

[**Abstract:0107**]

The Effect of Support Material on the Hydrogen Adsorption-Desorption Characteristics of Ru/SiO2 and Ru/Vulcan Catalysts

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The role of support material on the adsorption-desorption characteristics of hydrogen over Ru/SiO_2 and Ru/Vulcan catalysts were investigated. 1 wt% Ru loaded Ru/SiO_2 and Ru/Vulcan catalysts were prepared using incipient wetness impregnation method. The metal dispersions of the catalysts were determined via volumetric H_2-chemisorption technique. In order to analyze the adsorption-desorption characteristics of the catalysts, temperature programmed analysis techniques (H_2-TPR, Cooling in H_2, He-TPD) were applied. The fresh catalysts were reduced in the flow of H_2 in Ar up to 650 °C with a temperature ramp of 5 °C/min. After reduction, the catalysts were cooled down to room temperature in the flow of H_2 in Ar and then immediately He-TPD analysis up to 650 °C with a temperature ramp of 5 °C was performed. According to the results of "Cooling in H_2" analysis of 1 wt% Ru/SiO_2 and 1 wt% Ru/Vulcan catalysts, H/Ru ratios were calculated as 11.35 and 22.97, respectively. When He-TPD profile of the catalysts were examined, while 1 wt% Ru/SiO_2 had two desorption peaks at 185 °C and 685 °C, 1 wt% Ru/Vulcan had three desorption peaks at 100 °C, 395 °C, 660 °C. In addition to this, H/Ru ratio of 1 wt% Ru/SiO_2 and 1 wt% Ru/Vulcan were determined as 0.59 and 1.96, respectively. The experimental results showed that the hydrogen uptake amount of 1 wt% Ru/Vulcan is higher than 1 wt% Ru/SiO_2 in both Cooling in H_2 and He-TPD. The effect of surface and structural characteristics of support materials on the hydrogen adsorption-desorption behavior over Ru/SiO_2 and Ru/Vulcan catalysts will be discussed in the framework of relationship between Ru nanoparticles and support materials.

Keywords: Ruthenium, Hydrogen Adsorption-Desorption, Spillover

[**Abstract:0110**]

Metal-Organic Frameworks as Hydrogen Evolution Catalysts

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Platinum (Pt) and Pt-based materials are the most effective electrocatalysts for hydrogen evolution reaction (HER). However, because it is the most precious and rarest metal on the earth, large scale applications of Pt are unfeasible. Thus, to find a non-noble hybrid material with high activity and low cost as efficient hydrogen evolution catalyst is very challenging. One of the recent alternatives of hybrid materials as electrocatalysts is metal-organic frameworks (MOFs). MOFs have been attracting great attention because of their superior porosity, high surface areas and tunable properties. Among other applications such as hydrogen storage, separation, solar cell, and biomedical, MOFs are alternative materials for clean energy applications as hydrogen evolution. Herein, we summarized recent developments on HER using MOFs as heterogeneous catalyst.

Keywords: Hydrogen evolution reaction, Metal-organic frameworks, Heterogeneous electrocatalysis

[**Abstract:0112**]

Empirical Models for the Energy Consumption of Oil-in- Water Emulsion Treatment by Electro-coagulation Process

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Cutting oil emulsions (COE) are complex mixtures of water and base oils with additives for specific purposes. The oily phase acts as lubricant, reducing the friction between the metal piece and the tool. The aqueous phase, usually in the range of 95% (w/w), contributes to heat dissipation at a rate two to three times faster than the oil because of its higher specific heat. Cutting oil emulsions lose quickly their properties because of the severe operating conditions, and it is necessary their substitution. Oily wastewater discharged into the surface water, causes serious problem to the environment. To solve the problem with stable emulsion and oily wastewaters, a number of researchers have focused their attention on electrochemical methods for the separation of oil from o/w emulsion. In recent years, electrocoagulation (EC) has attracted great attention as an efficient and cost-effective process and is used in the removal of various pollutants. In this technique, characterized by its simple equipment, easy operation and low levels of sludge, the coagulant is dissolved from the anode with a simultaneous formation of hydroxyl ions and hydrogen gas occurring at the cathode.

In the EC process, many factors such as pH, applied electric current, the electrolyte concentration and the reaction time influence the process efficiency and energy consumption.

