







IHTEC 2019

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4th International HYDROGEN TECHNOLOGIES Congress

June 20-23, 2019
Trakya University
Edirne, Turkey

ABSTRACT BOOK

EDITORS
İbrahim DİNÇER
Adnan MİDİLLİ
Semiha ÖZTUNA
Doğan ERYENER

Edirne
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FOREWORDS

WELCOMING MESSAGE

to Participants of 4th International Hydrogen Technologies Congress

20-23 June 2019, Trakya University, Edirne, Turkey

Fossil Fuels (i.e., petroleum, natural gas and coal), which meet most of the world's energy demand today, are being depleted fast. Also, their combustion products are causing the global problems, such as the global warming, climate change, ozone layer depletion, acid rains, oxygen depletion and pollution, which are posing great danger for our environment and eventually for the life in our planet. Many engineers and scientists agree that the solution to these global problems would be replacing the existing fossil fuel system by hydrogen as the fuel and by fuel cells as the energy conversion devices. Hydrogen is the lightest, most efficient and cleanest fuel. Its use in fuel cells and in other energy conversion devices (such as the heat engines) will produce no greenhouse gases, no ozone layer depleting chemicals, no acid rain ingredients, no oxygen depletion and no pollution.

Around the world, there is extensive R&D work on Hydrogen Energy and fuel cells. Many types of fuel cells have been developed. Vehicle manufactures have built several hydrogen fuel cell cars and buses. Mercedes Benz. Hyundai, Toyota and Honda companies started selling hydrogen fuel cell cars. Many bus companies are selling hydrogen fuel cell buses. Internal combustion engines are being modified for hydrogen fuel. Hydrogen fueled appliances based on catalytic combustion have been developed. There is research and development work on hydrogen hydride refrigeration and air conditioning systems. Siemens Company is building hydrogen fuel cells for submarines. Aircraft manufactures are working on hydrogen fueled subsonic and supersonic transport planes. The preferred fuel of the space programs is hydrogen. Without hydrogen, it would not have been possible to send astronauts to the Moon. Hydrogen made it possible to travel to the moon. It provided the fuel for the rocket engine, electric through the fuel cells for the controls and the cabin, and the by-product from the fuel cells was the drinking water for the astronauts.

Scientists and Engineers from many countries of the world will gather at the IHTEC2019 Congress 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 the 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 the historic city of Edirne, Turkey.



T. Nejat Veziroğlu

Honorary Chair, IHTEC2019

Emeritus President, International Association for Hydrogen Energy

MESSAGE FROM THE PRESIDENT

Organizing the Fourth 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 have 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 as well as demand management.

It is also important to note that the National Hydrogen Energy Association was able to secure to organize the 23th World Hydrogen Energy Congress first time in 2020, 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 fourth congress in the area of hydrogen technologies, after organizing the first one in Yildiz Technical University in Istanbul, the second one in Cukurova University in Adana, the third one in Alanya Alaaddin Keykubat University in Alanya, 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 160 technical papers selected from 230 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 preparations for another successful gathering.

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 Co-Chairs, Dr. Semiha Oztuna and Dr. Dogan Eryener 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

WELCOME FROM THE CONFERENCE CO-CHAIRS

As conference chairs, we are very happy to serve for "The Fourth International Hydrogen Technologies Congress", and are now ready to fourth one as hosted by Trakya University in Edirne. This conference is organized as an annual event under the National Hydrogen Technologies Association. It brings together 4 keynote speakers and over 160 participants from 12 countries for a period of four days to discuss, disseminate and network on various aspects of hydrogen technologies and processes.

We wish to formally put on record our sincere thanks to numerous key people and organizations that have been instrumental in ensuring the success of IHTEC2019 in Trakya University in Edirne.

We would like to thank Prof. Dr. Erhan Tabakoglu, Rector of Trakya University and his management for their full support.

We would like to register our 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, we 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.

Semiha Öztuna
(Congress Chair, IHTEC2019)

Doğan Eryener
(Congress Co-Chair, IHTEC2019)

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SCIENTIFIC PROGRAM

SCIENTIFIC PROGRAM

Thursday, June 20, 2019

MAIN HALL	
07:30-09:30	**Registration**
09:30-10:00	Opening Talks **Semiha Oztuna** (Congress Chair) **Ibrahim Dincer** (President, National Hydrogen Energy Association) **Cem Uzun** (Vice-Rector, Trakya University) **Erhan Tabakoglu** (Rector, Trakya University)
10:00-10:45	**Overview Talk- Ibrahim Dincer** Alternative Dimensions of Hydrogen Energy And Future Directions
10:45-11:00	Coffee Break
	Keynote Speakers Chair: **Ibrahim Dincer**
11:00-11:45	**Keynote Speaker 1 - Steven Beale** Mathematical Modeling of Fuel Cells and Electrolyzers – A Review
11:45-12:30	**Keynote Speaker 2 - Umit B. Demirci** B-H and B-N-H Materials for Chemical Hydrogen Storage
12:30-14:00	Lunch

Thursday, June 20, 2019

Parallel Sessions 1		
	HALL - A	HALL - B
14:00-15:30	**Session 1A: Biological Hydrogen Production** Chair: **Bestami Ozkaya**	**Session 1B: Hydrogen Production-1** Chair: **Semiha Oztuna**
14:00-14:15	**(53)** Parametric Investigation of Biogas Production via Geothermal Based Thermophilic Biodigester ***Selçuk Inaç, Salih Ozen Unverdi, Adnan Midilli***	**(335)** Hydrogen Energy Research, Development and Innovation Activities in Turkey ***H.T. Arat, M.K. Baltacioglu, B. Tanc, M.G. Surer, I. Dincer***
14:15-14:30	**(315)** Feasibility of Biological Hydrogen and Alcohol Production from Sunflower Straw ***Öznur Yıldırım, Hülya Civelek Yörüklü, Doğukan Tunay, Emre Oğuz Köroğlu, Bestami Özkaya, Ahmet Demir***	**(274)** Effect of Ultrasonic Frequency on Sonic Hydrogen Production ***Sherif S. Rashwan, Ibrahim Dincer, Atef Mohany***
14:30-14:45	**(318)** Biohydrogen Production from Cotton Straws Using Different Pretreatment Methods: A Case Study ***Hulya Civelek Yoruklu, Emre Oguz Koroglu, Ahmet Demir, Bestami Ozkaya***	**(214)** Hydrogen Generation from Sodium Borohydride, Ammonia Borane and Their Mixtures Using Ni-B-Zr In-Situ Catalyst ***Deniz Lim, Gülay Özkan, Göksel Özkan***
14:45-15:00	**(143)** Biological Hydrogen Production By Using Co-Cultures of Pns Bacteria ***Görkem Baysal, Ebru Özgür, Inci Eroğlu, Meral Yücel***	**(334)** Design and Assesment of a New Solar Integrated Ammonia Fuel Cell and Geothermal Based Energy System ***Osamah Siddiqui, Ibrahim Dincer***
15:00-15:15	**(226)** Dark Fermentative Biohydrogen Production From Thermal Pretreated Wastewater Treatment Sludge ***İlgi Karapinar, Onur Balcan***	**(243)** Development and Performance Assessment of Parabolic Collector Based Combined System For Compressed Hydrogen Production ***Nejat Tukenmez, Murat Koc, Murat Ozturk***
15:15-15:30	**(1)** Alternative New Use for Corn: Hydrogen Production ***Özge Nayman Tiryaki, Sibel Irmak***	**(211)** A Study on Hydrogen Generation from $NaBH_4$ Solution Using Co-loaded Resin Catalyst ***Ayhan Abdullah Ceyhan, Serpil Edebali, Enis Fangaj***
15:30-16:00 Coffee Break		

SCIENTIFIC PROGRAM

Thursday, June 20, 2019

Parallel Sessions 1

HALL - C	HALL - D
Session 1C: **Hydrogen Production-2** Chair: **Murat Ozturk**	**Session 1D:** **Hydrogen Energy and Applications-1** Chair: **Mustafa Ilbas**
(322) Development of an Integrated Ocean Thermal Energy Conversion Based Trigeneration System for District Cooling, Ammonia and Power Production ***Ahmed Hasan, Ibrahim Dincer***	**(242)** Investigation of Hydrogen Gas with Graphical Method ***Gözde Tekeli, Beycan Ibrahimoglu, Zeki Yılmazoglu, Sinem Yurt***
(222) Al_2O_3-Supported Nanoparticles for Catalyzing the Hydrolysis of Ammonia Borane ***Mehmet Sait Izgi, Orhan Baytar, Müge Yayla, Hilal Kazıcı, Ömer Şahin***	**(244)** Adsorption Kinetics of Methane Reformer Off-Gases on Aluminum Based Metal Organic Framework ***Fehime Çakıcıoğlu Özkan, Deniz Angı***
(5) Sequential Dark and Photo-Fermentative Hydrogen Gas Production From Agar Embedded Molasses ***Muhammet Enes Mıynat, Hidayet Argun***	**(168)** The Thermal and Structural Analyzes of Elliptical Head Cryogenic Pressure Vessel For Cryo-Compressed Hydrogen Using FEA ***Ertugrul Selcuk Erdogan, Birsen Erdogan, Bertu Altindag***
(38) Synthesis of Magnetically Separable Visible Light Driven Photocatalysts for H_2 Generation ***Seda Davulcu, Özge Kerkez Kuyumcu, Duygu Akyuz, Atıf Koca, Rana Muhammed Zunain Ayaz***	**(247)** Synthesis of Monodisperse CoPt/KB Nanocomposites and Their Catalytic Performance in the Dehydrogenation of Ammonia-Borane ***Melike Sevim***
(94) Calcium Silicate-based Catalytic Filters for Partial Oxidation of Methane ***Elif Tezel, Halit Eren Figen, Sema Z. Baykara***	**(276)** Performance of Zn-Schiff Base Complex Catalyst in $NaBH_4$ Hydrolysis Reaction ***Dilek Kilinç***
(289) Prevention of Substrate And Product Inhibitions by Using a Dilution Strategy During Dark Fermentative Hydrogen Production from Molasses ***Muhammet Enes Mıynat, Hidayet Argun***	**(298)** Effects of PPy and PDMS Polymers Addition on GA as Electrical Conductivity and Hydrophobicity Improvment Agents ***Emine Öner, Ayşenur Öztürk, Ayşe Bayrakçeken Yurtcan***
15:30-16:00	**Coffee Break**

SCIENTIFIC PROGRAM

Thursday, June 20, 2019

Parallel Sessions 2

	HALL - A	HALL - B
16:00-17:30	**Session 2A: Gasification Based Hydrogen Production** Chair: **Safaa Mohamed Riad**	**Session 2B: Fuel Cells-1** Chair: **Mehmet Suha Yazici**
16:00-16:15	**(91)** Process Simulation of Chemical Looping Gasification for Syngas and Hydrogen Production ***Ömer Faruk Dilmaç, Nesibe Dilmaç, Merve Durmaz***	**(65)** Investigation of Metallic Bipolar Plate for Light-Weight PEM Fuel Cell Stack ***Kıvanç Karacan, Selahattin Çelik, Serkan Torors, Uğur Aydın***
16:15-16:30	**(233)** Biomass Gasification Modeling by Aspen Plus Within Waste-to-Energy Concept ***Atakan Öngen, Nazlıcan Karabağ, Hamda Mowlid Nur***	**(69)** Effects of Thermal Cycling on Joint Strength of Glass-Ceramic Sealing Performance for Solid Oxide Fuel Cells ***Emre Ucar, Bora Timurkutluk, Selahattin Celik***
16:30-16:45	**(309)** Determination of Hydrogen and Methane Production From Biological Sludge Based on Energy Equivalence and Environmental Impacts ***Doğukan Tunay, Öznur Yıldırım, Emre Oğuz Köroğlu, Bestami Özkaya***	**(104)** Effect of Electrolyte Coating Parameters and Different Sintering Temperatures on Performance of Anode Supported Planar Solid Oxide Fuel Cells ***Sezer Önbilgin, Çiğdem Timurkutluk, Selahattin Çelik, Bora Timurkutluk***
16:45-17:00	**(180)** Hydrogen Production by Methanolysis of $NaBH_4$ with a Plasma-Effective Co-Cu-B Catalyst ***Ömer Şahin, Mehmet Sait Izgi, Seda Tayboğa***	**(23)** CVD Graphene Supported Cobalt Macrocyclic Complex as Electrocatalyst for PEM Fuel Cell ***Sümeyye Dursun, Ramiz Gültekin Akay, Mehmet Suha Yazici***
17:00-17:15	**(10)** Synthesis of Dual Phase Cathodes for IT-SOFCs via Thermal Plasma ***Havva Eda Aysal, Doğancan Sarı, Fatih Pişkin, Tayfur Öztürk***	**(48)** Numerical Investigation of a Model PEM Fuel Cell Under Isothermal and Non-Isothermal Conditions ***Mustafa Ilbas, Guliz Özge İlhan, Berre Kumuk, Busra Özdemir***
17:15-17:30	**(317)** Analyses of an Ocean Current and Wind Energy Based Hydrogen Production and Desalination ***Fatih Sorgulu, Ibrahim Dincer***	**(312)** Evaluation of a Wind Energy Based System for Co-Generation of Methanol and Hydrogen Production ***Haris Ishaq, Ibrahim Dincer***
17:30-17:45	**(83)** Microwave Heated Reactor System with Multiwall Carbon Nanotube Supported Moybdenum Incorporated Catalysts to Produce Hydrogen from Ammonia ***Melih Guler, Dilek Varisli***	**(303)** Comparisons between Natural Gas Carriers on Energy Consumption and Economic Analysis: LNG, Ammonia and Methanol ***Mohammed Al Breiki, Yusuf Bicer***

18:00-20:00 RECEPTION - *FOYER*

Thursday, June 20, 2019

Parallel Sessions 2

HALL - C	HALL - D
Session 2C: **Fuel Cells-2** Chair: **Balazs Bokor**	**Session 2D:** **Hydrogen Energy and Applications-2** Chair: **Atakan Ongen**
(108) Effect of Surface Roughness on Sealant Performance of Glass Ceramic in Solid Oxide Fuel Cells ***Tolga Altan, Selahattin Çelik***	**(153)** Comparison of Emission and Fuel Consumption Values of a Gasoline Fuelled and Gasoline + Hydrogen Fuelled SI Engine Powered Light-Duty Vehicle in New European Driving Cycle ***Yasin Karagöz, Azade Attar, Özgün Balcı, Hasan Köten***
(41) Numerical Modeling of a Model Tubular Solid Oxide Fuel Cell Running on Amonia in Comparison with Hydrogen ***Mustafa Ilbas, Berre Kumuk, Molla Asmare Alemu, Busra Ozdemir***	**(165)** Thermal and Structural Analyzes of Torispherical Head Cryogenic Pressure Vessel for Liquid Hydrogen Using FEA ***Birsen Erdogan, E.Selcuk Erdogan, Isa Ertan***
(195) Production of Electricity Production from Methane by Microbial Fuel Cell System ***Afşin Yusuf Çetinkaya***	**(302)** Satellite-Based Remote Sensing of Tropospheric Methane in Trakya Region ***Cenk Atlig***
(240) Selection and Prioritization of Fuel Cell Types for Propulsion Systems of Small Unmanned Aerial Vehicles ***Murat Ayar, Görkem Yalın, Tahir Hikmet Karakoç***	**(167)** The Thermal and Structural Analyzes of Elliptical Head Cryogenic Pressure Vessel for Liquid Hydrogen Using FEA ***Ertugrul Selcuk Erdogan, Birsen Erdogan, Abdurrahim Uslu***
(241) Performance Analysis of a Hydrogen Fuel Cell Hybrid System for Unmanned Aerial Vehicle ***Görkem Yalın, Emre Özbek, Levent Akyalçın, Can Özgür Çolpan, Tahir Hikmet Karakoç***	**(026)** Comparison of the 0-D and 3-D Models of a Steam-Methane Reformer ***Yağmur Nalbant, Can Özgür Çolpan***
(213) Facile Synthesis of NiPt Bimetallic Nanocatalyst on Hybrid Support Materials for PEMFC Application ***Solen Kinayyigit, Ahmet Musap Mert, Zeynep Aydin, Selmiye Alkan Gursel***	(326) Design and Thermodynamic Analysis of Liquid Hydrogen Generation Processes Driven by Solar Energy ***Nejat Tukenmez, Murat Koç, Murat Öztürk***
(217) Low Cost Preparation of Bimetallic PtCu Nanoparticles Supported with Graphene Nanoplatelets and Carbon Black Hybrid as an Effective Electrocatalyst for PEM Fuel Cells ***Solen Kinayyigit, Zeynep Aydin, Abdelhakim Elmhamdi, Selmiye Alkan Gursel***	**(262)** A Policy on Sectoral Hydrogen Energy Utilization ***Adnan Midilli***

18:00-20:00 **RECEPTION** - *FOYER*

Friday, June 21, 2019

MAIN HALL	
	Keynote Speakers Chair: **Adnan Midilli**
09:00-09:45	**Keynote Speaker 3 - Makoto Harada** Current State of Japan's Hydrogen Energy - From R&D at Academic Sectors to Business Deployment
09:45-10:30	**Keynote Speaker 4 - Pierre Millet** Industrial Water Electrolysis: State-of-Art, Limitations & Perspectives
10:30-11:00	Coffee Break