Response surface methodology (RSM) is a statistical technique for designing experiments, building models, evaluating the effects of several factors/parameters and searching optimum conditions for the desirable responses. The main advantage of this method over other statistical experimental design methods is the reduced number of experiments that are to be conducted to evaluate the effect of multiple parameters and their interactions on the desired objective.

In this study a D-Optimal experimental design of response surface methodology has been employed to evaluate the individual and interactive effects of three independent parameters, namely current density (X1): 5–35 mA/cm2; initial pH (X2): 5–11; and reaction time (X3): 6–30 min on the energy consumption and conductivity. The results have been analyzed using Pareto analysis of variance (ANOVA). Analysis showed a high coefficient of determination value (R2 = 0,993) and satisfactory prediction for second-order regression model. Graphical response surface and contour plots have been used to locate the optimum values of studied parameters. The current density was an important parameter affecting energy consumption. High current density applied to electrocoagulation cell increased energy consumption (Fig 1). Energy consumption was found depend on the current density and reaction time. As a result, it was seen that energy consumption for oil removal by electrocoagulation method could be minimized at optimum conditions. The energy consumption for maximum oil removal is observed to 3,6 Kwh/m3 at the optimum conditions.

Keywords: Cutting oil emulsions, Electro-coagulation, Energy consumption, D-Optimal design, modeling

[**Abstract:0115**]

Management of Hybrid System Operating in Grid–connected and Standalone Mode

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The optimization of an energy system (photovoltaic /wind) is by nature difficult, the maximum power point varies according to the meteorological parameters (illumination, temperature, solar radiation incidence angle, pressure atmospheric humidity, speed and wind direction), and also the management strategy of the studied system. On the load side, whether continuous or alternative, it has a random behavior.

In this paper, the interface for connecting to the power grid with power regulation and system management will be described. the management will make it possible to operate in a connected or separate network (islanding) with automatic switching. Seen from the network, the assembly will operate as a source of sinusoidal voltage by regulating the voltages formed across the capacitors. The magnitudes of Voltage setting are the RMS value of the voltage, frequency and phase. This control will allow us to inject the desired active power and adjust the voltage at the connected network connection point, and to impose the voltage and frequency in a separate network.

Keywords: grid, hybrid,power, regulation, management

[**Abstract:0117**]

Power Generation System Control of a Hybrid Renewable System PVT-diesel with Storage

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The objective of this work is to study the performances of a hybrid system with storage. The controller design and simulation studies of a hybrid (PVT diesel/battery) power generation interface were illustrated to control active and reactive power in distribution systems.

To obtain the maximum power from a photovoltaic generator and to match the solar cell power to the environmental changes a DC DC buck-boost inverter controlled by the fuzzy logic command is used.

The effectiveness of system depends on the efficiency of the DC-into-AC conversion. In order to verify the proper operation of the proposed controller, a known electrical load profile has been considered. The performance of hybrid system using a multilevel Inverter is shown by the simulation in MATLAB/SIMULINK.

Keywords: PV, PVT, battery, power

[Abstract:0119]

The Relationship Between Fuel Flow Rate and Pressure Drop in a Direct Methanol Fuel Cell with Parallel Channels

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In this study, the relationship between the pressure drop on the channels due to the methanol flow and the geometry of the flow channels on the anode side of a direct methanol fuel cell has been investigated. Parallel type channels are used as flow channels. The active area of the fuel cell is 5x5 cm^2. The system consists of channels that are optimally placed in the active area, with channel widths and distance of the channels kept constant. Combinations of 1, 1.5, 2, 2.5, 3 mm measurements were used for flow channel width and distance between channels. The ratio of the area created by the prepared geometries to the active area (percentage of contact area) is defined as a new parameter..The pressure values at different flow conditions were measured and statistical analyzes were used to determine whether there was a significant difference between these values.

Keywords: methanol fuel cell, flow rate, pressure drop

[Abstract:0122]

Hydrogen Permeation Characteristics through Palladium Membrane with/without Vacuume

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A vacuum pump is being applied on the outlet sector of a typical membrane system. Same pressure differences is being controlled with/without vacuum. The permeances and the flow rate of two palladium (Pd) membranes under same pressure difference in pure H2, binary gas mixtures are investigated experimentally. With binary gas condition of 10% impurities (N2, CO2, or CO) in H2, the result shows that under same pressure difference, the one with vacuum on the outlet sector performs better regardless of gas types. The flow rate for pure H2 increased by 5% to 17% with vacuum and increased by 15% to 136% for binary gas. The profiles shows that the reduction by the gas impurities is ranked as CO>CO2>N2 and the effect of vacuum indicates that the worse permeance for the impurities it is, the more it can be improved by vacuum, the improvement is also ranked as. CO>CO2>N2.