Parallel Sessions 3

	HALL - A	HALL - B
11:00-12:30	**Session 3A:** **Thermodynamic Analysis - 1** Chair: **Can Ozgur Colpan**	**Session 3B:** **Thermodynamic Analysis - 2** Chair: **Tanay Sidki Uyar**
11:00-11:15	**(231)** Thermodynamic Analysis and Assessment of a Combined Biomass Gasification-SOFC Plant for Compressed Hydrogen Generation ***Yunus Emre Yüksel, Murat Ozturk, Ibrahim Dincer***	**(157)** Exergy Analysis of a Solar Based Hydrogen Production System ***Mutlucan Bayat, Mehmet Ozalp***
11:15-11:30	**(30)** An Integrated Solar Hydrogen Production System: Energy Assessment of an Electrolyzer Coupled with a Rankine Cycle ***Kenan Saka, Mehmet Fatih Orhan, Faruk Uygul, Mohamed S. Shahin***	**(313)** Exergy Analysis of the Scimitar Engine at Mach 5 ***Tayfun Tanbay, Ahmet Durmayaz***
11:30-11:45	**(0323)** Conceptual Development and Analysis of Integrated Gas-Cooled Fast Nuclear Reactor and Copper-chlorine Cycle for Electricity and Ammonia ***Maan Al Zareer, Ibrahim Dincer, Marc A. Rosen***	**(164)** Exergy Analysis of Direct Methanol Fuel Cell System ***Alper Can Ince, Can Ozgur Colpan, Mustafa Fazıl Serincan***
11:45-12:00	**(253)** CoRh Thin Coatings as Electrochemically Active Materials for Hydrogen Evolution Reaction in Alkaline Solution ***Dawid Kutyła, Abdullah Salcı, Anna Kwiecińska, Karolina Kołczyk Siedlecka, Remigiusz Kowalik, Piotr Żabiński, Ramazan Solmaz***	**(296)** Performance Assessment of Boron Thermochemical Cycle for Hydrogen Production ***Mustafa Tolga Balta***
12:00-12:15	**(212)** Hydrogen Generation from Hydrolysis of NaBH4 Using Co-loaded Resin Catalyst ***Serpil Edebali, Ayhan Abdullah Ceyhan, Enis Fangaj***	**(17)** Numerical Modeling of a Proton Exchange Membrane Compressor for Electrochemical Hydrogen Storage ***Ehsan Baniasadi, Somayeh Toghyani, Ebrahim Afshari, Nader Javani***
12:15-12:30	**(235)** Investigation of the Effects of Dry Air and Pure Oxygen on Gasification Products ***Nazlıcan Karabağ, Hamda Mowlid Nur, Atakan Öngen***	**(327)** Integrated Photoelectrochemical System For Enhanced Production of Hydrogen and Other Useful Commodities ***Canan Acar, Ibrahim Dincer***

Friday, June 21, 2019

Parallel Sessions 3

HALL - C	HALL - D
Session 3C: **Hydrogen and Combustion** Chair: **Ilgi Karapinar**	**Session 3D:** **Borohydride Fuel Cells-1** Chair: **Yılser Devrim**
(131) Combustion and Emissions Investigation of Syngas Fuels ***Mehmet Salih Cellek***	**(16)** Recyclability Study of Co_3O_4 and CoBO Particles in Sodium Borohydride Methanolysis for Hydrogen Production ***Aysel Kantürk Figen***
(71) Numerical Investigation of Hydrogen Enriched Methane/Air Combustion from Pollutants Aspect ***Mustafa Kemalettin Büyükakın, Semiha Öztuna***	**(99)** Kinetics of Sodium Borohydride Oxidation Reaction on Carbon-Supported Pd-Zn Catalysts ***Merve Doğan Özcan, Ramiz Gültekin Akay, Cenk Çelik, Ayşe Nilgün Akın***
(73) A Review of Hydrogen Usage in Internal Combustion Engines (Gasoline-Diesel-LPG) from Combustion Performance Aspect ***Dinçer Akal, Semiha Öztuna, Mustafa Kemalettin Büyükakın***	**(208)** The Effect of Co-Y Catalyst on Hydrogen Production by Hydrolysis Reaction of Potassium Borohydride ***Muhammed Bora Akin, Ömer Sahin***
(119) Numerical Analysis of Hydrogen Enriched Gasoline Combustion in a Constant Volume Vessel ***Özgür Oğuz Taşkıran***	**(101)** A Comparison; Photocatalytic and Photoelectrochemical Hydrogen Performances of Heteroatoms (Mo, Ni and Cu) Decorated RGO-Cd(1-x)ZnxS Synthesized with Solvothermal and Sulphurization Methods ***Duygu Akyüz, Ali Rıza Özkaya, Atıf Koca***
(137) A Process Simulation Study on Direct Light Olefin Synthesis from Hydrogen Rich Syngas ***Atilla Ersöz***	**(85)** Methanol Electrooxidation Activity of Binary CoAg Electrocatalyst ***Ece Altunbaş Şahin, Ramazan Solmaz***
(70) Hydrogenation Behavior and Microstructure Evolution of Intermetallic Mg2Ni Alloy Produced by Vacuum Arc Melting ***Sultan Öztürk, Sefa Emre Sünbül, Kürşat Icin, Gözde Bayazit Sekitmen, Şadan Özcan***	**(331)** Performance Improvement of a Fuel Cell Hybrid Electric Vehicle in Different Driving Cycles ***Pouria Ahmadi, Mehrdad Raeesi, Sina Changizian, Nader Javani***

Friday, June 21, 2019

12:30-14:00 Lunch

Parallel Sessions 4

	HALL - A	HALL - B
14:00-15:30	**Session 4A: Borohydride Fuel Cells-2** Chair: **Inci Eroglu**	**Session 4B: Hydrogen Storage** Chair: **Tayfur Ozturk**
14:00-14:15	**(63)** Comparison of Pd-Co/C Catalysts Prepared by Modified Polyol and Supercritical CO_2 Deposition Methods for Direct Borohydride Fuel Cells ***Cem Gözlü, Ramiz Gültekin Akay, Ayşe Nilgün Akın, Fatma Ulusal, Bilgehan Güzel, Ebru Erünal***	**(50)** Characterization of Hydrogen Storable Properties of Mg-Ni Alloy Ribbons Produced by Melt Spinning Method ***Sultan Öztürk, Sefa Emre Sünbül, Kürşat Icin, Gözde Bayazit, Şadan Özcan***
14:15-14:30	**(93)**Pd-Co/C Catalysts Preparation with Microwave Assisted Polyol Method for Direct Borohydride Fuel Cells ***Cem Gözlü, Elvin Ecem Bekler, Ramiz Gültekin Akay, Ayşe Nilgün Akın***	**(160)** Simplified Model for Stabilized Premixed Flame in Porous Media ***Aldélio Bueno Caldeira, Çiğdem Susantez***
14:30-14:45	**(125)** Investigation of the Performance of a Direct Borohydride Fuel Cell with Low Pt/C Catalyst Loading ***Anil Can Turkmen, Kursat Can Ata, Tuncay Kadioglu, Cenk Celik, Ismet Tikiz, Ramiz Gultekin Akay***	**(171)** Hydrazine Borane Synthesis for Hydrogen Storage Applications ***Merve Rabia Gürlük, Gülay Özkan, Göksel Özkan***
14:45-15:00	**(129)** Investigation of the Performance of a Direct Borohydride Fuel Cell with Low Pd/C Catalyst Loading Under Different Operating Conditions ***Anil Can Turkmen, Tuncay Kadioglu, Kursat Can Ata, Cenk Celik, Ismet Tikiz, Halil Ibrahim Sarac***	**(166)** Thermal and Structural Analyzes of Torispherical Head Cryogenic Pressure Vessel for Cryo-compressed Hydrogen Using FEA ***Birsen Erdogan, E. Selcuk Erdogan, Samet Bayraktar***
15:00-15:15	**(100)** Kinetic Properties of Nickel–Titanium–Boride (Ni–Ti–B) Catalysts for Sodium Borohydride Hydrolysis Reaction ***Oğuz Kaan Özdemir***	**(332)** Combinatorial Development of Active Materials for Energy Storage And Conversion ***Tayfur Ozturk***
15:15-15:30	**(9)** Electrochemical Modeling of Molten Salt-Based Electrolytic Ammonia Synthesis for Solar Fuel Applications ***Yusuf Bicer, Farrukh Khalid***	**(314)** Solar-Driven Hydrogen Production and Injection in Lake Salt Natural Gas Storage Caverns ***Mert Temiz, Nader Javani***

15:30-16:00 Coffee Break

Friday, June 21, 2019

12:30-14:00 Lunch

Parallel Sessions 4

HALL - C	HALL - D
Session 4C: **Material Applications for Hydrogen Energy Technologies** Chair: **Nader Javani**	**Session 4D:** **Hydrogen Production-3** Chair: **Ahmet Durmayaz**
(77) Investigation of Parametric Synthesis Conditions of n-Butylamine Borane as Hydrogen Storage Material ***Hatice Begüm Murathan, Gülay Özkan, Göksel Özkan***	**(78)** Water Splitting Activity of Rhodanine Self Assembled Monolayer Films ***Abdullah Salcı, Ramazan Solmaz***
(178) Synthesis and Characterization of Nanostructured Co-Fe-B Using Different Support Materials for Ammonia Borane Hydrolysis ***Hilal Çelik Kazici, Mehmet Sait Izgi, Ömer Şahin***	**(24)** Design and Assessment of a Geothermal Driven Multigeneration System for Hydrogen Production ***Fatih Yilmaz, Murat Öztürk, Reşat Selbaş***
(328) Numerical investigation of flameless combustion in a furnace under high temperature ***Mehmet Salih Cellek***	**(254)** Pd Activated Binary MoCu Electrocatalysts for Alkaline Water Splitting ***Ramazan Solmaz***
(179) CeO_2 Supported Multimetallic Nano Materials as an Efficient Catalyst for Hydrogen Generation from the Hydrolysis of $NaBH_4$ ***Mehmet Sait Izgi, Orhan Baytar, Ömer Şahin, Hilal Çelik Kazıcı***	**(288)** An Investigation on $CoCl_2$ Activated Hydrogen Generation by Hydrolysis of MgH_2 for Portable Applications ***Bilge Coşkuner Filiz***
(92) Ammonia Decomposition Reaction to Produce COx-free Hydrogen Using Carbon Supported Cobalt Catalysts in Microwave Heated Reactor System ***Rukan Can Seyfeli, Dilek Varisli***	**(80)** Production of Hydrogen by the Electrochemical Reforming of Glycerol ***Merve Gördesel, Özgü Yörük, Duygu Uysal Zıraman, Özkan Murat Doğan, Bekir Zühtü Uysal***
(294) Effect of Hydrophobic PDMS-OH/CTAB Catalyst Layer Coating on Water Management in PEM Fuel Cell ***Ayşenur Öztürk, Ayşe Bayrakçeken Yurtcan***	**(74)** Transcriptome Analysis of the Effects of Light and Dark Cycle on Hydrogen Production Metabolism of Rhodobacter capsulatus DSM1710 ***Muazzez Gürgan, Harun Koku, Inci Eroglu, Meral Yücel***

15:30-16:00 Coffee Break

Friday, June 21, 2019

Parallel Sessions 5		
	HALL - A	HALL - B
16:00-17:45	**Session 5A:** **Modelling and Analysis of Hydrogen Energy Technologies** Chair: **Canan Acar**	**Session 5B:** **Fuel Cells-3** Chair: **Umit B. Demirci**
16:00-16:15	**(3)** Modelling and Optimization of Solid Oxide Fuel Cells Using Artificial Neural Networks ***Feride Cansu Iskenderoğlu, Mustafa Kaan Baltacıoğlu, Mehmet Hakan Demir, Arianna Baldinelli, Linda Barelli, Gianni Bidini***	**(4)** Evaluation of Methanol at Start-up for the PEMFC Cold Start Process ***Alparslan Topcu, Kadir Aydın, Selahattin Çelik***
16:15-16:30	**(20)** Performance Evaluation of Precooled Claude Liquefaction Cycle for Hydrogen Liquefaction ***Ceyhun Yilmaz***	**(8)** Investigation of Compression Pressure Distribution of Proton Exchange Membrane Fuel Cell ***Arife Uzundurukan, Muhittin Bilgili, Yilser Devrim***
16:30-16:45	**(59)** Thermofluidynamic Modelling of Hydrogen Absorption in Different Hydride Beds by Using COMSOL Multiphysics Software ***Fawzi Elhamshri, Muhammet Kayfeci***	**(118)** Design, Manufacturing and Testing of High Temperature PEM Fuel Cell Stack ***Yağmur Budak, Hüseyin Devrim, Yılser Devrim***
16:45-17:00	**(117)** Modification and Modelling of Gas Diffusion Layer on PEM Fuel Cells ***Şeyma Kil, Oğuz Kaan Özdemir, Hasan Sadıkoğlu***	**(174)** Effect of Channel Depth on Fuel Cell Performance of a Proton Exchange Membrane Fuel Cell with a Serpentine Flow Channel ***Ismail Özgün, Hüseyin Kahraman***
17:00-17:15	**(183)** Modelling and Simulation of a Hybrid Electric Air Vehicle ***Hüseyin Turan Arat, Meryem Gizem Sürer***	**(229)** PEM Fuel Cell Performance with Solar Air Preheating ***Alper Uzun, Balazs Bokor, Dogan Eryener***
17:15-17:30	**(329)** Conventional and Enhanced Exergy Analyses of a Hydrogen Liquefaction System ***Zafer Utlu, Arif Karabuğa***	**(308)** Synthesis and Characterization of Co-doped CeO_2 Ceramic Electrolyte For IT-SOFC ***Handan Özlü Torun, Rabia Kırkgeçit***
17:30-17:45	**(316)** Analysis of an Integrated System for Ammonia Production from Renewable Hydrogen in Istanbul ***Merve Ozturk, Ibrahim Dincer***	**(66)** Investigation of Hydriding and Thermal Properties of Near-Eutectic Mg-Ni Alloy Fabricated by Rapid Solidification Process ***Sefa Emre Sünbül, Sultan Öztürk, Kürşat Icin, Gözde Bayazit Sekitmen, Şadan Özcan***

Friday, June 21, 2019

Parallel Sessions 5

HALL - C	HALL - D
Session 5C: **Hydrogen Production-4** Chair: **Pierre Millet**	**Session 5D:** **Hydrogen Production-5** Chair: **Steven Baele**
(120) Enhancement of the Photoelectrochemical Performance of Titania Nanorod Array for Hydrogen Production by Cerium Doping ***Abrar Ahmad, Gurbet Yerlikaya, Halime Paksoy, Gülfeza Kardaş***	**(275)** KBH_4 Hydrolysis Reaction for Hydrogen Generation via Palladium Complex Catalyst ***Dilek Kilinç, Ömer Şahin***
(142) Enhanced Photoelectrochemical Activity of Reduced Graphene Oxide Decorated $Cd_xZn_{1-x}S$ Photocatalyst for Hydrogen Production ***Rana Zunain Muhammad Ayaz, Duygu Akyüz, Özlem Uğuz, Seda Davulcu, Cevat Sarioğlu, Fatma Karaca, Ali Rıza Özkaya, Atıf Koca***	**(230)** Performance Assessment of Geothermal Power System Design for Hydrogen Generation and Liquefaction ***Yunus Emre Yüksel, Murat Ozturk, Ibrahim Dincer***
(25) Thermodynamic Analysis of Hydrogen Generation System Consisting of Biomass Gasifier, Gas Turbine Cycle and Hydrogen Compression Plant ***Fatih Yilmaz, Murat Öztürk, Reşat Selbaş***	**(130)** Design and Implementation of Hydrogen Generation and Liquation Economy Using Artificial Neural Network on Field Programmable Gate Array ***Ismail Koyuncu, Ceyhun Yilmaz, Murat Alçın, Murat Tuna***
(114) ZIF-derived CuPt@Ag as catalyst for hydrogen evolution reaction ***Gurbet Yerlikaya, Mehmet Burak Koca, Birgül Yazıcı, Gülfeza Kardaş***	**(177)** Eupergit CM Supported Co-Mn-B Nanoparticles as Catalyst for the H_2 Production from NH_3BH_3 Methanolysis ***Hilal Çelik Kazici, Mehmet Sait Izgi, Ömer Şahin***
(138) Investigation of an Experimental Hydrogen Production System for 2 kWe PEM Fuel Cell Microcogeneration Unit ***Atilla Ersöz, Egemen Akar, Özgürcan Korkmaz, Nilüfer Topuz, Çiğdem Karadağ, Betül Erdör Türk***	**(192)** Advantages of Microwave Environment from Non-Applied Microwave Environment by Catalytic Effect of Ni-B Catalyst Production of Hydrogen From Sodium Boron Hydride ***Ebuzer Cengiz, Arzu Ekinci, Ömer Şahin, Melih Kuncan***
(144) Photoelectrochemical-Photocatalytic Dual Hydrogen Production System ***Özlem Uğuz, Duygu Akyüz, Rana Muhammed Zunain Ayaz, Seda Davulcu, Cevat Sarıoğlu, Fatma Karaca, Ali Rıza Özkaya, Atıf Koca***	**(193)** The Catalytic Effect of Co-La-Cr-B Catalyst on the Release of Hydrogen in $NaBH_4$ Solution ***Arzu Ekinci, Ebuzer Cengiz, Ömer Şahin***
(22) Artificial Neural Networks Modeling of Geothermal Energy Assisted Hydrogen Production by PEM Water Electrolysis ***Ceyhun Yilmaz***	**(84)** The Effect of Annealing Temperature on Photo-electrochemical (PEC) Properties of Spin-coated SnS2 Photo-anodes ***Felisters Zvavamwe, Cevat Sarıoğlu***