Keywords: Pd-memebrane, vacuum, binary gas, same pressure difference.

[**Abstract:0145**]

Ordered Mesoporous Carbons (OMC) Synthesized by Self-assembly Method and the Effects of Acidity and Carbon Source to Surfactant Ratio

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Ordered mesoporous carbons (OMC's) are promising materials with many potential application areas such as fuel cells, catalytic synthesis, separation and drug delivery. For fuel cell applications, the OMC carbons are required to posess certain properties such as large pore size and uniform pore structure. The early synthesis methods for OMC depended on hard templates which restricted the textural properties of the final product with those of the template [1,2]. Those OMC carbons typically had pore sizes under 5 nm which are not suitable for fuel cell applications. The more recent self-assembly techniques enable a one-pot synthesis route without using a template and provide a better control over the physical properties of the product [3].

In this study, it was aimed to develop large pore sized OMC's that can be used as catalyst support fort he PEM fuel cells. Carbons were synthesized by organic-inorganic self assembly method where resorcinol and formaldehyde were used as carbon source and Pluronic F127 was used as structure directing agent. TEOS was used as silica source to increase the pore size. The effects of acid concentration and carbon source to surfactant ratio on the composite yield, pore size and texture were investigated. Samples were analyzed by nitrogen adsorption, XRD, TGA, SEM-EDS and TEM. Results showed that the composite yield increased with acid concentration while the effect at low concentrations was greater. It was found that a greater ratio of carbon source to surfactant led to larger pore size but less ordered structure. An ordered mesoporous carbon with a surface area of 711 m2/g and a mean pore size of 8.1 nm was synthesized. It was found that the obtained structures had mainly three dimensional interconnected pore texture which is advantageous for mass transfer. The OMC's prepared in this study are well suited for fuel applications.

Keywords: Ordered mesoporous carbon, Self assembly, Pluronic F127

[**Abstract:0159**]

Bio-ethanol Reforming for Hydrogen and Methane Production

Yuji Ando

Yuji ANDO

Ethanol steam reforming over various catalysts was studied to clarify the best conditions for selective methane production from ethanol. In the sequence of catalyzed reactions, H2 production was followed by reduction of CO and CO2 to CH4. The compositions of the product gases obtained over Ru/CeO2 and Ru/SiO2 were close to the chemical equilibrium composition at 673 K. However, the product gas compositions obtained over Ru catalysts and Ru-based alloy catalysts were far from the chemical equilibrium composition at 623 K. Ethanol steam reforming was then conducted with a two-stage catalyst system that involved ethanol C–C bond cleavage in the first stage and reduction of CO and CO2 to CH4 in the second stage. The product gas compositions obtained over Ru-Pt/SiO2+Ru/Al2O3 and Pd/Al2O3+Ru/Al2O3 were close to the chemical equilibrium composition at 623 K.

Keywords: Ethanol, hydrogen, methane

[**Abstract:0168**]

Electricity Generation and Wastewater Treatment with Microbial Fuel Cells Using Homemade Beer Wastewater

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Fuel cells (FC) are devices that directly convert chemical energy into electrical energy. Microbial fuel cells (MFC) are FC types that use microbial organisms (bacteria, yeast, etc.) on the anode surface as catalyst in fuel cells, so that these bio-electrochemical systems convert chemical energy of the substrates directly into electrical energy by catalytic reaction of bacteria with electrochemical activity. (Moon et al, 2006)

Interest in MFCs began in the 20th century by first measuring the potential difference between chambers of a FC in one section of the metabolic microorganism and the substrate in the other. Obtained potential difference (voltage) was observed to generate electric current when a resistance was applied between the two compartments. (He and Angenent, 2015)

In the preliminary studies, the power obtained was very low because of the problem in the transport of electrons to the electrode surface, to overcome this problem mediators were used to accelerate the electron transfer to the anode surface. Subsequent studies have shown that some bacteria can use their active microbial intermediates as internal mediators, and these systems are called "mediatorless" MFCs. It has been observed that the electrons of bacterial species such as Shewenalla and Geobacter can be directly transferred to the anode electrode. (Allen and Bennetto, 1993)