Friday, June 21, 2019

17:45-18:30 Poster Session

Chair: **Ugur Akbulut**

0032	Synthesis and Electrochemical Analysis of Transition Metal (Zn, Cu, Mn) Doped $Ba_{0,5}Sr_{0,5}Co_{0,8}Fe_{0,2}O_{3-\delta}$ Perovskite Structure for Hydrogen Evolution Reaction ***Emre Yusuf Göl, Ahmet Aytekin, Ecem Ezgi Özkahraman***
0060	Modeling and Optimization of Hydrogen Charging in Metal Hydride-Based Storage Systems Using Heat Pipe ***Fawzi Elhamshri, Muhammet Kayfeci***
0086	Hydrogen Production via Ethane Dehydrogenation in Microwave Heated Reactor over Mesoporous Alumina Supported Chromium Catalyst at Low Temperature ***Pınar Çitli, Hüseyin Arbağ, Nuray Oktar, Gülşen Doğu***
0087	Hydrogen and Ethylene Production by Ethane Dehydrogenation in Microwave Heated Reactor System: Effect of Reaction Temperature ***Büşra Eryıldırım, Hüseyin Arbağ, Nuray Oktar, Gülşen Doğu***
0088	Improved Fuel Cell Properties of Nano-TiO_2 Doped Polyvinylidene Fluoride and Phosphonated poly(vinyl alcohol) Composite Blend Membranes for PEM Fuel Cells ***Yavuz Yağızatlı, Berdan Ulaş, Aygün Çalı, Alpay Şahin, Irfan Ar***
0126	Direct Synthesis of Dimethyl Ether on TPA Incorporated HZSM-5 Zeolites ***Birce Pekmezci Karaman, Nuray Oktar, Gülsen Doğu, Timur Doğu***
0128	Direct Synthesis of Dimethyl Ether from Syngas over Silicotungstic Acid Containing Catalyst ***Merve Çelik, Birce Pekmezci Karaman, Nuray Oktar, Gülsen Doğu, Timur Doğu***
0146	A Density Functional Theory Study of Molecular Hydrogen Adsorption on Mg site in OFF Type Zeolite Cluster ***Numan Yüksel, Osman Nuri Şara, Mehmet Çopur, Mehmet Ferdi Fellah***
0150	Analysis and Modeling of a Membrane Electrode Assembly in a Proton Exchange Membrane Fuel Cell ***Kenan Saka, Mehmet Fatih Orhan, Hüseyin Kahraman***
0151	Assessment of Gas Diffusion Layers in a Proton Exchange Membrane Fuel Cell: Design and Analysis ***Mehmet Fatih Orhan, Hüseyin Kahraman, Kenan Saka***
0175	Activity of Modified Sol-Gel Alumina Supported Ni Catalysts in Dry Reforming of Methane ***Mert Yekta Doğan, Hüseyin Arbağ, Nail Yaşyerli***

19:00-22:00 GALA DINNER & AWARD CERENOMY

Friday, June 21, 2019

17:45-18:30 Poster Session

Chair: **Ugur Akbulut**

0197	The Synthesis and Characterization of Pt Based Hybrid Materials as an Efficient Nanocatalyst for the Dehydrogenation of Hydrazine-Borane in Water ***Yaşar Karataş, Mehmet Gülcan, Fatih Şen***
0198	Synthesis and Characterization of Extremely Active Polymer/Carbon Nanotube Based Platinum Nanohybrids for Hydrogen Evolution from the Hydrolysis of Methylamine-Borane ***Yaşar Karataş, Mehmet Gülcan, Fatih Şen***
0203	Activity of Iron and Yttrium Catalysts in CO_2 Reforming of Methane ***Ayşe Genç, Hale Akansu, Güliz Nil Varlı, Mehmet Taşdemir, Hüseyin Arbağ, Nail Yaşyerli, Sena Yaşyerli***
0205	Performance of Silica Supported Ni catalysts in Steam Reforming of Biomass Derived Acetic Acid ***Nurbanu Cakiryilmaz Sahingoz, Hüseyin Arbag, Nuray Oktar, Gülsen Dogu, Timur Dogu***
0215	Investigation of Applicability of PVA Based Membranes Sulfated by Different Sulfonation Agents for DMFC ***Nazlı Yenihan Yüzer, Tuncay Kadioğlu, Ramiz Gültekin Akay, Nilüfer Durmaz Hilmioğlu***
0232	A New Model Proposal Based on Global Warming ***Gözde Göktaş, Mükerrem Şahin***
0253	CoRh Thin Coatings as Electrochemically Active Materials for Hydrogen Evolution Reaction in Alkaline Solution ***Dawid Kutyła, Abdullah Salcı, Anna Kwiecińska, Karolina Kołczyk Siedlecka, Remigiusz Kowalik, Piotr Żabiński, Ramazan Solmaz***
0256	A Cost Model Approach on Sub-ground Salt Hydrogen Storage ***Yıldırım Tosun***
0216	Investigation of a Fe-Cl Thermochemical Cycle for Hydrogen Production ***Farid Safari, Ibrahim Dincer***
0333	BaZr0.80Y0.20O3 - SrCe0.95Yb0.05O3 Dual Phase Perovskite Oxides for Hydrogen Separation ***Ömer Özcan, Fatih Pişkin***

19:00-22:00 GALA DINNER & AWARD CERENOMY

Saturday, June 22, 2019

Parallel Sessions 6		
	HALL - A	HALL - B
09:00-10:15	**Session 6A:** **Hydrogen Production-6** Chair: **Yusuf Bicer**	**Session 6B:** **Hydrogen Energy and Applications-3** Chair: **Ramazan Solmaz**
09:00-09:15	**(252)** Experimental Investigation of Hydroxyl Gas Production by Using Distilled and Ultra-Pure Water ***Mustafa Kaan Baltacıoğlu, Mustafa Tunahan Başar, Feride Cansu Iskenderoğlu, Çağlar Conker***	**(263)** Microstructural Investigation of Electrospraying Parameters in LSCF Films Coated on GDC Electrolyte ***Sedat Akkurt, Can Sandıraç***
09:15-09:30	**(250)** Hydrogen Energy Production and Storage Analaysis in Pressure Regulation Measuerement Stations (RMS-A) ***Yunus Uraltaş, Zehra Yumurtacı***	**(196)** Safety Measures for a Weather Forecasting Balloon Filled with Hydrogen ***Hasan Ozcan, M Huseyin Cetin***
09:30-09.45	**(187)** Hydrogen and Chlorine Productions with Electrolysis of Waste Acid and Base Generated in Metal Plating Industry ***Ghassan Chehade, Nabeel Alrawahi, Ibrahim Diner, Burak Yuzer, Huseyin Selcuk***	**(170)** FO-PI Speed Control of the BLDC Motor Which Parameters of the Controller Determined by MSA Optimization and Which Energized by PEM-FC ***Tevfik Yigit, Hakan Celik***
09:45-10:00	**(82)** Investigation of Effects of Post-annealing Atmosphere and Temperature on Structural and Photo-electrochemical Properties on Electrodeposited SnS Photo-electrode ***Sercan Soyöz, Selim Demirci, Cevat Sarıoğlu***	**(158)** Highly Durable Phosphonated Graphene Oxide Doped Polyvinylidene Fluoride (PVDF) Composite Membranes ***Aygün Çalı, Yavuz Yağızatlı, Alpay Şahin, Irfan Ar***
10:00-10:15	**(56)** A New Approximation to Production of High Efficiency Hydrogen with Water Electrolysis ***Arzu Coşkun Avci, Ethem Toklu***	**(147)** Development of a Novel Renewable Energy Based Integrated System for Hydrogen Production ***Aras Karapekmez, Ibrahim Dincer***
10:15-10:30 Coffee Break		

Saturday, June 22, 2019

Parallel Sessions 6

HALL - C

Session 6C:
Hydrogen Energy Policies and Strategies

Chair: **Sudi Apak**

(330) Assessment of the Hydrogen Production System for Domestic Type Use

Begum Erten, Zafer Utlu, Arif Karabuga

(29) Extruded Pellets of Microwave Leached Activated Char/Active Carbon/ Clay Mixtures for Hydrogen Sorption

Yıldırım Tosun

(112) An Urban Hydrogen-Based Transportation Scenario Analysis

Doğancan Beşikci, Egemen Sulukan, Tanay Sıdkı Uyar

(321) Performance Assesment of Hydrogen Production with Iron Based Chemical Looping Fed by Coffee Waste

Onur Oruc, Ibrahim Dincer

(207) Catalytic Performance of Silica Covered Nickel-Iron Bimetallic Core-Shell Microspheres for Hydrogen Production

Gamze Gunduz Meric, Süleyman Kaytakoglu, Levent Degirmenci

10:15-10:30 Coffee Break

Saturday, June 22, 2019

Parallel Sessions 7		
	HALL - A	HALL - B
10:30-12:00	**Session 7A:** **Hydrogen Energy and Applications-4** Chair: **Fehime Cakicioglu Ozkan**	**Session 7B:** **Hydrogen Evolution** Chair: **Huseyin Selcuk**
10:30-10:45	**(19)** Design and Building PEM Fuel Cell Stacks with Different Configurations: Stack Operation Conditions ***Kenan Saka, Mehmet Fatih Orhan, Hüseyin Kahraman***	**(162)** Hydrogen Evolution Behaviour of Nickel coated TiO_2 ***Hasan Uzal, Ali Döner, Hüseyin Bayrakçeken***
10:45-11:00	**(81)** Development of the Liquid Fuel Based Fuel Cell for Air-Independent Propulsion Systems ***Elif Seda Akça, Arife Uzundurukan, Yılser Devrim***	**(293)** Exergoeconomic Comparison of Various Geothermal Driven Power and Hydrogen Production Plants ***Hasan Ozcan, I Sheikh Hasan***
11:00-11:15	**(154)** On Vehicle Comparison of Gasoline Fueled SI Engine, Hydrogen Fueled SI Engine and Hydrogen Fueled SI Engine + Microbial Fuel Cell Powered Systems ***Azade Attar, Yasin Karagöz, Özgün Balcı, Sefa Kale, Hasan Köten***	**(7)** Investigation of the Effect of the Initial Reactant Molar Ratio on the Synthesis of Sodium Amidoborane and Its Hydrogen Capacity ***Gülay Özkan, Sena Akkuş, Göksel Özkan***
11:15-11:30	**(172)** The Stability Region Analysis of Fractional-Order PI Controller for Fuel Cell Micro grid with Time Delay ***Burak Yıldırım, Mahmut Temel Özdemir***	**(246)** Methane decomposition over Fe-based catalysts ***Meltem Karaismailoglu, Halit Eren Figen, Sema Zeynep Baykara***
11:30-11:45	**(249)** Hydrogen economy and energy use efficiency of rice production in Turkey's İpsala region ***Erhan Atay, Sudi Apak***	**(185)** Evaluation of Hydrogen Production in Electrodialysis Process Treating Industrial Saline Wastewater ***Burak Yuzer, Iberia M. Aydin, Huseyin Selcuk, Ghassan Chehade, Ibrahim Dincer***
11:45-12:00	**(284)** Synthesis and hydrogen storage performance of Zn doped MWCNTs ***Songül Kaskun, Muhammet Kayfeci***	**(109)** CoNiFeS Nanoparticles Dispersed on Graphite Cathode for Hydrogen Evolution Reaction ***Mehmet Burak Koca, Gurbet Yerlikaya, Birgül Yazıcı, Gülfeza Kardaş***
12:00-12:15 Closing Ceremony in Main Hall		
12:15-13:30 Lunch		
13:30- 19:00 SOCIAL PROGRAME (City Tour; Selimiye Mosque, Health Museum, Karağaç)		

Saturday, June 22, 2019

Parallel Sessions 7

HALL - C	HALL - D
Session 7C: **Hydrogen Energy and Applications-5** Chair: **Birol Kilkis**	**Session 7D:** **Hydrogen Energy and Applications-6** Chair: **Hidayet Argun**
(286) A New Approach to Improve the Performance of PEM Fuel Cells: APTES Polymer Modification of the Catalyst Layer ***Hande Ungan, Ayşe Bayrakçeken Yurtcan***	**(220)** Preparation of GO Based Co-Cu-B and Investigation of Hydrogen Production Performance ***Ömer Şahin, Ali Bozkurt, Müge Yayla, Hilal Çelik Kazıcı, Mehmet Sait Izgi***
(21) Oxygen Reduction Kinetics in the Ordered Mesoporous Carbon Supported Pt Catalysts ***Silver Güneş, Fatma Çiğdem Güldür***	**(51)** An Investigation of Two Phase Flow Analysis on Hydrogen Gas Production by Water Electrolysis ***Arzu Coskun Avci, Ethem Toklu***
(184) A Solar Air Heating System Integrated with Hydrogen Energy for Low Energy Buildings ***Balazs Bokor, Hacer Akhan, Dogan Eryener***	**(58)** H_2 Storage at Ambient Temperature using Cu(I)-SSZ-39 ***Bahar Ipek Torun, Ismihan Altiparmak, Deniz Üner***
(11) Design of a Sustainable Hydrogen House for Future Hydrogen Cities ***Birol Kilkis***	**(105)** Thermoeconomic Optimization of Various Geothermal Driven Power and Hydrogen Configurations ***Ibrahim Shikh Hasan, Hasan Özcan***
(103) Effect of Production Parameters on Photoelectrochemical Water Splitting of Fe_2O_3 Thin Film: Optimisation Study Using Response Surface Methodology (RSM) ***Selim Demirci, Cevat Sarıoğlu***	**(173)** Hydrogen Production and Storage Analysis of a System by Using TRNSYS ***Berrin Karacavus, Kadir Aydın***
(111) Design and Development of Air Cooled PEFC Stack – Flow Design Optimization Through Computational Fluid Dynamics (CFD) ***K Hari Gopi, Natarajan Rajalakshmi***	**(161)** An Overview of Hydrogen as a Fuel for Internal Combustion Engines ***Adem Ugurlu, Semiha Oztuna***

12:00-12:15 Closing Ceremony in Main Hall

12:15-13:30 Lunch

13:30- 19:00 SOCIAL PROGRAME (City Tour; Selimiye Mosque, Health Museum, Karağaç)

KEYNOTE / INVITED SPEAKERS

KEYNOTE / INVITED SPEAKERS

KN-01

Mathematical Modeling of Fuel Cells and Electrolyzers – A Review

Steven B. Beale

Institute of Energy and Climate Research, IEK3-, Jülich 52425, Germany

Mathematical models can provide insight into the performance of fuel cells and electrolyzers at a number of length-scales: Cell models are at the heart of electrochemical engineering applications. These are typically based on either computing the local ideal potential and subtracting losses, or by obtaining solutions to the full electric field equations in both ionic and electronic regions. For low temperature polymer electrolyte cells, two-phase liquid-gas flow, including evaporation/condensation, must be taken into account, as well as oxygen solution effects. The choice of closure constants is important, but these are difficult to obtain in practice. Effective properties, such as diffusivities and permeabilities, can be obtained by performing micro-scale calculations of representative elements of volume, which may be obtained from discretizing 3-D samples. Inter-phase drag and heat/mass transfer factors may also be obtained from volume-of-fluid and other techniques in the channels and porous layers. Detailed stack models generally require enormous computational resources and may therefore be supplanted with volume-averaging techniques that provide 90% of the information at 10% of the cost. A model without validation and verification is of little value. It is shown with local measurements of current density and concentration of reactants, that the mathematical models are correct: While physical experiments are important, the present generation of experimental techniques cannot match the level of detail of current models that display information in terms of local extrema that no experiment can capture.

KEYNOTE / INVITED SPEAKERS

KN-02

B-H and B-N-H Materials for Chemical Hydrogen Storage

Umit B. Demirci

University of Montpellier, France

One of the major obstacles hindering the deployment of the eagerly-expected "hydrogen economy" is hydrogen storage. Over the past decade, several approaches have been developed, including physical, physicochemical, and purely chemical storages. In our lab, we focused our efforts on solid- and liquid-state boron- and/or nitrogen-based materials (i.e. B-H and B-N-H materials) for chemical hydrogen storage. B-H and B-N-H materials have attracted much attention primarily due to high gravimetric hydrogen densities (rH = 10-20 wt%) and "low" dehydrogenation temperatures (<50°C in hydrolytic conditions, and <200°C in thermolytic conditions). Despite irreversibility of storage, this kind of materials has some prospects thanks to existing chemical recycling/regeneration schemes. A first typical, and old, example is sodium borohydride $NaBH_4$ (rH = 10.8 wt% H). It is attractive as it is able to fast release up to 7 wt% H_2 by hydrolysis at 20-80°C when e.g. a cobalt-based catalyst is used. Importantly, water provides half of the generated hydrogen, such as: $NaBH_4 + 4H_2O \rightarrow NaB(OH)_4 + 4H_2$. The reaction is based on the reaction of the hydridic Hd- hydrogens of NaBH4 and the protic Hd^+ hydrogens of H_2O. A second typical, and old, example is ammonia borane NH_3BH_3 (rH = 19.5 wt% H). Like sodium borohydride, it is able to produce H_2 by hydrolysis in the presence of a catalyst. However, the great interest we have on ammonia borane is related to the presence, in each of the molecule, of protic Hd+ and hydridic Hd- hydrogens that are in intra- and inter-molecular interactions Hd+---Hd- (so-called dihydrogen bonding). Such properties explain the solid state of the compound below 100°C, and the formation of H_2 above 100°C through a two-step process summarized as follows: $xNH_3BH_3 \rightarrow [-NHBH-]x + 2xH_2$. Based on our knowledge on both of the aforementioned compounds, we have developed a series of alternative and/or new B-H and B-N-H materials for chemical hydrogen storage, as well as for as potential fuel of direct liquid fuel cells. The 4th International Hydrogen Technologies Congress (IHTEC-2019) will thus be a great opportunity to give an overview of B-H and B-N-H materials, present few of them more in details, and discuss about their application prospects.

KN-03

Current State of Japan's Hydrogen Energy - From R&D at Academic Sectors to Business Deployment

***Makoto Ryo Harada*[1], *Hirohisa Uchida*[2]**

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The R&D of hydrogen energy and relevant activities are advancing drastically in Japan.

The roles of industrial sectors are essential to realize hydrogen society compared with those of academic sectors. The progress in business with hydrogen energy is mainly realized by stationary and mobile products of fuel cell. In this stage, there are still several important issues such as hydrogen production, transport and storage. However, Japan changed its policy and made it a priority to aim for the construction of a hydrogen energy society. Japan's policy is changing. The combination of hydrogen energy with renewable energy is also in progress. Renewable energy is attracting high attention in the world from the sight of SDGs. In this case, energy storage and control of fluctuating output of renewable energy (solar and wind) are of great importance. Recently, we succeeded with mass production of nano-structured FeTi hydrogen storage alloy by mechanical alloying. The Ministry of the Environment Japan adopted our project: Renewable energy storage with nano-structured FeTi hydrogen storage alloy - aiming at CO_2 reduction. The cost of this alloy is about 1/3 of conventional alloys, and very adequate to store hydrogen produced by renewable energy in a large scale for a longer time. In this talk, current state of R&D and business deployment of hydrogen energy in Japan will be introduced, and a very prominent project of renewable energy storage and output control using a hydrogen storage alloy will be discussed. In this stage, there are still several important issues such as hydrogen production, transport and storage. The combination of hydrogen energy with renewable energy is also in progress. Renewable energy is attracting high attention in the world from the sight of SDGs. In this case, energy storage and control of fluctuating output of renewable energy (solar and wind) are of great importance. Recently, we succeeded with mass production of nano-structured FeTi hydrogen storage alloy by mechanical alloying. The Ministry of the Environment Japan adopted our project: Renewable energy storage with nano-structured FeTi hydrogen storage alloy - aiming at CO_2 reduction. The cost of this alloy is about 1/3 of conventional alloys, and very adequate to store hydrogen produced by renewable energy in a large scale for a longer time. In this talk, current state of R&D and business deployment of hydrogen energy in Japan will be introduced, and a very prominent project of renewable energy storage and output control using a hydrogen storage alloy will be discussed.

Keywords: Hydrogen energy, renewable energy, fuel cells, hydrogen strage alloy, SGDs

KN-04

Industrial Water Electrolysis: State-of-art, Limitations & Perspectives

Pierre Millet

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Water dissociation by electrolysis is an old and mature process of the chemical industry. In the frame of the energy transition, it is considered as a cornerstone technology for the large scale production of molecular hydrogen and for energy storage. Modern water electrolysers use different cell design and components, and operate at quite different temperature and pressure, to produce this hydrogen. The most popular and advanced techniques found on the market are the so-called "alkaline", "PEM" (Proton Exchange Membrane) and, to a lesser extent, "solid oxide" processes. Up to now, most water electrolysis plants have been operated at quasi-constant power, for the stationary production of hydrogen which is then used as chemical in various downstream processes. New applications (in particular those related to the energy-value of electrolytic hydrogen) are emerging, bringing new operational constraints and requiring customized designs. For example, the use of transient power sources such as photovoltaic panels or wind turbines, or the grid connection for grid balancing operation. Such applications require better process flexibility and reactivity: improvements are needed at system level to comply with new operating requirements. The purpose of this communication is to provide an overview of the state of art in the field of water electrolysis, to discuss some specific limitations and to provide future development perspectives. The design and operational characteristics of main water electrolysis technologies are described. Different indicators are used to compare their performances at stack and balance-of-plant levels: (i) the specific energy consumption and efficiency; (ii) the coulombic efficiency; (iii) the ability to operate in flexible and reactive conditions in order to meet power grid requirements; (iv) some safety indicators related to H_2/O_2 cross-permeation; (v) the long-term durability of performances; (vi) the hydrogen cost (capex/opex analysis). Experimental results obtained on MW-scale systems are used to support the discussion.

ORAL ABSTRACTS

ORAL ABSTRACTS

[**Abstract:0001**]

Alternative New Use for Corn: Hydrogen Production

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Hydrogen as a fuel has the highest specific energy content of all conventional fuels. Its only waste is pure water. Current technology options for hydrogen production are very expensive. Use of an effective method with a suitable feedstock is necessary for cost-effective and high yield hydrogengas production. The present study was designed to produce hydrogen gas from corn kernels by aqueous-phase reforming (APR). Various types of corn varieties were evaluated to produce hydrogen rich gas mixture in the aqueous phase over carbon supported platinum catalyst at relatively mild processing conditions. The gas mixtures produced from corn hydrolysates were composed of H_2, CO, CO_2 and CH_4. Hydrolysates of various types of corn varieties produced 335-585 ml hydrogen gas mixtures which were composed of roughly 78.5% hydrogen gas. Hydrogen production yield were significantly differed amoung corn varieties. The field corn varieties were better feedstock than popcorn for high yielding hydrogen gas production.

Keywords: Hydrogen, APR, corn, corn varieties

[**Abstract:0003**]

Modelling of SOFC Using Support Vector Regression and Random Forest Algorithms for Estimating the Output Voltage

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Artificial neural networks (ANN) can be considered as a computational tool or a technique that offer an alternative way to solve complex problems. They work with the data processing logic of a brain cell and can increase their knowledge with the results obtained from the experiments. They are tolerant of errors caused by missing data and non-linear problems. Therefore, they can quickly estimate and generalize the relationship between the inputs and the ouputs of a process ANNs are used in various applications such as control, optimization, modeling, signal processing, pattern recognition, power systems, production, and renewable energy systems. In the framework of energy generation, fuel cells are a highly preferred alternative energy conversion technologies because of they turn the chemical energy of a fuel directly into electrical energy. For a number of applications, Solid Oxide Fuel Cells (SOFCs) are the best fuel cell variant due to fuel flexibility. SOFC performance is influenced by the fuel composition, operating conditions, environmental conditions, materials used and system design. Therefore, reliable simulation tools are needed to control and optimize the operation of SOFC. Due to the high variability of the fuels used in SOFC applications and the non-linearity of the electrochemical systems, artificial neural networks can be used to ensure optimization of these systems. In this paper, a model of a SOFC is obtained by using three efficient modeling techniques such as Random Forest (RF), Support Vector Regression and Artificial Neuro-Fuzzy Inference System which are among the powerful tools. The models are generated by using the measured experimental data in these techniques. The modelling performances of the developed models are compared with each other and the most promising model is determined. Accordingly, the models are tested with the data which are not used in training process and the results are compared with the experimental data to observe the prediction performances. Consequently, the results show that sufficient modeling techniques for modeling the SOFCs.

Keywords: Fuel cell, Artificial Neuro-Fuzzy Inference System, Random Forest, Support Vector Regression SOFC, renewable energy

ORAL ABSTRACTS

[**Abstract:0004**]

Evaluation of Methanol at Start-up for the PEMFC Cold Start Process

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Fuel cell vehicles (FCVs) has gained popularity as transportation alternative choice to internal combustion vehicles (ICVs) in recent years. Zero emissions (produce water vapor only) and silent working specifications are most important features for FCVs on ICVs. Proton exchange membrane (PEM, or polymer electrolyte membrane) fuel cell (PEMFC) is one of the most developed fuel cell type and widely used as power source in fuel cell vehicle (FCV) technologies due to its superior characteristics such as fast start-up, high efficiency, system robustness, and zero emission. PEMFC has the different application potential in areas that stationary, portable and auxiliary power units as well as automotive applications. It is operate at relatively low temperature (20-90 °C range) but it should start and operate at subfreezing temperatures. Some countries have cold weather conditions and FCV should satisfy that expectations. Reactant and oxidant gases supplies to the catalyst layer thanks to flow channels and water produces as a result of electrochemical reactions. Normally that water droplets remove from flow channels, but in subfreezing temperatures; water droplets can freeze in reaction fields. These ice formations which occurred sub-zero temperatures block gas transport ways as well as lead to cell voltage degradation and cause start-up failure. This phenomena known as cold start which means start-up at subzero temperatures. Cold start strategies fall into two categories of 'Keep Warm' and 'Thaw at Start' [20]. Keep Warm strategies aim that heat the PEMFC during parking to avoid freezing. On the other hand, Thaw at Start strategies aim that heat the PEMFC at start-up and increase the temperature above zero. Both of strategies adopted in literature, but much energy consumes in Keep Warm strategies. Because PEMFC system has to be heated continuously for keep at above zero. Therefore, system is going to consume energy continuously. Thaw at Start strategies much adopted according to Keep Warm strategies, because PEMFC stack has to be heated when system start-up only. In this study, cold start characteristics of PEMFC stack was investigated using methanol as internal heating source at start-up. Different cold start techniques were applied and results compared at different subzero temperatures. Results indicated that methanol is reliable reactant for PEMFC cold start applications.

Keywords: PEM fuel cell, cold start characteristics, methanol

[**Abstract:0005**]

Sequential Dark and Photo-Fermentative Hydrogen Gas Production from Agar Embedded Molasses

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In this study hydrogen was produced by sequential dark (DF) and photo-fermentation (PF) from agar embedded molasses. Batch experiments were carried out in serum bottles at anaerobic conditions. DF and PF inocula were heat treated hot-spring sludge and an isolated wild-type culture from a pond, respectively. DF culture was inoculated into agar embedded molasses media. Then, the effluent of DF was subjected to PF under 5 klux illumination. The purpose for inclusion of molasses into solid agar matrix was to allow microorganisms to benefit from the substrate as per demand in a slow manner instead of a direct contact with high substrate concentration in liquid form that may result in fast volatile fatty acid (VFA) formation and low pH levels destroying microbial activity. As a result it was possible to produce hydrogen at high sugar concentration (36.2 g/L) and low adaptation time in DF. Hydrogen formation yield of DF increased from 1.8 molH_2/mol glucose to 3.1 molH_2/mol glucose with PF. Moreover, total sugar and TVFA consumption efficiencies for DF and PF were 97% and 74.3%, respectively. Embedding molasses in agar prevented fast pH decreases and provided a convenient media for effective DF.

Keywords: Dark fermentation, photo-fermentation, molasses, agar matrix, hydrogen

[**Abstract:0007**]

Investigation of the Effect of the Initial Reactant Molar Ratio on the Synthesis of Sodium Amidoborane and Its Hydrogen Capacity

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Sodium amidoborane ($NaNH_2BH_3$) contains high hydrogen, has attractive dehydrogenation properties, and it is possible to recover products resulting from dehydrogenation. Therefore, researches on this material have been recognized as one of the promising candidates for hydrogen storage. In this study, the synthesis of sodium amidoborane in different mole ratios of the initial reactants and the thermolysis at different temperatures were investigated to measure the hydrogen capacity of the synthesized products. In the synthesis of sodium amidoborane, the highest conversion rate (87%) was reached with the initial reactant molar ratio of 1,5. The highest H_2 production efficiency (97%) in the thermolysis studies was achieved with a molar ratio of 1,25 at 300°C. In order to characterize the synthesized sodium amidoborane materials and thermolysis products, FTIR, XRD, GCMS and quantitative analysis techniques were utilized.

Keywords: Sodium amidoborane, ammonia borane, hydrogen production

[**Abstract:0008**]

Investigation of Compression Pressure Distribution of Proton Exchange Membrane Fuel Cell

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One of the most popular, usable and efficient Fuel Cell (FC) type is the Proton Exchange Membrane Fuel Cell (PEMFC). There are a lot of factors which have direct effects on PEMFC efficiency and one of the most important ones is contact pressure magnitude and distribution on the active area of PEMFC. When active area compressed by the conventional screw method, deformation occurs on the area because homogeneous contact pressure distribution is not achieved on the PEMFC in this compression method. Compression pressure also directly effects on the ohmic losses area at PEMFC characteristic curve. Therefore, the safe operation and satisfactory cell performance of a PEMFC depend on suitable compression method and force. In this work, the effects of compression on the PEMFC performance were investigated both numerically and experimentally. Contact pressure analysis was investigated by numerically with Ansys three-dimensional finite element method (3D FEM). Total deformation, equivalent stress and strain were obtained by Static Structural analysis. The geometrical and material properties of all the PEMFC components, such as membrane, bipolar plates, current collector and screw were used for accurate simulation. PEMFC performance tests were also established by comparing the simulation results at various levels of assembly pressures. PEMFC tests were performed in a single PEMFC hardware with a 25 cm^2 active area via the PEMFC test station with H_2/air at 70°C. During the experiments a special hydraulic press was used to compress PEMFC hardware homogenously and pressure distributions were observed with using sensitive pressure measurement films placed between PEMFC. Pressure distribution was observed by color variations of the pressure film. Finally, optimum compression pressure was obtained both experimentally and theoretically.

Keywords: Proton exchange membrane fuel cell, compression, clamping, homogenous compression, ANSYS 3D FEM

ORAL ABSTRACTS

[**Abstract:0009**]

Electrochemical Modeling of Molten Salt-Based Electrolytic Ammonia Synthesis for Solar Fuel Applications

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In this study, an electrochemical modeling of ambient pressure ammonia synthesis is developed and then integrated with a nuclear power plant for achieving sustainable energy systems. The electrochemical ammonia synthesis is performed at medium temperatures around 200˚C in a molten salt medium consisting of NaOH and KOH eutectic mixture. The developed electrochemical model accounts for the ohmic, concentration and activation overpotentials. The theoretical as well as actual voltage values are determined to reveal the losses within the synthesis chamber. Nuclear power plant can produce large amounts of electricity and thermal energy. Therefore, in this work, the required electricity for the electrochemical reaction is provided from a nuclear power plant. Detailed thermodynamic analysis of the complete system is conducted to calculate the energetic and exergetic performances under varying conditions. Ambient pressure electrochemical ammonia synthesis is a substitute for conventional Haber-Bosch process. Hence, the results of this study show that steam methane reforming based-ammonia production can be replaced by nuclear assisted-electrochemical ammonia synthesis for bulk-scale ammonia production to be used in various sustainable energy systems such as power generation, cooling, heating and transportation.

Keywords: Ammonia, electrochemical, nuclear, sustainable, model, Haber-Bosch

[**Abstract:0010**]

Synthesis of Dual Phase Cathodes for IT-SOFCs via Thermal Plasma

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The combinatorial approach is particularly suitable for identification of suitable cathode materials. This involves a simultaneous deposition of thin film cathodes each with a different composition in a single experiment. The composition and microstructure of cathode materials has a large impact on the performance of solid oxide fuel cells (SOFCs). A main goal in SOFC research is the development of cathodes with a sufficiently low electrochemical resistance (~0.15 $\Omega.cm^2$) at operating temperatures significantly below 800°C. Focus has been shifted to particularly mixed conducting perovskites of the La1-xSrxCoO_3—δ (LSC), La1−xSrxMnO_3±δ (LSM), LaxSr1−xCoyFe1−yO_3−δ (LSCF) family [1]. Since, Crumlin et al.[2] and Sase et al. [3] exhibit improved electrochemical performance with hetero-structures [4]. Oxygen surface exchange was found to be enhanced at the heterointerface of LSC214/LSC113 [3]. It was recently shown that the sputter deposited (La0.8Sr0.2) CoO_3 (LSC-113) - (La0.5Sr0.5)2CoO4 (LSC-214) dual phase cathode yield the best performance where the mixture had an amorphous-like structure [5]. In this study a composite cathodes LSC113-LSC214 and LSF-LSM were synthesized via thermal plasma using a large flow rate of quenching gas yielding non-equilibrium cathode powder. The purpose is to see if similar performance improvement could be obtained with plasma synthesized composite powders. The powders were screen printed onto suitable electrolytes and were characterized based on EIS responses using a symmetric cell under air.

Keywords: amorphous, cathode, dual phase, intermediate, temperature, solid oxide fuel cell

ORAL ABSTRACTS

[**Abstract:0011**]

Design of a Sustainable Hydrogen House for Future Hydrogen Cities

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A retrofit type of sustainable hydrogen house has been designed for a conventional, three-story, brick Dutch house in Delft in conjunction with the Hydrogen City Project of TU Delft. This retrofit encompasses solar PVT, roof-type vertical axis wind turbine, ground-source heat pump, fuel cell, electrolyzer and hydrogen storage system. The existing hydrogen car belonging to TU Delft has also been evaluated for auxiliary hydrogen storage system, including the car battery. Heating and cooling of the house is accomplished by hybrid HVAC walls, radiant ceiling panels with capillary tubing. Humidity control is accomplished by desiccant wheel system in the attic. Existing condensing boilers and grid power are retained for back-up purposes. This house will lay an experimental and validation base for the full Dutch decarbonization and hydrogenation strategy for 2050.

Keywords: Hydrogen house, hydrogen car, fuel cell, ground-source heat pump, solar PVT, exergy analysis

[**Abstract:0016**]

Recyclability Study of Co_3O_4 and CoBO Particles in Sodium Borohydride Methanolysis for Hydrogen Production

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Cobalt based catalysts (-oxide, borides, -chloride, etc.,) are effective for borohydrides hydrolysis/solvolysis reactions and most investigated catalysts for hydrogen generation (Coşkuner, Kantürk Figen, and Pişkin 2013, 2014; Liu, Li, and Suda 2006; Ozerova et al. 2012; Xu et al. 2018; Yan et al. 2015). The recycling of catalyst is one of the major challenge from economic and environmental points of view for the globalization of hydrogen energy systems. This work was dealed with the recyclability study of Co_3O_4 and CoBO particles synthesized by a conventional sol-gel prosedure with the aim of catalyzing the methanolysis reaction of sodium borohydride ($NaBH_4$). In the open literature, the using of catalysts in multiple subsequent cycles has not been utilized for the hydrogen generation from methonalysis. The initial activity of the fresh catalysts, characterized by XRD, SEM and BET tecniques, was measured at room temperature. The hydrogen evolution curves calculate the activity in ml.min−1.gcat−1 and conversion in %. The recyclability of the each particles was measured upon 20 cycle, and after each one the catalyst was kept in the reaction solution. For each cycle, same amount of $NaBH_4$ was added into the residual solution and the reaction was performed. After the 1st and 20th cycles, the catalyst was isolated from the solution for post used analyses. Morevover this, boron and cobalt content in spent solution was also measured in order to clarified the activity change of catalyst after cycles.