MFCs may also be utilized to process and treat waste water during electricity generation. This is particularly beneficial for the industries producing wastewaters having microorganisms such as beer factories. MFC's that will be utilized in industries like this may be used to purify the wastewater without excess electricity consumption and by even producing some amount of electricity by microbes (bacteria) oxidizing organic compounds in the anode chamber. Another advantage is that; compared to activated sludge process and anaerobic digestion, MFC's can operate at room temperature. (Mengqian et al)

In this study homemade beer wastewater was used as the substrate in the laboratory, the parameters affecting the system outputs related to the electrical potential generation and treatment. A two-chamber plexiglass MFC reactor was designed and constructed, Nafion TM membranes were used as the separator and ion-exhange medium and carbon fiber paper was used as electrode material. The system operated continuously was monitored for 3 days and chemical oxygen demand (COD) decreased over time. The power density obtained and normalized to the anode chamber volume. MFC system constructed is being studied to investigate the effects of different microorganisms, wastewater compositions and substrates on the power and COD removal.

Keywords: electricity, wastewater, mfc, treatment, home-made

[**Abstract:0182**]

Synthesis of Active and Reusable Nano Catalyst from Graphene Oxide (GO) Stabilized Pt-Ir Nanoclusters for DMAB Dehydrogenation Reaction at Room Temperature

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The synthesis and characterization of Platinium-Iridium nanocluster with graphene oxide (GO) supporting agent was examined for using as heterogeneous catalyst in the catalytic dehydrogenation reaction of dimethylamine-borane (DMAB). Ethanol super hydride method was used to synthesize GO stabilized Pt-Ir nanocluster. The characterization of synthesized product was made by TEM, HRTEM, XRD and XPS analytical techniques and highly crystalline and colloidally stable Pt-Ir nanocluster structure is observed according to the results of these methods. Finally, catalytic performance, efficiency, isolation and reusability of synthesized nanocluster was examined for the dehydrogenation reaction of DMAB at room temperature.

Keywords: Bimetallic Complex, Dehydrogenation of DMAB, Heterogeneous Nano catalyst, Monodispersed Nanoparticles.

[**Abstract:0183**]

Synthesis of Highly Active Pt-Rh Nanoclusters Stabilized on Graphene Oxide for Hydrogen Evolution Reaction

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An ultrafine nanocatalyst system was prepared for dehydrogenation of Dimethylamine-borane in this study. Producted system was consist of Platinium-Rhodium nanoclusters with supporting agent graphene oxide (GO). Pt-Rh nanoclusters within GO was prepared with in-situ techniques by using chloride salt of metals. TEM, HRTEM, XRD, UV-vis and XPS analytical techniques were used for the characterization of Pt-Rh@ GO. Kinetic studies were performed according to variable concentrations, temperature and durability of Pt-Rh@ GO. Thus, some kinetic studies were performed for determine turnover frequency (TOF), reaction rate and activation parameters for catalytic dehydrogenation reaction of dimethylamine-borane. Finally, Pt-Rh@ GO catalyst was compared with other catalysts used for dehydrogenation of DMAB in the literature. It was concluded that, GO stabilized Pt-Rh@ GO heterogeneous nanoclusters showed high effect and reusable stability with one of the highest TOF value.

Keywords: Bimetallic Pt-Rh Nanocomposites, Heterogeneous Nano catalyst, İn-situ Techniques, Well-dispersed Nanocluster

[**Abstract:0187**]

Energy and Exergy Analyses of an Integrated Hydrogen Production and Liquefaction System with Waste Material Gasification

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In this paper, the comparative energetic and exergetic analyses of a waste material gasification based integrated system is conducted to achieve hydrogen production and liquefaction. The waste materials gasifier component is utilized in integration with a Brayton cycle, a Stirling engine cycle, a single effect absorption cooling system, and a PEM electrolyzer for the purpose of multigeneration. The present integrated system generates power, heating, cooling and domestic hot water along with liquid hydrogen production. The design indicators of integrated system and the influences of operating conditions on the energetic and exergetic efficiency of multigeneration system and also other sub-systems are investigated. The energetic and exergetic efficiency of waste materials gasification based integrated system are calculated as 61.57% and 58.15%, respectively. Furthermore, a parametric study is carried out to investigate the effects of different system design indicators on the integrated system exergy destruction rates and exergy efficiencies.