Keywords: Recyclability, sodium borohydride, methanolysis, hydrogen production

ORAL ABSTRACTS

[**Abstract:0017**]

Numerical Modeling of a Proton Exchange Membrane Compressor for Electrochemical Hydrogen Storage

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Electrochemical hydrogen compression (EHC) is a promising alternative to conventional compressors for hydrogen storage at high pressure, because it has a simple structure, low cost of hydrogen delivery, and high efficiency of about 95%. In this study, the performance of an EHC is evaluated in terms of energy and exergy analyses using three-dimensional numerical modeling and finite volume method. In this regard, the effects of operating temperature and pressure on the energy and exergy efficiencies are examined. The results reveal that the energy and exergy efficiency of EHC stack improve by increasing operating temperature from 363 K to 393 K at current density of 5000 A m^{-2}. It is concluded that energy and exergy efficiency of EHC stack decrease by 25% and 5.4% by increasing the cathode pressure from 1 bar to 30 bar, respectively.

Keywords: Electrochemical compressor, proton exchange membrane, hydrogen, CFD model, exergy efficiency

[**Abstract:0019**]

Design and Building PEM Fuel Cell Stacks with Different Configurations: Stack Operation Conditions

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The performance of a proton exchange membrane fuel cell (PEMFC) under different operating conditions such as stack operating temperature, pressure and humidity affects were investigated experimentally and their interrelationships are discussed. Performance affecting mechanisms in the PEMFC i.e. water management, mass transport phenomenon, ionic and electrical conductivity are assessed at various operating conditions. Additionally, results are verified using a single PEM fuel cell with an active surface area of 5 centimeters square. Results show that the overall performance can increase remarkably with the optimum operating parameters. As operating temperature drops, activation losses increase remarkably, humidity and water management are disrupted, and the reaction rate falls. Increasing the operating pressure, positively affect the cell performance. This improvement can be explained with the rise in the partial pressure and density of reactant gasses at the cell active area. At different humidity ratios, the best performance is at near 100% reactant humidity at both the cathode and anode.

Keywords: Proton exchange membrane, fuel cell, stack operating conditions

[**Abstract:0020**]

Performance Evaluation of Precooled Claude Liquefaction Cycle for Hydrogen Liquefaction

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This paper presents a thermodynamic analysis and optimization of a cycle used for hydrogen liquefaction in order to evaluate and compare their performance under given working conditions and system component efficiencies. A Precooled Claude cycle is considered for hydrogen liquefaction to storage for later use. First and second law relations are developed for the cycle and performance parameters are evaluated. Thermodynamic performance optimization is applied using the genetic algorithm method to the liquefaction cycle. Hydrogen liquefaction fraction, the coefficient of performances and second law of efficiencies are calculated for the hydrogen liquefaction. The actual work consumption of hydrogen liquefaction in the cycle is calculated to be 10.0 kWh/kg LH_2. The cycle COP and second law efficiency are calculated to be 0.10 and 28.2% respectively.

Keywords: Cryogenic, Precooled Claude, thermodynamic analysis.

[**Abstract:0021**]

Oxygen Reduction Kinetics in the Ordered Mesoporous Carbon Supported Pt Catalysts

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The oxygen reduction reaction (ORR) kinetics for Pt supported on ordered mesoporous carbon was investigated. Ordered mesoporous carbon was synthesized using a self-assembly system, where Pluronic F127 and formaldehyde were used as carbon source. Catalyst loading was achieved by two different methods; wet impregnation reduction and wet impregnation reduction after surface modification. The kinetics of ORR were investigated by rotating disk electrode voltammetry.

Keywords: Oxygen reduction reaction, ordered mesoporous carbon, rotating disk voltammetry

ORAL ABSTRACTS

[**Abstract:0022**]

Artificial Neural Networks Modeling of Geothermal Energy Assisted Hydrogen Production by PEM Water Electrolysis

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In this study, the thermodynamic and economic analysis of a geothermal energy assisted hydrogen production system was performed using real-time Artificial Neural Networks (ANN). During the modeling of the system in the computer environment, a liquid geothermal resource with a temperature of 200°C and a flow rate of 100 kg/s was used for electricity generation, and this electricity was used as a work input in the electrolysis unit to split off water into the hydrogen and oxygen. In the designed system, the net work produced from the geothermal power cycle, the overall exergy efficiency of the system, the unit cost of the produced hydrogen and the simple payback period of the system were calculated as 7500 kW, 46.0%, 1.08 $/kg and 4.0 years, respectively. In the second stage of the study, ANN model with a single hidden layer was used for modeling the system. The activation functions of the hidden layer and output layer were Tangent Sigmoid and Linear functions, respectively. 45 datasets were used for learning while 15 datasets were used for testing.

Keywords: Geothermal energy, hydrogen production, Artificial Neural Networks.

[**Abstract:0023**]

CVD Graphene Supported Cobalt Macrocyclic Complex as Electrocatalyst for PEM Fuel Cell

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Carbon supported Pt are state of the art catalyst for polymer electrolyte membrane fuel cells (PEMFC)s because of high electrochemical activity and chemical stability. Limited resources and cost of Pt have put restrictions on large-scale commercialization of PEMFCs. Transition metal (TM) complexes (Co-porphyrins or Co-phthalocyanines) were explored as possible catalyst to replace or reduce Pt as cathodes. CVD graphene supported Co-Nx macrocycles were prepared by impregnation method using different solvents. Different pyrolysis temperatures were investigated for better catalytic activity and stability. Rotating Disk Electrode (RDE) and single fuel cell measurements were carried out. Open circuit voltage (OCV) was in the range of 0.5-0.6 V (vs. SCE) in RDE measurements. It is possible that oxygen reduction reaction may proceed through reaction below: $O_2 + 2H^+ + 2e^- = H_2O_2$ E=0,695 V (SHE) Compare to reduced $CoCl_2$ and $Co(NO_3)_2$, cobalt phthalocyanine (CoPc) gives larger current below 0.4 V(vs. SCE). While Vulcan support gives early reduction current, graphene support provided higher current beyond 0.3 V (vs. SCE). Research paper will discuss results for RDE and single PEM fuel cell measurements.

Keywords: CVD graphene, Co phthalocyanine catalyst, PEM fuel cell

[**Abstract:0024**]

Design and Assessment of a Geothermal Driven Multigeneration System for Hydrogen Production

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In this study, a design and assessment of geothermal power based integrated plant for hydrogen production is analyzed. A clean and sustainable hydrogen production method has been proposed. The proposed system consists of the geothermal energy cycle, double turbine organic Rankine cycle, heat pump system, and proton exchange membrane electrolyzer. In the double turbine organic Rankine cycle subsystem, to analyze the effect of different working fluids on the system performance, three different organic fluids have been preferred, which are the propane, n-butane and isobutane, because of their environmental properties. According to these different fluids, the change in the hydrogen production rate, energy and exergy efficiency of whole system are studied. In addition, the effect of geothermal source temperature on the system efficiency and hydrogen production rate is examined and presented graphically. Results show that the hydrogen production rate is calculated as 0.003023 kg/s, 0.00252 kg/s and 0.002467 kg/s for propane, n-butane and isobutane fluids, respectively. Also, the overall energy and exergy efficiencies of proposed study for propane fluid found to be 25.14 % and 29.32%, respectively. Furthermore, the effects of some design parameters such as geothermal energy temperature and reference temperature on the energetic and exergetic performance of the system are parametrically investigated

Keywords: Geothermal, hydrogen, energy, exergy, multigeneration system.

[**Abstract:0025**]

Thermodynamic Analysis of Hydrogen Generation System Consisting of Biomass Gasifier, Gas Turbine Cycle and Hydrogen Compression Plant

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In this paper, a new hydrogen generation plant is investigated, including the biomass gasification system, Brayton cycle, Rankine cycle, high temperature steam electrolyzer, hydrogen compression process and fresh water production cycle for multi-generation purpose. This integrated plant utilizes the biomass energy as renewable energy resource. In one option for the effectively and efficiently hydrogen storage is the hydrogen compression system, where compress to the nearly 700 bar at reference temperature. The hydrogen production and storage plant is analyzed in the Engineering Equation Solver program. The hydrogen production and storage plant is analyzed in the Engineering Equation Solver software package. The energetic and exergetic analyses are performed on the hydrogen generation integrated plant. Based on these analyses, the overall energetic and exergetic efficiencies of the proposed plant for multigeneration are found to be 52.8% and 46.5%, respectively.

Keywords: Biomass gasification, hydrogen production and compression, energy, exergy.

ORAL ABSTRACTS

[**Abstract:0026**]

Comparison of the 0-D and 3-D Models of a Steam-Methane Reformer

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A fuel processing system that consists of a steam-methane reformer (SMR), a water-gas shift reactor (WGS) and a catalytic burner is used to produce hydrogen-rich reformate gas in some fuel cell-based cogeneration systems. In these systems, methane and hot steam are mixed and sent to SMR in which endothermic chemical reaction that produces reformate gas occurs. The hot flue gas from the catalytic burner provides the required heat for this reaction. The hydrogen-rich reformate gas basically includes hydrogen, carbon monoxide, methane, carbon dioxide, and water vapor. In this study, a computational fluid dynamics (CFD) based 3-D model of an SMR used in such a system is developed using COMSOL Multiphysics and compared with a 0-D model. Using the 3D model, the distributions of molar flow rates of each gas and temperature within the reactor geometry are found. In addition, these parameters at the outlet of the reactor are calculated and compared for each modeling approach.

Keywords: Steam-methane reformer, reactor modeling, hydrogen-rich reformate gas, COMSOL Multiphysics.

[**Abstract:0029**]

Extruded Pellets of Microwave Leached Activated Char/Active Carbon/ Clay Mixtures for Hydrogen Sorption

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The packed bed sorption of Hydrogen gas are carried out over 100 microns on active carbon char and clay pellets. in order to avoid this disturbing flow manner of that gas, clay pellets were compressed in sorption column chamber. The cycles of gas transport was managed till saturation of carbon pellets. The simulated sorption on solid carbon porous structure and capturing for Hydrogen gas on active carbon or char developed mechanical separation used. Extruded pellets pressed with 40%,60% and 80% active carbon, active clay mixtures and microwave leached activated forms were used in our absorption experiments at 1- 2rnrn sized pellets. The pellets size-sorption simulation was provided a 7-8% Hydrogen gas sorption and also 14-15% soot addition provided highly developed compressibility.

Keywords: Microwave activation, active carbon, hydrogen sorption, hydrogen storage

[**Abstract:0030**]

An Integrated Solar Hydrogen Production System: Energy Assessment of an Electrolyzer Coupled with a Rankine Cycle

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Hydrogen is produced by means of a water splitting process, mainly electrolysis, which requires energy input provided by harvesting solar energy. The proposed model integrates the solar harvesting system into a conventional Rankine cycle, producing electrical and thermal power used in domestic applications,and hydrogen by high temperature electrolysis (HTE) using a solid oxide steam electrolyzer (SOSE). The model is divided into three subsystems: the solar collector(s), the steam cycle, and an electrolysis subsystem, where the performance of each subsystem and their effect on the overall efficiency evaluated. Moreover, a parametric analysis is carried out to study the performance of the system under different conditions. The analysis carried out studies the effect of varying the area of the solar collector on the rate of hydrogen produced. Finally, a comparative analysis is done with a parabolic trough and a heliostat field to investigate which works most effectively with the plant and has the highest rate of hydrogen produced.

Keywords: Hydrogen production, rankine cycle, electrolyzer, parabolic trough, heliostat field

[**Abstract:0038**]

Synthesis of Magnetically Separable Visible Light Driven Photocatalysts for H_2 Generation

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In this work, we investigated about magnetically seperable photocatalysts which are efficient in the visible light, so H_2 generation would be possible by harvesting solar light. Magnetic core (Fe_3O_4), ($NiFe_2O_4$) / TiO_2 shell structured photocatalysts have been synthesized by complex assisted vapor-thermal method. Also, Ni_2+ loaded samples have been synthesized to enhance the visible light absorption. As-prepared photocatalysts have been characterized by XRD, UV-DRS, Raman spectroscopy. Photoelectrochemical measurements and methylene blue degradation reactions have been performed for prescience about the H_2 generation activity.

Keywords: Photocatalyst, core-shell, Fe_3O_4/TiO_2

[**Abstract:0041**]

Numerical Modeling of a Model Tubular Solid Oxide Fuel Cell Running on Amonia in Comparison with Hydrogen

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SOFCs are attractive fuel cell systems because of their ability to run a range of fuels, in addition to pure hydrogen. One of the most popular types of cell design for SOFCs is tubular cell. The tubular cell has advantages in sealing, cell-to-cell connection, thermal cycling and start-up because of its symmetric geometry. Based on present numerical simulations, it is found that the performance of cells is strongly dependent on cell design. In this numerical work, numerical modeling and analysis of tubular SOFCs by using ammonia as a source of hydrogen has been performed. This paper describes the numerical results of a model tubular solid oxide fuel cell running on amonia as a fuel and compares the performances with respect to hydrogen. The results show that the performance of the anode supported solid oxide fuel cell(AS-SOFC) is considerably high, when amonia is used as a fuel. Results indicate that the use of amonia as a fuel for SOFCs, is comparable to the use of hydrogen. The numerical modelling results prove conclusively that ammonia can be treated as an attractive alternative fuel and used directly in SOFCs.

Keywords: Modeling, tubular SOFC, ammonia, hydrogen

[**Abstract:0048**]

Numerical Investigation of a Model PEM Fuel Cell Under Isothermal and Non-Isothermal Conditions

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A fuel cell is an energy conversion device that converts the chemical energy of a reaction into direct electricity with water and heat by-products. Without the use of a steam boiler or turbine, only the chemical reaction produces electrical energy. It is obtained by electrochemical reaction between hydrogen (H_2) and oxygen (O_2). In this paper, hydrogen fuel cells were examined and computational fluid dynamics analysis was done for isothermal and non-isothermal conditions and the results of the analysis were compared. The fuel cell Proton Exchange Membran Fuel Cell to be analyzed was selected and CFD analysis was performed. When the results were evaluated, it was observed that with the increase in the protonic conductivity, the current density would increase and the Proton Excange Membran Fuel Cell increased kinetically with the temperature increase, but the increase in temperature would decrease the performance of Proton Exchange Membran Fuel Cell.

Keywords: Numerical investigation, PEM Fuel Cell, isothermal and non-isothermal conditions

ORAL ABSTRACTS

[Abstract:0050]

Characterization of Hydrogen Storable Properties of Mg-Ni Alloy Ribbons Produced by Melt Spinning Method

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60Mg-40Ni (wt. %) alloy ribbons have been prepared by melt spinning method. The structural and hydrogenation properties of ribbons produced by melt spinning method were studied with employing XRD, SEM, and Sievert hydrogen measurements. The alloy ribbons had two phases which are α-Mg solid solution and finely dispersed particles of Mg_2Ni, in addition to crystalline structure. Absorption activation experiments were carried out at 350 ^{0}C and at 3.7 MPa to reveal hydriding properties of produced ribbons. Maximum hydrogen absorption capacity was found as 4.42 % mass.

Keywords: Melt spinning method, hydrogen storage, magnesium nickel alloy, hydriding properties

[Abstract:0051]

An Investigation of Two Phase Flow Analysis on Hydrogen Gas Production by Water Electrolysis

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The behavior of the hydrogen and oxygen gas obtained by the alkaline electrolysis of water in the fluid is critical for the process efficiency. It is important to calculate and analyze the distribution of hydrogen as the main problem in electrolysis. The production of hydrogen in solution depends on many parameters. In electrolysis, the transition between the hydrogen molecule formed on the electrode in a finite volume and an electrolyte solution (liquid - gas) surrounding it is explained generally by ion transfer mechanisms. In this study, physical modeling of the alkaline electrolysis method of water was determined. For this model, analytical studies related to two-phase flow modeling were carried out. Void fraction, mass flow, quality,velocity of fluids, wetting angle, bubble buoyancy were examined. The forces acting on the hydrogen gas formed on the electrode and the forces acting on the hydrogen gas in the form of a complete bubble were examined. The parametric function of the acceleration velocity of the hydrogen gas after production is derived. It was calculated that the rate of rise depends on the void ratio of hydrogen and the density of the electrolyte and hydrogen. In modeling the separation of hydrogen gas from the electrode, the velocity of the hydrogen gas bubble under the influence of drift and lifting forces is also calculated depending on the drift coefficient. In this analytical analysis, the rate of rise of hydrogen gas was found to depend on the diameter of the bubbles formed, the viscosity of the electrolyte and the density of the electrolyte and hydrogen. In the two-phase flow regimes in the electrolyte solution, the rate of hydrogen gas was determined for both the bubble flow and the slug / churn flow passage.

Keywords: Alkaline electrolysis, energy, hydrogen, two phase flow

ORAL ABSTRACTS

[**Abstract:0053**]

Parametric Investigation of Biogas Production via Geothermal Based Thermophilic Biodigester

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The main objective of the study is to parametrically investigate the performance of a geothermal energy based thermophilic anaerobic biodigester system producing biogas for a Solid Oxide Fuel Cell (SOFC) system..the operating temperature of thermophilic anaerobic biodigester system was selected to be 55 oC. For this purpose, the energetic and exergetic performances of the thermophilic anaerobic biodigester system were evaluated in accordance with the operating conditions of an SOFC system selected from the literature. Biogas production of thermophilic anaerobic biodigester was set by depending on the operating conditions of the SOFC system. Accordingly, the maximum energy and exergy efficiencies of the thermophilic anaerobic biodigester system were found to be 0.726 and 0.580, respectively, at the SOFC operating temperature of 633 °C at 8000 A/m^2 current density. In addition, at the 1000 K SOFC operating temperature, the minimum and maximum amount of biomass required by the biodigester system was estimated to be at 0.168 kg/s and 0.321 kg/s in order to produce 0.025 kg/s and 0.044 kg/s of biogas in case the SOFC has current densities of 5500 A/m^2 and 9500 A/m^2, respectively.

Keywords: Energy, exergy, biodigester, biogas, geothermal energy

[**Abstract:0056**]

A New Approximation to Production of High Efficiency Hydrogen with Water Electrolysis

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Traditional energy sources are bordered in certain geographical areas around the world so researchers have led the country to search for new and clean energy because of the environmental effects of traditional energy sources. Hydrogen has been regarded as a clean energy carrier for many years and has been the subject of scientific studies. It is known that the increase in energy demand with the rising momentum is the most advanced hydrogen energy system that can provide environmentally friendly and sustainable. Hydrogen energy has taken its place as one of the most important alternative energy sources in the coming years due to its characteristics, potential and usage areas. The development of clean, sustainable and cost-effective hydrogen production processes is the key to the future hydrogen economy. All theoretical analyzes of hydrogen gas producing applications by water alkaline electrolysis ($2H_2O \rightarrow 2H_2+O_2$) have been carried out from a perspective of classical physics. It is known that energy efficiency is an important key point in all future work. Therefore, the interdisciplinary structure of the different dimensions of electrolysis in the studies are important. In this study, the potential voltage required for decomposing hydroxyl ion (OH^-) from hydrogen atom (H^++) by performing water molecule and hydrogen atom modeling is calculated to be lower than the decomposition voltage in the literature by using quantum tunneling method. This work reevaluated the concept of alkaline electrolysis from the point of view of modern physics and quantum physics. It has adapted the new concepts that the quantum physics has gained to the scientific world to energy efficiency and has given a different perspective to the literature. This study analyzes and proposes new systems to be produced today and tomorrow with regard to electrolysis by means of analytical and numerical methods which shed light on the design of new electrolysis reactors.

Keywords: Water electrolysis, energy, hydrogen, quantum tunneling

ORAL ABSTRACTS

[**Abstract:0058**]

H_2 Storage at Ambient Temperature Using Cu(I)-SSZ-39

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The low volumetric energy density of H_2 necessitates a lightweight, safe and economical onboard H_2 storage system to achieve 4.5 wt.% target storage capacity (for 300 mil driving range) on H_2 fuel cell vehicles. Even though phyisorption onto nanoporous adsorbents such as metal-organic- frameworks and activated carbons can reach 8.5 wt. % H_2 storage at 80 bars and at 77 K (on MOF 210 [1]), the H_2 storage capacities can not surpass 1.5 wt.% at ambient temperatures due to the reported low H_2 adsorption enthalpies (between 13 and 4 kJ/mol [2]). Cu(I)-exchanged zeolites are suggested to achieve surprisingly higher H_2 adsorption values at room temperature due to the reported H_2 isosteric heat of adsorption values between 73 and 13 kJ/mol (Cu(I)-ZSM-5 and Cu(I)-SSZ-13 [3,4]). In this study, Cu(I)-exchanged SSZ-39 (with building units of double-6-membered rings and 8-membered rings) and Cu(I)-exchanged zeolite Y (double-6-membered rings and a larger pore opening:12-membered ring) have been tested for H_2 adsorption at temperatures between 278 K and 304 K. Cu(I)-SSZ-39 showed higher H_2 storage capacities reaching 83 μmol g^{-1} (0.02 wt. %) at 100 kPa and 278 K (where Cu(I)-Y showed 35 μmol g^{-1} (0.007 wt. %) at 100 kPa). The isosteric heat of H_2 adsorption values for Cu(I)-SSZ-39 has also been found to be much higher (between 80 and 40 kJ/mol, see Figure) than Cu(I)-Y (22 and 15 kJ/mol) explaining the higher H_2 adsorption capacity of Cu(I)-SSZ-39. Comparison of isosteric heat of H_2 adsorption values on Cu(I)-SSZ-39 and Cu(I)-Y, together with the theoretical H_2 binding energies on Cu(I) on the 6-membered rings and 8-membered rings, enabled identification of Cu(I) sites on Cu(I)-SSZ-39 favoring H_2 adsorption with binding energies as high 80 kJ/mol.

Keywords: Hydrogen storage, zeolite, Cu(I)-exchange

[**Abstract:0059**]

Thermofluidynamic Modelling of Hydrogen Absorption in Different Hydride Beds by Using COMSOL Multiphysics Software

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In this paper, a performance analysis of metal hydride based hydrogen storage during absorption process is presented. A 3-D mathematical model is developed in order to simulate the thermofluidynamic behaviour of different metal hydrides (e.g.; $MmNi_{4,6}Al_{0,4}$, $LaNi_{4.75}Al_{0.25}$, Mg_2Ni, and $LaNi_5$). A simulating study is made by solving simultaneously the energy, mass-momentum, and kinetic law differential equations of conservation by using COMSOL multiphysics 5.2a software to obtain some approaches in the large scale. Hydrogen storage capacity were analyzed depending on some reactor design parameters such as; having heat pipe and fins at the reactor, metal hydride particle size, hydrogen inlet pressure, inlet radius of the reactor, coolant temperature, general convective heat transfer coefficient and wall thickness of the reactor. Numerical results obtained are found in a good agreement with experimental data available in the previous work. Some parameters like temperature distribution inside the reactor, amount of the hydrogen mass to be stored in the reactor, the time durations of them and the variations of the equilibrium pressure of the system were optimized. In summary, this paper demonstrates the modeling and the selection of optimum geometry of a metal hydride based hydrogen storage container based on minimum absorption time and easy manufacturing aspects.

Keywords: Metal hydride, hydrogen storage, absorption, thermofluidynamic, heat pipe, simulaton

ORAL ABSTRACTS

[**Abstract:0063**]

Comparison of Pd-Co/C Catalysts Prepared By Modified Polyol and Supercritical CO_2 Deposition Methods for Direct Borohydride Fuel Cells

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Developing an anode catalyst with high activity and selectivity towards direct borohydride electro-oxidation (BOR) is one of the main scopes in direct borohydride fuel cells (DBFC) in literature. For this purpose, different metals may be employed as DBFC anode catalysts. Among them Pd-based catalysts show the most promising performance. Moreover; C is a very effective borohydride hydrolysis catalyst and some studies proved that Co containing structures within the catalyst can be selective towards BOR. Since the electrochemical reactions occur on the surface of the catalysts, their preparation methods and synthesis conditions such as temperature and pressure have important role on the structure of catalyst surface. In this study, Pd-Co/C catalyst was prepared by a modified polyol method, using ethylene glycol as reducing agent at 210 °C, pH value of 10 and reaction time of 2 hours using Pd and Co acetate precursors. Another sample was prepared via supercritical CO_2 (scCO2) deposition at 90°C and 2000 psi using Pd bipyridyl precursor. In order to compare the effect of catalyst synthesize methods and conditions different techniques were used. X-ray Diffractometer (XRD) and X-ray Photoelectron Spectroscopy (XPS) were used to determine the crystalline structures while Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) for the metal loading of the catalysts. Transmission Electron Microscope (TEM) and Energy Dispersive X-ray Spectroscopy (EDX) were used for further surface investigations. Electrochemically Active Surface Area (ECSA) and the selectivity towards BOR of the catalysts were determined via Cyclic Voltammetry (CV) measurements. Lastly, Chronoamperomtry (CA) was used to determine the stability of these catalysts for 1000 seconds. Results showed that Pd-Co/C catalyst prepared by polyol method achieves the formation of Pd-Co alloy which have approximately 10 – 20 nm whereas the catalyst prepared by $scCO_2$ deposition achieved bi-metallic Pd and Co structure with the particle diameters of 44,6 nm and 32,1 nm respectively. Preliminary electrcatalytic measurements of both samples showed similar activities even though having different structures.

Keywords: Direct borohydride fuel cell, electrocatalysis, polyol method, supercritical carbondioxide deposition method, Pd-Co/C catalysts

ORAL ABSTRACTS

[Abstract:0065]

Investigation of Metallic Bipolar Plate for Light-Weight PEM Fuel Cell Stack

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Bipolar plates constitute significant percentage of a fuel cell system in terms of cost, weight and structural strength. Conventional graphite bipolar plates have low density, high conductivity and corrosion resistance. However, brittle and porous nature of graphite obliges to use thicker slices, which means an increase in total weight and volume of a fuel cell stack, yielding relatively lower specific and volumetric power density. For mobile applications of PEM fuel cells, the volumetric and specific power density should be taken into consideration. The cost and ease of the manufacturing process is also an issue as well as mechanical or chemical properties of the material. Metallic bipolar plates can be considered a reasonable alternative of graphite. Material cost, fabrication of flow channels and some post-processes for graphite plates make large-scale manufacturing more complex compared to cutting and stamping processes for metals. This study offers the comparison of two different metallic materials used as bipolar plate and two flow channel depths for each. 304L Stainless steel and pure Titanium, which become prominent in the literature, are chosen as the starting materials. Serpentine flow channels with 0.36 mm and 0.55 mm depths are applied on both 0.1 mm thick steel and titanium plates. The stamping process is simulated via DYNAFORM and FLD diagrams are obtained for four cases. According to the simulations, it is seen that both materials can be formed in the desired shape without any cracks. Thus, the stainless steel is found to be advantageous due to lower cost. In addition, CFD and electrochemical analyses are conducted together in COMSOL Multiphysic program. For 304L plate, under the same conditions, %50 decrease in volume and %23 decrease in weight for a single plate are achieved compared to graphite.

Keywords: PEM fuel cell, metallic bipolar plates, light-weight stack, modeling

[Abstract:0066]

Investigation of Hydriding and Thermal Properties of Near-Eutectic Mg-Ni Alloy Fabricated by Rapid Solidification Process

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In this study, the near-eutectic Mg80-Ni20 (wt.%) alloy ribbons were produced by melt spinning method, and the structural, thermal, and hydriding properties of the ribbons were analyzed. Thermal stability of melt-spun ribbons was examined with DSC at 3^{0}C/min heating rate and cooling rate. Two peaks were detected at 124 ^{0}C and 317 ^{0}C during heating and, one peak was encountered at 212^{0}C during cooling. Activation experiments of the melt-spun ribbons were performed under 350 ^{0}C temperature and 12 bar hydrogen gas pressure for 60 hours duration. The absorption and desorption kinetics of the ribbons were investigated. The hydrogen absorption and desorption capacities were found as 5.50 % and 5.41 %, respectively.

Keywords: Rapid solidification, melt spinning process, thermal properties, hydrogen storage, Mg-Ni alloy

ORAL ABSTRACTS

[**Abstract:0069**]

Effects of Thermal Cycling on Joint Strength of Glass-Ceramic Sealing Performance for Solid Oxide Fuel Cells

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Solid Oxide Fuel Cells (SOFCs) are high efficient systems that convert fuel directly into electricity with an electrochemical conversion. However, there are some challenges to be solved in order to ensure the commercialization of SOFCs and to expand its areas of application. One of these challenges is sealing. A typical sealing for SOFCs is expected to provide a compatible thermal expansion coefficient with other system components under the required operating conditions while at the same time it should serve the necessary adhesion, mechanical strength, chemical stability and electrical insulation. For this reason, glass-ceramics are widely used as sealants in SOFCs. To develop a suitable glass-ceramic sealant, it is therefore necessary to understand the crystallization kinetics, the sealing properties and the chemical interactions of the sealant in contact with other cell/stack components under SOFC operating conditions. In this study, the effects of powder content in glass-ceramic sealant pastes on the joint strength to bond two metallic interconnectors are investigated. In addition, the effects of thermal cycling on the bonding performance are also studied.

Keywords: Solid oxide fuel cell, glass-ceramic sealant, joint strength, thermal cycling

[**Abstract:0070**]

Hydrogenation Behavior and Microstructure Evolution of Intermetallic Mg_2Ni Alloy Produced by Vacuum Arc Melting

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Intermetallic Mg_2Ni alloy was prepared by vacuum arc melting. Effect of arc melting was investigated scanning electron microscopy. As-cast alloy has been crushed to a few milimeter small pieces. The crushed pieces were been milled process by four hours. Structural and hydrogenation properties of produced powders was studied x-ray diffraction, scanning electron microscopy and Sievert-type hydrogen sorption analyses. Their hydrogen sorption properties were characterized by Sievert's type apparatus at different temperatures. The XRD analysis showed that the as-cast Mg_2Ni alloy consist of some phases except for Mg_2Ni intermetallic phase. As it is seen that intermetallic Mg_2Ni alloy is not obtained by vacuum arc melting. However, maximum hydrogen absorption capacities of the Mg_2Ni powders were found approximately 0.7, 1.63 and 2.05 (wt. %) at 250°C, 300°C and 350°C, respectively.

Keywords: Mg2Ni, vaccum arc melting, melt spinning, hydrogen storage

[**Abstract:0071**]

Numerical Investigation of Hydrogen Enriched Methane/Air Combustion from Pollutants Aspect

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In this paper, the non-premixed hydrogen enriched methane/air combustion was investigated numerically with the use of a CFD code. A water cooled 3D natural gas boiler was taken as the combustion medium. The hydrogen addition to methane was adjusted in such a way that the boiler capacity (kW) was kept constant. The eddy dissipation combustion model was utilized for the numerical analysis. The CO_2, CO, NO_X emissions and temperature distributions in the combustion chamber were obtained according to the different compositions of hydrogen enriched methane fuel. In addition, the emissions in the flue gas and flue gas temperature values were obtained and the boiler efficiencies were calculated. The results showed that hydrogen addition to methane reduced the carbon emissions, while it substiantally augmented the formation of the NOX emissions.

Keywords: Methane, NO_X emissions, hydrogen enrichment

[**Abstract:0073**]

A Review of Hydrogen Usage in Internal Combustion Engines (Gasoline-Diesel-LPG) from Combustion Performance Aspect

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With the increasing industrialization and energy demand in the world, the demand for fossil fuels is increasing day by day. For this reason, many countries are taking research studies on alternative energy systems against this increasing energy demand. Hydrogen is an alternative fuel with high efficiency and superior features. The development of hydrogen-powered vehicles in the transport sector will reduce fuel consumption of engines and reduce air pollution from exhaust emissions. In this study, the use of hydrogen as a fuel in vehicles and the current experimental studies in the literature were reviewed. The effects of hydrogen usage on engine performance and exhaust emissions are explained. In internal combustion engines, depending on the amount of hydrogen added to the fuel system, it is seen that torque and power increases in gasoline and LPG engines, while exhaust emissions are reduced. When the diesel engine reaches high revolutions, torque and power decreases and exhaust emissions are negatively affected.

Keywords: Gasoline-diesel-LPG, torque, power, emission, hydrogen addition

ORAL ABSTRACTS

[**Abstract:0074**]

Transcriptome Analysis of the Effects of Light and Dark Cycle on Hydrogen Production Metabolism of Rhodobacter Capsulatus DSM1710

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Biohydrogen produced by photosynthetic purple non sulfur bacteria (PNSB) is a clean and renewable method of hydrogen production. These bacteria can be employed in outdoor photobioreactors for sustainable large scale biohydrogen production. Diurnal cycles in outdoor conditions affect hydrogen production as it halts in the absence of light and resumes when light is available. This cyclic illumination reduces hydrogen productivity while duration of hydrogen production extends compared to continuous illumination. In this study the transcriptome of the PNSB *Rhodobacter capsulatus* has been analyzed by microarray in order to understand the metabolic changes the bacteria experience during shift to a light period after a dark period in hydrogen production medium. *R. capsulatus* DSM1710 was employed in 30/2 acetate/glutamate medium with cyclic illumination of 12h light/12h dark where the light intensity was 114 Watt/m^2 in 150 mL glass reactor bottles. After 3 cycles of light and dark, sample taken in the light period was compared with that taken in dark cycle using custom design Affymetrix GeneChip TR_RCH2a520699F. Moreover, bacterial growth, hydrogen production, acetate consumption and bacteriochlorophyll content were evaluated. The results revealed that genes of nitrogenase system, photosynthetic apparatus and electron transport were up regulated with exposure to light after a dark period, consistent with resumed hydrogen production in the light period. This shift also stimulated gene expression of carbon fixation metabolism. The absence of light was shown to trigger a stress response in *R. capsulatus*. Microarray results were validated with real time quantitative PCR. The results will provide valuable information about relationship between several metabolisms with hydrogen production of various PNSB.