Keywords: Exergy, waste material gasification, Brayton cycle, Stirling engine, hydrogen, liquefaction

[**Abstract:0190**]

The Role of Temperature on Aluminium Oxide Embedded MWCNTs for Hydrogen Adsorption

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Multi walled carbon nanotubes (MWCNTs) are widely used in Hydrogen adsorption studies because of their unique confirmation, porous structure and high aspect ratio. As hydrogen storage medium, generally MWCNTs have been supplemented with alkali metals or compounds to enhance the storage capacity. In this work, hydrogen adsorption of aluminium oxide (Al2O3) nanopowder decorated MWCNTs (Al2O3-MWCNTs) was examined under -273 ˚C, 0 ˚C and 25 ˚C temperatures at ambient pressure. The structure confirmation of the synthesized Al2O3-MWCNTs was characterized by X-ray diffraction (XRD) analysis, Energy Dispersive X-ray (EDX) and Scanning Electron Microscopy (SEM) observations. A sieverts-like apparatus was used for hydrogenation of Al2O3-MWCNTs under -273 ˚C, 0 ˚C and 25 ˚C temperatures. The results present that, the highest hydrogen storage capacity of Al2O3-MWCNTs was observed at the cryogenic temperature.

Keywords: Hydrogen adsorption, aluminum oxide, MWCNTs

[**Abstract:0191**]

A Comparative Study of Control Strategies for Vehicles with Hydrogen Fuel Cell/Battery/Supercapacitor in the Electrical Grid-Independent Applications

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This paper depicts a means of using a Proton Exchange Membrane (PEM) Fuel Cell (FC) as the primary energy source and a Li-ion battery (BAT) and a supercapacitor (SC) as energy storage technology. These in-vehicle technologies are connected to the DC-bus with DC-DC power converters for suitably supply the power demanded by the traction motor. Thus, the system performance of the vehicle is examined independently of the electrical grid. Here, an appropriate energy management system and a well-designed control strategy both increase productivity and vehicle dynamics. At the same time, different control strategies have been compared that are designed according to the same power demands of the vehicle. The results have been analyzed in terms of hydrogen fuel consumption, energy efficiency and sustainability of control systems.

Keywords: PEM fuel cell, Li-ion battery, hydrogen fuel cell vehicles, supercapacitor, control strategy, hydrogen consumption.

[**Abstract:0200**]

Wood Char - Active Carbon Production for H2 Adsorption and Storage

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Şırnak nut shell char, waste wood and lignite were pyrolized and carbonized as powder in industrial furnaces and carbonized by microwave furnace. Turkish lignite fine and coal fine have great economic and ecological benefits in burning after being washed and cleaned. The distribution and quality of Şırnak biochar reserves makes it possible to consume in the water treatment as high reactivity by porosity of 42,7 %, high micro mesoporous and nanoporous content with %7,8 and at high adsorption value of 126mg/kg will be considered. The modified pyrolyzing method was using agglomerated pyrolyzing and microwave carbonization as active carbon and char in the form of micron sized. The parameters of this pyrolyzing method produced there active char by this method and test results of adsorption with active carbon was not effective as biochar. The size of the large agglomerate managed high flow adsorption. It is an effective method especially in high metal load and backwash. It has been determined to be successful in high density and low porous active carbon and less carbonized lignite.

Keywords: microwave, modified carbonized, agglomerated char, biochar, metal adsorption, water treatment

[**Abstract:0209**]

Biohydrogen Upgrading Towards a Cleaner Energy Production

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From a variety of biological wastes, biohydrogen production through anaerobic fermentation process is growing worldwide. It is considered as a cleaner solution in current energy scenario and this technology is environment friendly, economical, and known as the most efficient - as compared to all other technologies of energy production - through biological energy conversion processes.

In this technology, there is an increasing demand for upgraded biohydrogen, to be used as vehicle fuel or in proton exchange membrane (PEM) fuel cell. Because biogas derivered from anaerobic fermentation is mainly composed of hydrogen (H2) and carbon dioxide (CO2) and trace amounts of other impurities such as carbon monoxide and sulphur compounds. However, the presence of CO2 in H2 in a fuel cell would reduce the fuel cell performance and could degrade the catalyst activity. The high percentage of CO2 (up to 25%) and some other impurities, poison especially platinum based catalysts, and limit economic feasibility. Also CO2 is found to form a cloud and block H2 from reaching the platinum sites. Because of this unavailability of hydrogen a performance loss exists in fuel cells. Therefore upgrading biogas by removing CO2 could make hydrogen to become acceptable for more advanced utilisation. Depending on the end use, biogas upgrading is necessary and it is important to optimize upgrading process in respect to low energy consumption, high efficiency and giving high hydrogen content in the upgraded biogas.

For this purpose several biogas upgrading processes including pressure or temperature swing adsorption, pressurized water scrubbing, amine swing absorption, cryogenic separation and membrane technologies have been developed for CO2 removal. Therefore this study aims to thoroughly evaluate and describe the biogas upgrading technologies that are commercially available and in operation today. The technologies are described in detail by presenting the theory behind the separation mechanism, the upgrading process as a complete system and operational issues.

Keywords: Biohydrogen, biogas upgrading, carbon dioxide, membrane gas permeation

[**Abstract:0217**]

Hydrogen Generation From the Hydrolysis of Dimethylamine- Borane at Room Conditions by Using Polyvidone Protected Ruthenium Nanocatalyst

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Van Yüzüncü Yıl Üniversitesi, Fen Fakültesi, Kimya Bölümü, Tuşba-Van

Boron based chemical hydrides (LiBH4, NaBH4, Ca(BH4)2, Mg(BH4)2) and boron-nitrogen (B–N) compounds (NH-3BH3, NR3BH3 (R = H or alkyl), (CH3)2NHBH3, NH3B3H7, NH4B3H8, N2H4BH3) have been considered as solid hydrogen storage materials. Among these materials, B–N compounds are much better suited for this purpose due to their high gravimetric hydrogen storage capacity. Dimethylamine-borane ((CH3)2-NHBH3, DMAB) is appropriate material due to its high efficiency of H2 production, high stability, and nontoxicity (Caliskan et al. 2012; Wechsler et al. 2008; Zahmakiran and Özkar 2009). Hydrolysis of DMAB produces 3 mol of H2 per mole by using 2 mol of water (1):

Herein we report highly active nanocatalyst for the room temperature dehydrogenation of dimethylamine-borane in water. Polyvidone protected Ru nanocatalyst was synthesized via a classical alcohol reduction technique and were characterized by carrying out TEM, HR-TEM, TEM/EDX, P-XRD analysis, UV/Vis and XPS spectroscopy. Moreover, detailed kinetic studies on the catalytic hydrolysis reaction were applied to assess the activation parameters.

Keywords: Nanocatayst, dimethylamine-borane, polyvidone, hydrolysis, ruthenium

[**Abstract:0224**]

Optimization of Thermal Pre-treatment Conditions By Box-Wilson Method For Dark Fermentative Biohydrogen Production From Fruit and Vegetable Wastes

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One of the biggest challenges of the next decade is to identify alternative renewable energy sources that are environmentally friendly; as fossil fuels are non-renewable, polluting and harmful to nature. Nevertheless, fossil fuels are highly used amongst other energy sources. On the other hand, as an alternative way, hydrogen is a clean and high energy (122 kj/g) resource. Dark anaerobic fermentation is considered as one of the most promising hydrogen production methods due to its low energy demand and production process using renewable sources. The rate limiting step of dark fermentation is the hydrolysis stage of complex substrate. For easily accessible to microbial attack, several pre-treatment methods can be implemented.

Thermal pre-treatment is known as one of the best methods for enhancing hydrogen production yields. In this study, eight different thermal pretreatment conditions, which are determined by Box-Wilson statistical approach (100°C-10 min, 105°C-1.5 min, 105°C-8.5 min, 110°C-5 min, 110°C-10 min, 117°C-1.5 min, 117°C-8.5 min and 120°C-10 min) have been used for biohydrogen production from fruit and vegetable wastes. Totally, 9 samples (including one control) in triplicates were prepared, using 60 mL as working volume. The maximum hydrogen production of 61 mL H2/g VS was observed with 1.5 min treatment at 117°C. The Box-Wilson statistical model was significant (R2=0.91). The results showed that the optimum temperature conditions were 98-102°C for long treatment time (8-11mins) and 118-122°C for short treatment time (1-4mins). The kinetic results were performed by Gompertz equation and the hydrogen production rates changed between 1.24-2.91 mL H2/min. A maximum volatile fatty acids concentration of 23 g/L was observed with 110°C-10 min treatment. The dominant volatile fatty acids were acetic acid and butyric acid; however, the ethanol production was observed in low H2 producing reactors. Hence, this study showed an alternative approach to conventional heat treatment operations (80°C-1 h) with short treatment time.