Keywords: Biohydrogen, {Rhodobacter capsulatus}, light/dark cycle, gene expression, microarray

[**Abstract:0077**]

Investigation of Parametric Synthesis Conditions of n-Butylamine Borane as Hydrogen Storage Material

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Hydrogen is found out to be an energy carrier which is why scientists continuously studying on storing hydrogen to use it as an energy source. This study focuses on the synthesis of n-butylamine borane ($C_4H_{14}BN$, n-BAB) which has a good potential as a hydrogen storage material. n-BAB was synthesized by taking stoichiometric ratio of reactants. After synthesising the n-BAB, under vacuum conditions the product was separated by filtration, evaporation and finally in drying oven. The effect of temperature, reaction time and solvent amount on the production efficiency of n-BAB was investigated. Production efficiencies were calculated by comparing the experimental findings and theoretical calculations. According to calculations, production yield ranged from 40% to 70%. Highest yield was found at 32.5^{0}C, with 0.15M sodium borohydride (SBH) for 2.5h reaction time. Experimental results showed that, reaction time has a strong effect on the yield. In addition to enhance the production yield, solvent amount must be increased which is caused by the shorter retention time above room temperature. Fourier Transform Infrared Spectroscopy (FTIR) and X-Ray Diffraction (X-RD) analysis were performed to define the structural properties of synthesized n-BAB. According to experimental findings, synthesized n-BAB products can be produced in high purity.

Keywords: n-Butylamine borane, hydrogen storage, amine borane synthesis

ORAL ABSTRACTS

[**Abstract:0078**]

Water Splitting Activity of Rhodanine Self Assembled Monolayer Films

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Rhodanin self-assembled monolayer (Cu/Rh-SAM) films were fabricated supporting on copper in 10 mM rhodanine containing methanol for 24 h film formation time. The surface structure of the film characterized with the help of scanning electron microscopy (SEM) and atomic force microscopy (AFM). The distribution of the film over the surface was examined using energy dispersive X-ray spectroscopy (EDX) technique. The water splitting activity of the films was studies in 1 M KOH solution. For this aim, many electrochemical techniques were used. The experimental results showed that very homogenously distributed and closely assembled films were prepared on copper. The hydrogen generation activity of the Cu/Rh-SAM electrode was significantly improved with respect to bulk Cu. The water splitting reaction starts at lower potentials and larger current densities at a fixed potential were appeared at the Rh-SAM modified electrode with respect to bare copper. The enhanced electrocatalytic effect was assigned to larger electrochemical active surface area and good electrochemical activity of Rh-SAM film. Therefore, the Rh-SAM layer could be suggested as a candidate supporting material for fabrication of cathode to be used in alkaline electrolysis systems to produce hydrogen gas. Acknowledgments: Preparation and characterization of SAM films were supported by TUBİTAK (Project Number: 113M613). Methanol electrooxidation studies were supported by Bingöl University Scientific Research Projects Coordination Unit (Project Number: FEF.2017.00.013). The authors are greatly thankful to TUBİTAK and BÜBAP for financial supporting. The authors also would like to thank to Bingöl University Central Laboratory for characterization measurements and Chemistry Department for electrochemical measurements.

Keywords: Rhodanine self-assembled monolayer, copper, water splitting, hydrogen evolution reaction

[**Abstract:0080**]

Production of Hydrogen by the Electrochemical Reforming of Glycerol

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Production of hydrogen from glycerol, a by-product in biodiesel production process, by electrochemical reforming is a promising and economic method due to its low demand in energy. By utilizing the functionality of 3-OH groups present in the molecular structure, it is quite viable to produce hydrogen from glycerol. With this new electrolytic process, hydrogen can be produced using domestic and renewable resources. Thus, the aim of this study was to investigate the conversion of glycerol by electrochemical reforming into hydrogen, which is accepted to be an alternative fuel and energy carrier for the near future. Experiments were performed at different ranges of glycerol concentration, operating temperature and with different electrode materials. Firstly, it was seen that electrochemical reforming efficiency of glycerol was improved with increase in operating temperature from 20 to 90°C. Then, experiments were performed using different electrodes. The experiments have shown that the highest current density among the investigated electrode materials was obtained with copper electrode. Electrochemical reforming of glycerol could be achieved by applying a lower cell voltage compared to water electrolysis system. Based on these first findings, further experiments were carried out using 0.4 M aqueous glycerol solution slightly acidified with sulfuric acid and copper electrode at 90°C. Hydrogen production was found to begin at cell potentials close to 0.2 V. Cell performances were found as 5 mA/cm^2 at 0.28 V, 10 mA/cm^2 at 1 V and 20 mA/cm^2 at 1.55 V. These experimental results indicated that pure hydrogen production from glycerol at low temperatures and atmospheric conditions was possible. Since the theoretical voltage for glycerol electrochemical reforming is low, there is scope for further reduction in energy consumption for hydrogen production with this benign and promising method.

Keywords: Hydrogen, glycerol, electrochemical reforming

ORAL ABSTRACTS

[**Abstract:0081**]

Development of the Liquid Fuel Based Fuel Cell for Air-Independent Propulsion Systems

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Due to environmental pollution and global warming caused by fossil fuels, interest in renewable energy sources is increasing day by day, although their efficiencies are very low. Fuel cell (FC) is used as a power source works with high efficiency and it is environmental friendly. Proton exchange membrane fuel cell (PEMFC) is one of the most prominent types of FC in terms of having the characteristics of high efficiency, quick start-up, high power density and simple design. In this study, for air independent propulsion systems, liquid-fed (sodium borohydride/hydrogen peroxide) $NaBH_4/H_2O_2$ PEMFC was designed and for air independent propulsion systems. When designing the PEMFC and choosing its components, the issues of the systems were taken into account. Using $NaBH_4$ as the reactant to avoiding hydrogen storage problems and H_2O_2 as the oxidant to achieve higher power densities because its reduction in fuel cells has a lower activation barrier and faster kinetics than four-electron O_2 reduction. In the experimental tests, a 5 cm^2 single cell with serpentine channel was used at 25-65°C. Two different catalyst, gold was supported on graphene (Au/G) and palladium was supported on graphene (Pd/G), used on the cathode and the anode side, respectively. According to the performance and characteristics of the liquid-fed $NaBH_4/H_2O_2$ PEMFC, it is a promising candidate for air independent propulsion systems in terms of having high power density and avoiding hydrogen storage difficulties.

Keywords: Proton exchange membrane fuel cell, hydrogen peroxide, sodium borohydride, air-independent propulsion systems, liquid fuels

[**Abstract:0082**]

Investigation of Effects of Post-annealing Atmosphere and Temperature on Structural and Photo-electrochemical Properties on Electrodeposited SnS Photo-electrode

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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 (2.37x104cm^2V-1s-1) and holes (7.35x104cm_2V-1s-1) mobility and suitable band gap (Eg: 1.2-1.7 eV). The aim of this work is the investigation of SnS photo-electrodes for photo-electrochemical splitting of water. In this work, SnS photo-electrodes were prepared on fluorine-doped tin oxide (FTO) coated glass by electrodeposition of SnS films and the post-annealing at different temperature (200-300°C). The effect of annealing atmosphere (Argon and Sulfur) and temperature on structural and photo-electrochemical (PEC) water splitting efficiency were investigated. The crystal structure and surface morphology of the SnS photo-electrodes were characterized using an X-ray diffractometer (XRD) and Field emission scanning electron microscopy (FESEM), respectively. PEC performances of the SnS photo-electrodes were determined in the 0.1 M H_2SO_4 electrolyte solution.

Keywords: SnS, electrodeposition, post-annealing, hydrogen generation, water splitting, photo-electrochemical (PEC)

ORAL ABSTRACTS

[**Abstract:0083**]

Microwave Heated Reactor System with Multiwall Carbon Nanotube Supported Moybdenum Incorporated Catalysts to Produce Hydrogen from Ammonia

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Utilization of hydrogen as an environmentally friendly energy carrier increases steadily due to its high energy content and clean burning properties. Hydrocarbons have been used widely to produce hydrogen and formation of COx components are inevitable during this synthesis, but, having high purity hydrogen is important especially for PEM fuel cells in order to prevent poisoning of catalyst. Recently, ammonia has been considered as an important resource for hydrogen production since it has high hydrogen density and COx free hydrogen can be simply produced by its decomposition. In this work, multiwall carbon nanotube (MWCNT) supported molybdenum incorporated catalysts were used for ammonia decomposition reaction in microwave heated system (SAIREM Company, with a maximum working power of 2 KW and a frequency of 2.45 GHz). Carbon source was used not only as a catalyst support but also as a microwave receptor. Activities of the catalysts were found to be negligible at a reaction temperature lower that 550°C (GHSVNH3: 36,000ml/hgcat) in the conventionally heated system having a tubular furnace. Eventhough an increase in temperature favored the reaction, ammonia conversion value was still low, i.e. at about 40 %. On the contrary, ammonia conversion was observed at lower reaction temperature, such as 350°C, and total conversion was achieved even at 450°C in microwave heated reaction system under the same experimental conditions. Moreover, it was about 10 W or less power, sufficient for heating the synthesized catalysts up to 500°C. Direct transfer of energy to the active sites, formation of hot spots, also considered as "microplasmas" within the catalytic bed, are the main reasons of getting higher activity from the catalysts in microwave system as compared to conventionally system. In the structure of the catalysts, molybdenum carbide was formed under microwave application while molybdenum nitride was determined under conventional heating. Formation of these carbide species were supposed to be another improving effect on the catalytic activity of the catalysts under the microwave application.

Keywords: COx-free hydrogen, ammonia, microwave, multiwall carbon nanotube, molybdenum

Acknowledgements

This work is supported by The Scientific and Technological Research Council of Turkey (TUBITAK) through the Project No: 214M148.

[**Abstract:0084**]

The Effect of Annealing Temperature on Photo-electrochemical (PEC) Properties of Spin-coated SnS_2 Photo-anodes

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Tin disulphide, SnS_2, a two-dimensional semiconductor has received considerable attention as a potential photo-catalyst and photo-electrode because of its favourable optical properties and abundance and non-toxicity of its constituent elements. In this study SnS_2 thin films were prepared by spin coating of SnS_2 powders produced by sulphurisation of tin oxide powders on fluorine doped tin oxide (FTO) glass. The crystal structure, surface morphology and optical properties of the SnS_2 films are characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM) and UV–VIS spectrophotometry.The effect of annealing temperature on the composition and photo-electrochemical (PEC) response of the SnS_2 films is investigated.

Keywords: tin disulphide, photo-catalyst, annealing temperature, photo-electrochemical

[**Abstract:0085**]

Methanol Electrooxidation Activity of Binary CoAg Electrocatalyst

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Fuel cells are are considered to be future energy converting devices. There are many types of fuel cells and are being studied and developed intensively (Lavlor, 2013). Direct methanol fuel cells (DMFCs) are active research topic of fuel cells and are considered to be future energy converting devices due to their many superior advantages such as good characteristic of small size,higher energy conversion efficiency, low working temperature, easy storage of fuel, relatively low-cost, high energy density, low weigh and ready availability of methanol as fuel (Carton, 2010). Although Pt is a good electrocatalyst to be used for oxidatiopn of methanol, poisoning of this matel with the intermediates and high cost produyction are major problems. Alternatively, cheaper transition metals are used for this aim. The use of active templetes reduses the use of expensive metals. Activated carbon, carbon black, graphite and graphitic materials have been used for many years as support materials for precious metal catalysts (Dicks, 2006). In this study CoAg binary electrocatalysts were fabricated on carbon felt electrode. The electrocatalysts were characterized with surface characterization techniques and applied as anode for methanol oxidation in KOH solution. Very good activity was obtained at the fabricated anode.

Keywords: Methanol electrooxidation, graphide, cobalt-silver binary coating

[**Abstract:0091**]

Process Simulation of Chemical Looping Gasification for Syngas and Hydrogen Production

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Fossil and renewable solid fuels are used as a feedstocks in Chemical looping gasification (CLG) for syngas and hydrogen production. Chemical looping gasification is environmentally friendly thermochemical conversion processes. This study evaluates the chemical looping gasification process simulations of Turkish lignite as a fossil fuel and saw dust as a renewable fuel. In this regard, SimSci PRO/II process simulation software was used for the effect of parameters such as operation temperature of main reactors and utilization of iron-based oxygen carriers.

Keywords: Chemical looping gasification, process simulation, hydrogen production, Turkish lignite

ORAL ABSTRACTS

[**Abstract:0092**]

Ammonia Decomposition Reaction to Produce COx-free Hydrogen Using Carbon Supported Cobalt Catalysts in Microwave Heated Reactor System

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Hydrogen energy is now one of the strongest candidates to solve the world's growing energy problem. Nowadays, noncarbonaceous sources have become alternative resource for hydrogen production to prevent the formation of COx components, since these byproducts cause a decrease in fuel cell performance due to their poisoning effect. Ammonia is a valuable chemical that can be commonly used in different industrial processes to produce fertilizers etc. At ambient temperature and pressure, ammonia is present in gaseous form. It can be easily liquefied at 298 K under the pressure of about 10 bar and can be stored in relatively inexpensive pressure vessels. Ammonia has been considered as a promising hydrogen carrier due to its superior properties such as high hydrogen storage capacity comparing to the other liquid fuels. In the present study, hydrogen production from ammonia was investigated in a microwave heated system over the carbon supported cobalt containing catalysts catalysts and the results were compared with the corresponding results obtained in a conventionally heated tubular reactor. Various carbon-containing materials such as mesoporous carbon and activated carbon were chosen as support materials because of their high microwave absorption properties. Catalysts were prepared by following an impregnation procedure adjusting the amount of loaded metal in carbon material between 5-35%. The synthesized catalysts were subjected to activity tests in Microwave system (SAIREM Co.) with a frequency of 2.45 GHz, and by changing the power, the reaction temperatures were adjusted between 250 to 600°C and it was about 10 W or less power, sufficient for heating the synthesized catalysts up to 600°C. A complete conversion of ammonia under the flow of pure ammonia (GHSV: 36000 ml/h gcat) was achieved over carbon supported cobalt catalysts at about 400°C. Unlike conventionally heated reaction system, about 75 % ammonia conversion were also seen in microwave heated system at 300°C. In the conventional system, complete conversion of ammonia was seen at 600°C. The reason of this difference can be explained as the heating principle of microwave reactor. Microwave reactor system directly transfers the heat required for the reaction to the active surface, create hot zone formations called hot spots and reduce heat loss unlike a conventional system.

Keywords: Ammonia, COx-free hydrogen, microwave, carbon, cobalt

[**Abstract:0093**]

Pd-Co/C Catalysts Preparation with Microwave Assisted Polyol Method for Direct Borohydride Fuel Cells

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Fuel cells are appliances that allows the conversion of chemical energy to electricity with high efficiency. Development of catalysts which can be used for fuel cells plays very crucial role. Mostly noble metals are alloyed with transition metals as anode catalysts. Pt is the most studied noble metal for fuel cells. Since Pd shows similar kinetic behavior to Pt, a lot of studies are present in literature as a good alternative for Pt. To achieve high power outputs nano-sized catalysts are preferable and synthesizing them requires different methods than conventional catalysts preparation methods. One of them is polyol method which uses polyols as reducing agent. In literature using microwawe as heat source in polyol method resulted superior catalysts compared to conventional polyol method. In this study study, carbon-supported Pd-Co alloy catalysts were synthesized by microwave assisted polyol method and the effects of preparation parameters such as pH of reaction media, power of microwave source and reaction time, on catalyst structure were investigated. Ethylene glycol was chosen as reducing agent and acetate salts of Pd and Co were used as precursors. pH values of 10, 11 and 12 were chosen as parameters. Power of the microwawe source were set to be 460W, 600W and 700W. The reaction time was chosen to be 30 seconds, 60 seconds and 90 seconds. The characterization methods such as X-ray diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Transmission Electron Microscope (TEM) and Energy Dispersive X-ray Spectroscopy (EDX) were used to determine the structure of the catalysts. Cyclic Voltammetry (CV) was used to determine Electrochemically Active Surface Area (ECSA) of the catalysts and their selectivity towards borohydride electro-oxidation in Direct Borohydride Fuel Cells in highly basic media. Chronoamperomertry method was used to determine the stability of the catalysts for 1000 seconds. Preliminary results showed the formation nano-sized Pd-Co alloys having high ECSA values.

Keywords: Direct borohydride fuel cell, Pd-Co/C, microwave polyol method, anode catalyst

[**Abstract:0094**]

Calcium Silicate-based Catalytic Filters for Partial Oxidation of Methane

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Development and testing of catalytic filters for partial oxidation of methane to increase hydrogen production in a biomass gasification process constitute the subject of the present study. Nickel was coated on calcium silicate filters via co-impregnation technique, and catalytic filters were characterized by ICP-MS and TPR techniques. The influences of varying reaction temperatures and calcium silicate based material on methane conversion and hydrogen selectivity have been investigated. An increase in temperature up to 750°C has positive effects on the results According to preliminary results obtained from reactions with 6 % methane-nitrogen mixture, and catalytic filters were tested with model biogas at 750°C. Although approximately 93 % methane conversion was observed with 6 % methane-nitrogen mixture, 97.5 % methane conversion was obtained with model biogas containing CH_4, CO_2, CO, and N_2 at 750 °C. These results indicate the high potential of calcium silicate material for partial oxidation of biogas containing methane as a base material for catalytic filters.

Keywords: Hydrogen production, partial oxidation of methane, tar reforming, candle filter, bimetallic catalyst

ORAL ABSTRACTS

[**Abstract:0099**]

Kinetics of Sodium Borohydride Oxidation Reaction on Carbon-Supported Pd-Zn Catalysts

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In this study, PdZn/C catalysts with different Pd:Zn molar ratio (1:1, 2:1 and 3:1) and Pd/C catalysts were prepared by NaBH4 impregnation-reduction technique with ultrasound irradiation method. The physical properties of the electrocatalysts were determined by X-ray diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS) and Transmission electron microscopy (TEM) technologies. Electrochemical characterizations of catalysts were carried out by cyclic voltammetry (CV), Chronoamperometry (CA) and Linear Sweep Voltammetry (LSV). The catalytic activities of the prepared (PdZn/C and Pd/C) and a commercial Pd/C catalyst in BH4- electrooxidation were performed by LSV with different rotation rates in 1 M NaOH and 0,01 M NaBH4 solution and the results were compared. The current densities recorded for all prepared catalysts were found to be increasing with the increasing rotation rate of disc electrode which indicates the reaction kinetics were controlled by the BH4- ion diffusion. Furthermore, the number of electrons was calculated with the Levich equation using linear sweep voltammograms. The results showed that the addition of Zn to Pd/C catalyst was improved the catalytic activity towards BH4- electrooxidation which exhibits good potential for DBFC systems.