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Keywords: Biohydrogen, Thermal Pretreatment, Fruit and Vegetable Wastes, Box-Wilson Method, Dark Fermentation

[**Abstract:0225**]

Analysis of Biohydrogen Production via Dry Anaerobic Digestion of Fruit And Vegetable Waste

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The dry anaerobic digestion for biohydrogen production is relatively novel technology that requires less water and smaller reactor volume. In addition, the digestate obtained from the process can be easily handled and can be used as soil amendment. In this study, fruit and vegetable waste (FVW) (6.4 kg, wet weight) collected from the local municipality (Izmir, Turkey) was treated in a 55 L custom made dry fermenter (DF). The inoculum used was collected from a local biogas plant that uses dairy product as feed (Izmir, Turkey) and was undergone pre-treatment at 105°C for 10 min in order to gather hydrogen producers. A 13 L fully automated reactor (ST) (INFORS HT Labfors 5 reactor, Switzerland) was placed adjacent to the DF for the purpose of treating the daily collected leachate. Throughout the experiment, the leachate was collected from the DF twice a day and was introduced into the ST. Respective amounts of liquid from the ST were taken out and sprayed over the DF. The experiment was performed under mesophilic condition without any pH control. The amount of gas produced were continuously monitored using gas flow meters (μFlow, Sweden) attached to the outlet of each reactor. The percentage of hydrogen present in the produced gas was measured using a gas chromatography (Agilent, 6890N). Periodically the liquid samples were also collected to monitor the VFAs using GC. Other parameters analyzed were total sugar, soluble COD, ammonia concentrations, total solids (TS) and volatile solids (VS). The maximum percentage of hydrogen measured at the head space of the reactor was 30 % and the cumulative hydrogen production was 5700 mL. The major VFAs produced were isobutyrate (maximum: 5048 mg/L) and acetic acid (maximum: 3563 mg/L). Compared to the previous studies (data not shown) with less frequent feeding, this study with twice daily feeding couldn't improve the overall hydrogen production. As thus, it can be concluded that feeding frequency does not significantly enhances the hydrogen production through dry fermentation and this is important as it plays a major role in the economy of the process.

Keywords: Biohydrogen, renewable energy, dry fermentation, anaerobic digestion

[**Abstract:0230**]

Phase Transition and Photoelectrochemical Properties of Copper Oxide Photoelectrodes Fabricated by Electrodeposition

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In this study, photoactive materials containing copper oxides have been prepared with high quality and stability in various compositions by electrodeposition method. These materials based on copper oxide have been characterized and compared using XRD, EDX, UV-Vis, FTIR, and electrochemical techniques. Based on the electrochemical production conditions; phase changes of photoactive materials and, at which conditions which phase or phases are present, were evaluated in detail. It was carried out that a full phase change from single-phase Cu2O to single-phase CuO. Here, copper oxide compounds with different optical properties were prepared without the addition of any element or impurity except from copper and oxygen. The semiconductors have been found to have direct band gap that is more preferred for solar energy applications. Photoelectrochemical (PEC) performances of the copper oxide electrodes containing a different phase structure were determined, and the changes of PEC activities were examined comparatively.

Keywords: Copper oxides, electrodeposition, phase transition, photoelectrocatalytic activity

[**Abstract:0231**]

Enhanced Photoelectrocatalytic Performance of ZnO/Cu2O Photoelectrodes

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This work reports on a systematic study of the influence of Cu2O doping on the structural, optical and photoelectrochemical characteristics of ZnO. ZnO doped with Cu2O were prepared by a practical electrochemical method. Characterization of the materials was performed by XRD, EDX, UV–Vis spectroscopy and photoelectrochemical (PEC) techniques. The XRD and UV–Vis spectroscopy results showed a single phase of ZnO for the lower Cu2O deposition time (at time≤3 min), while a secondary phase of Cu2O evolved for 5 min deposition time. The absorbance spectra, and EDX results confirm the presence of ZnO and Cu2O. This work showed that ZnO doped with Cu2O grown for 3 min have the best PEC performance. ZnO/Cu2O photoelectrodes are suggested as a competitive candidate for advanced PEC detection, may be for the extended field of PEC water splitting.

Keywords: ZnO/Cu2O photoelectrodes, electrodeposition, photoelectrochemistry

[**Abstract:0239**]

The Investigation of Three-Dimensional Copper Nanodomes as Anode Materials for Direct Methanol Fuel Cells

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In this study, three-dimensional (3D) copper nanodomes (CuNDs) were fabricated and characterized as potential anode materials for direct methanol fuel cells. The CuNDs were fabricated by a combined method of soft lithography-nanosphere lithography and physical vapor deposition (PVD) using polydimethylsiloxane (PDMS) as template. The nano structures were characterized using scanning electron microscopy and atomic force microscopy. Their electrochemical activity against methanol electrooxidation was studied in KOH solution with the help of electrochemical measurements. Their electrochatalytic activity was compared to that of bulk and polished Cu. It was found that the well-structured and homogenously distributed CuNDs could be fabricated using these combined methods. The methanol electrooxidation activity of the 3D-NDs in alkaline solution was considerably improved when compared to bulk Cu. The improved activity of the nanostructures was related to good intrinsic activity of Cu for this reaction and their large real surface area.

Acknowledgements: The authors are greatly thankful to Bingöl University Scientific Research Projects Coordination Unit (BÜBAP) (Project Number: BAP-FEF.2016.00.009) for supporting of materials and Bingöl University Central Laboratory for characterization measurements. The authors also would like to thank to Assoc. Prof. Dr. Mehmet Kahraman for his kind helps to prepare PDMS templates.

Keywords: Copper nanodomes, methanol electrooxidation, direct methanol fuel cells

[**Abstract:0240**]

Pt, Pd and Ag Modified NiCuZn Raney Electrodes for Alkaline Water Electrolysis

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Pt, Pd and Ag modified alkaline leached NiCuZn composite coatings were electrochemically fabricated on a copper electrode. The electrocatalysts were characterized by scanning electron microscopy and energy dispersive X-ray spectroscopy. The hydrogen evolution activity of the modified electrodes was tested in 1 M KOH solution. For this aim, cathodic current-potential curves and electrochemical impedance spectroscopy (EIS) techniques were used. Furthermore, the electrochemical and physical stability of the electrodes as a function of electrolysis time were tested in the same electrolyte using electrochemical and spectroscopic techniques.

The modification of alkaline leached NiCoZn ternary coating by deposition of small amounts of Ag, Pd and Pt can further enhance the hydrogen evolution performance of this Raney-type electrode when compared to NiCoZn individually. It was found that modification of the alkaline leached NiCuZn coatings with the platinum group metals enhances its hydrogen evolution activity greatly. The improved activity was realated to large real surface area, good intrinsic activity of Pt, Pd and Ag as weel as possible synergistic effect between the metal. Their hydrogen evolution activity and stability depend on the type of loaded metal.

Acknowledgements: The authors are greatly thankful to Çukurova University research fund (Project Number: FEF2006D8) and TUBITAK (Project Number: 106T542) for financial support.

Keywords: Pt, Pd, Au- modified NiCuZn electrocatalysts, alkaline water electrolysis, hydrogen energy

[**Abstract:0244**]

$Mg_{60}Ni_{40}$ Alloy Synthesis and Investigation of Hydrogen Storage Properties

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In this study, rapidly solidified Mg60-Ni40 (wt. %) alloy ribbons were synthesized by melt spinning method. According to this process, inductively melted liquid alloys were ejected on the copper wheel by rotating high speed and gas pressure via a nozzle and was quenched as ribbons. Relatively uniform and continuous ribbons were synthesis nearly 60 μm thickness with this process. The structural and hydrating properties of the ribbons were investigated with scanning electron microscope (SEM), X-ray diffraction (XRD). Its hydrogen storage properties were determined by Sievert type hydrogen storage physical measurement method. XRD patterns of produced and hydrated ribbons were characterized by presence of two different phases of Mg and Mg2Ni and their hydrides. The difference between hydrated and unhydrated ribbons were determined with SEM pictures. When the ribbons were synthesized, they were not active for absorbing the hydrogen. Their activation were done in 350 ^{0}C and 19 bar hydrogen gas atmosphere along 24 hours. Its maximum hydrogen absorption and desorption capacity was found as more than 5 % weight. According to pressure-concentration-temperature (PCT) measurement, two different plateau pressure was found. This results can be attributes to their different phases.

Keywords: Hydrogen storage, melt spinning, rapid solidification, magnesium nickel hydride, Sievert, PCT

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