Keywords: Borohydride electrooxidation, bimetallic nanoparticles, kinetic parameter

[**Abstract:0100**]

Kinetic Properties of Nickel–Titanium–Boride (Ni–Ti–B) Catalysts for Sodium Borohydride Hydrolysis Reaction

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Hydrogen is considered to be a promising next-generation energy source due to its high heat value and possible generation from renewable sources. hydrogen can be stored traditionally in pressurized tanks, by adsorption on high surface area, nanostructured materials (activated carbon, carbon nanotubes, metal organic frameworks (MOFs), etc.) and hydrogen storing alloys, but all of these methods have some drawbacks such as low volumetric and gravimetric storage, high energy consumption, and safety considerations. Chemical hydrides ($NaBH_4$, NaH, LiH, KBH_4, $NaAlH_4$, etc.) are promising candidates for pure hydrogen production and stored at room temperature. Because the adsorption and desorption kinetics of these chemical hydrides are fast enough to provide continuous H_2 supply and transportation of hydrogen containing media is possible at close to atmospheric temperature and pressure conditions. Among them, sodium borohydride ($NaBH_4$) is the most advantageous hydride due to its different properties such as high hydrogen capacity (10.8 wt.%), non-flammability, non-toxicity and stability in alkaline media. he alkaline sodium borohydride solution can only be hydrolyzed in the presence of suitable catalysts, and many studies have been done to find the suitable catalysis. In the present work, new and efficient Nickel-Titanium Boride (Ni-Ti-B) catalysts will be developed for catalytic hydrolysis reaction of alkaline $NaBH_4$ solution. Hydrogen generation rate will be measured using the ternary Ni-Ti-B catalyst as a function of different Ti concentration, solution temprature, $NaBH_4$ concentration, and NaOH (a base-stabilizer) concentration. The performance of the system will be analyzed from themodynamic points of view and will be compared with the pristine Co-B catalysts.

Keywords: Sodium boron hydride, hydrolysis, boride catalysis

ORAL ABSTRACTS

[**Abstract:0101**]

A Comparison; Photocatalytic and Photoelectrochemical Hydrogen Performances of Heteroatoms (Mo, Ni and Cu) Decorated RGO-Cd(1-x) ZnxS Synthesized with Solvothermal and Sulphurization Methods

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Here, we report a comparison of heteroatom doped and/or loaded RGO-Cd(1-x)ZnxS photocatalysts designed with different synthesis methods (solvothermal and thermal sulphurization) in PC and PEC systems. RGO-Cd(1-x)ZnxS both loaded as co-catalyst and doped with molybdenum (Mo), copper (Cu) and nickel (Ni) via different techniques such as photodeposition and chemical doping to form a ternary composite and heteroatom doped single component. The crystal structure and morphology of the composites were characterized with X-ray diffraction (XRD), Raman spectroscopy (RS), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS) and UV-Vis diffuse reflectance spectroscopy (DRS) techniques. Synthesized and characterized photocatalysts were tested in PC and PEC systems under solar irradiation. The photocatalytic activity tests showed that the photocatalysts by solvothermal method exhibited much higher activity than photocatalysts which were synthesized by sulphurization method under solar light irradiation. In addition, it was observed that the PC performance of photocatalysts prepared with photodeposition loading approach was higher than the ones prepared with heteroatom doping approach. However, the PEC study of these photocatalysts displayed the reverse effect of the PC study. This study demonstrates the importance of heteroatom loading and synthesis method as an effective strategy to increase PC and PEC performances for RGO-Cd(1-x)ZnxS without noble metal.

Keywords: Photocatalyst; photocatalytic, photoelectrochemical, hydrogen production

[**Abstract:0103**]

Effect of Production Parameters on Photoelectrochemical Water Splitting of Fe_2O_3 Thin Film: Optimisation Study Using Response Surface Methodology (RSM)

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In this study, α-Fe_2O_3 thin films are fabricated by annealing of electrodeposited Fe films on transparent conductive substrate. α-Fe_2O_3 has been extensively studied for photoelectrochemical (PEC) water splitting. The aim of this study is to produce and characterise α-Fe_2O_3 thin films and optimize the effect of production paramaters on photoelectrochemical water splitting using response surface methodology (RSM). Response surface methodology (RSM) is employed in order to optimize different production parameters such as deposition time (s), ferrous sulphate concentration (mol/L), annealing temperature (°C) and pH value. Phase structure, surface morphology, and optical properties of the α-Fe_2O_3 photoanodes are characterized by using an X-ray diffractometer (XRD), scanning electron microscopy (SEM) and UV–VIS spectrophotometer, respectively. Photoelectrochemical (PEC) water splitting performances of the α-Fe_2O_3 thin films are determined in the 1 M NaOH electrolyte solution. Electrodeposition method could be good candidate for production of efficient α-Fe_2O_3 photoanodes for enhancement of PEC performance.

Keywords: α-Fe_2O_3, Thin film, electrodeposition method, response surface methodology, photoelectrochemical water splitting

[**Abstract:0104**]

Effect of Electrolyte Coating Parameters and Different Sintering Temperatures on Performance of Anode Supported Planar Solid Oxide Fuel Cells

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Solid Oxide Fuel Cells (SOFCs) are electrochemical devices that work at high temperatures and convert the chemical energy of a fuel directly into electrical and heat energy with a high conversion efficiency. Yttria stabilized zirconia (YSZ) has been extensively used electrolyte material for SOFCs. The coating methods of YSZ-based electrolyte for anode supported cells significantly affect the open circuit voltage and thus the performance of SOFCs. In this study, the effect of electrolyte coating methods and sintering temperature on the performance of anode supported planar SOFCs are experimentally investigated to determine the optimal electrolyte structure. Three different electrolytes are prepared via deep coating, tape casting and screen printing techniques in this respect. The electrolytes are also sintered at 1325, 1350, 1375 and 1400°C to study the effects of the sintering temperature. The electrolytes are evaluated based on the electrochemical performance. For this purpose, anode supported cells having 1cm^2 active area are fabricated using Crofer 22 APU as interconnector, porous nickel and crofer mesh as anode and cathode current collecting meshes, respecetively, together with LSM cathode and NiO anode current collecting pastes. Based on the cell performance results, the best cell delivers a peak power density of 923 mW/cm^2 at an operating temperature of 800 °C.

Keywords: Solid oxide fuel cell, electrolyte, coating method, sintering temperatures, electrochemical characterization.

[**Abstract:0105**]

Thermoeconomic Optimization of Various Geothermal Driven Power and Hydrogen Configurations

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Geothermal energy is the earth's heat in shape of water, vapor or mixture located at the shallow ground crust which could be utilized as a cogeneration system integrated with other applications like hydrogen arrangements. Hydrogen is the future alternative of gasoline and fossil fuel so it has a higher heating value and simpler methods to extract. Several power configurations presented by the flashing technology with some other conventional cycles bounded with water electrolysis (PEMP) for efficient hydrogen production to be evaluated and optimized thermodynamically then thermoeconmiclly that is conducted in the paper. The comparison between all power cogeneration cycles based on the thermal and exergy efficiencies next to the total cost to meet 1MW power demand.

Keywords: Geothermal, hydrogen production, thermoeconomic

ORAL ABSTRACTS

[**Abstract:0108**]

Effect of Surface Roughness on Sealant Performance of Glass Ceramic in Solid Oxide Fuel Cells

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Planar solid oxide fuel cells (SOFC) is the most widely used design due to ease of manufacturing and higher power density. On the other hand, planar structure requires sealing materials which can be effective at high temperatures. Sealant is critical for the long-term performance and reliability of SOFC, because a poor seal leads to leakage, which reduces the cell performance, wastes fuel and threats the safe operation of fuel cell stacks due to chemical reaction between the fuel and oxidant. The glass-ceramic composites are among the favorable materials for SOFC sealing application due to their high stability at high operating temperatures (600 °C-850 °C). The glass-ceramics can chemically bond to both the metallic interconnectors and the ceramic based electrode/electrolyte and provide a gas tight connection. However, even though the glass ceramic has good properties, the fabrication process consists of several steps to obtain a gas tight sealing. In this study, the joint strength of glass-ceramic sealant between two metallic interconnectors (Crofer® 22 APU) and, metallic interconnectors and electrode/electrolyte are experimentally investigated depending on the surface roughness of the metallic interconnector. The surfaces of the samples are sanded with different grits of sandpaper. Thus, roughened surfaces are obtained and adhesion are examined for each case. Profilometer is used to inspect the surface roughness of samples. According to the experimental results, the optimum case is reported.

Keywords: SOFC, sealant, glass ceramic, surface roughness.

[**Abstract:0109**]

CoNiFeS Nanoparticles Dispersed on Graphite Cathode for Hydrogen Evolution Reaction

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With the increase in population in our world, the need for energy is increasing. Most of this energy need is met by fossil fuels. The energy that is supplied from fossil fuels is being replaced by clean energy sources such as wind energy and solar energy. Hydrogen fuel is the best alternative for these clean energy sources because of the release of water when it burns. The easiest way to obtain hydrogen is the electrolysis of water. However, the overpotentials encountered in the electrolysis of water increase the cost of this method. Therefore, studies are continuing to produce better catalytic surfaces [1, 2]. ZIF structures are known as subclasses of MOF structures. ZIFs are structures formed by the combination of imidazole derivatives and metal. These structures serve as initiators in the production of nanometals or nanocomposites [3]. The aim of this study is to determine the cathode for hydrogen production with low overpotential, high electrocatalytic property, stable with time and has corrosion resistance. Some ZIFs were synthesized by 2-methyl imidazole and Co, Ni and Fe salts in methanol medium. The synthesized ZIFs, called ZIF-67(Co), ZIF-67(Ni) and ZIF-67(Fe), were put into a tube furnace and annealed at 800 °C for 2 h with 3 °C min-1 heating rate to produce nano sized metal mixture [4]. The mixture and sulphur powder were mixed carefully and put into a tube furnace and annealed at 350 °C for 2 h. The obtained mixture was coated on carbon rod electrode by %5 nafion solution. Surface morphology and chemical composition of synthesized ZIFs, prepared metal mixure and prepared electrode was determined by scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX). The HER activity of the prepared electrode was investigated on in 1 M KOH medium. Electrochemical analyses were carried out by cathodic polarization curves, electrochemical impedance spectroscopy (EIS), hydrogen evolution experiments and stability tests of electrodes. From the results obtained, CoNiFeS@C shows low hydrogen overpotential and proves to be more economical for hydrogen evolution reaction.

Keywords: ZIF, nanocomposite, CoNiFeS@C, hydrogen, water electrolysis, HER

ORAL ABSTRACTS

[**Abstract:0111**]

Design and Development of Air Cooled PEFC Stack - Flow Design Optimization Through Computational Fluid Dynamics (CFD)

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Air-cooled polymer electrolyte fuel cells have gained tremendous interest for application as portable power systems, due to its simple construction, ease of operation and minimum balance of plant sub-systems. This results in the minimization of complexity of system, parasitic power loss as well as overall cost of the system. Thus, the air flow field design plays an important role in the development of an air-cooled stack, as they have a dual role of supplying reactant as well as acts as coolant. The requirement of uniform gas distribution and minimal pressure drop across the flow area is of prime significance for efficient gas utilization and easy removal of water. Recently, research pertaining to the modification of flow design both by modeling as well by experimental investigation have attracted an increased interest. Computational Fluid Dynamics (CFD), a simulation tool based on solving governing flow equations, has been widely used for simulating flow distribution profile. Thus, the present work deals with the design of a novel type flow field for cathode, and further optimization of flow design for uniform distribution profile throughout the active area. The flow field geometry designed by 3-D modeling software, and the factors affecting the flow distribution pattern such as effect of inlet boundary conditions, modification of flow field design and air inlet ports dimension were investigated and optimized. In addition, the anode flow field design has also been simulated for its uniform flow distribution and optimized. The flow design (both anode and cathode) optimized using CFD has been machined on graphite plates, and a two-cell stack assembly has been constructed and evaluated experimentally for performance studies. It is evident from I-V polarization curve that the present design demonstrated a current density of 140 mA/cm^2, which has on par performance with the commercial air-cooled stack.

Keywords: Air-cooled PEM fuel cells, computational fluid dynamics, flow design optimization, I-V polarization

[**Abstract:0112**]

An Urban Hydrogen-Based Transportation Scenario Analysis

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Electrical vehicles stands out as a preferable option tackling the conventional propulsion problems. Due to its nature and production, hydrogen is both accessible to every country and an eco-friendly resource on production and storage aspects. Despite all of the positive issues, the production cost of hydrogen is still relatively higher than the conventional fuels. Nevertheless, many countries e.g. USA, Germany, UK, France and Japan have already implemented widespread refueling stations across their countries. In this perspective, the objective of this paper is to analyze the implementation cost and environmental effects of the penetration of hydrogen-based vehicle systems including hydrogen production, distribution, refueling stations and fuel cell powered cars by 2023. To achieve this, a hypothetical scenario has been applied to the Burdur-TIMES energy-economy-environment model. A complete chain of hydrogen technology and energy components have been introduced with specified data to the model. In the baseline scenario of Burdur; passenger transportation demand has been calculated as approximately 0.91 PJ in 2016 and 1.76 PJ in 2031; while the HYD scenario dislocated 20% of this demand to the hydrogen based vehicles. Results shows that, installation of hydrogen production and hydrogen powered vehicles mitigates the greenhouse emissions significantly despite their relatively higher investment costs compared to the conventional resources; where these efforts against the climate change contributes the country profile in a good manner in the international environment.

Keywords: Energy modelling, renewable energy, hydrogen energy, burdur, answer-TIMES, fuel cell

ORAL ABSTRACTS

[**Abstract:0114**]

ZIF-Derived CuPt@Ag as Catalyst for Hydrogen Evolution Reaction

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Hydrogen is produced from water electrolysis is known as zero-emission fuel and burns to produce water vapor. It can be made renewable. So the problem of environmental pollution and energy shortage can be solved out at the same time. Zeolite Imidazolate Frameworks (ZIF) is established with tetrahedral units formed by one transition metal cation and four imidazolate anions and used to produce nanoparticles. In this study, ZIF-Cu, ZIF-Ag, ZIF-Pt were synthesized by 2-methyl imidazole and Cu, Ag and Pt salts in methanol medium. The synthesized ZIF were put into a tube furnace and annealed to produce metal mixture [4]. The obtained metal mixture was coated on carbon rod electrode [5]. Surface morphology and chemical composition of synthesized ZIFs, prepared metal mixure and prepared electrode were investigated by scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX) techniques. The prepared electrode was investigated for hydrogen evolution reaction activity. Electrochemical analyses were carried out by cathodic polarization curves, electrochemical impedance spectroscopy (EIS), hydrogen evolution experiments and stability tests of electrodes. From the results obtained, CuAgPt@C shows low hydrogen overpotential and proves to be more economical for hydrogen evolution reaction.

Keywords: Zeolite imidazolate framework, hydrogen storage, catalyst, CuAgPt, electrolysis

[**Abstract:0117**]

Modification and Modelling of Gas Diffusion Layer on PEM Fuel Cells

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Fuel cells are environmentally friendly energy converters that directly transform the chemical energy of a fuel into electricity. Fuel cells are classified according to the type of electrolyte they contain and proton exchange membrane fuel cells (PEM) are the most common type of fuel cells due to their advantages. Significant trouble about commercialization of PEM fuel cell is high cost of components. In addition to high catalyst costs, a low water management problem that shorts fuel cell life is a matter, which needs to be solved. The gas diffusion layer (GDL) within the components of the fuel cell has an important role in effective water management. In this study, a model which determines the activity of electro catalyst in half cells has been developed, in order to have an idea about the responses in the fuel cell system. Experimental data will be used to better reflect and simplify the system. The study will be performed in the presence of various parameters and the results will be compared with the developed model. As a result of this study, with the help of developed model, oxygen reduction reaction (ORR) activities of catalysts will be learned without doing any electrochemical tests.

Keywords: PEM fuel cell, Pt electro catalyst, ORR, hydrophobic layer, mathematical model.

[**Abstract:0118**]

Design, Manufacturing and Testing of High Temperature PEM Fuel Cell Stack

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In recent years, the energy requirement has been increasing with the developing of technology and population. The Proton Exchange Membrane Fuel Cell (PEMFC) considered to be the preferred alternative energy technology in recent years due to its high efficiency, low emission, high power density, quiet operation and short start-up period. High Temperature PEMFC (HT-PEMFC) provides many advantages such as easy water management and high carbon monoxide tolerance thanks to over 100 °C of operation temperature. Tolerance is great importance that HT-PEMFC can be usable with reformat gases obtained from a short process of natural gas, which are frequently used today, so their commercialization. In this study, the test station was developed in order to test HT-PEMFC by reformate gas ($H_2/CO_2/CO$;75/22/3) and then, single HT-PEMFC tested to determine design parameters of the stack with H_2 and reformate gas supply. After single cell tests, HT-PEMFC stack which has 150 cm^2 active area and 12 cells were designed. According to design of bipolar plates, the pressure differences between inlet and outlet of reactant gases were measured for different flow rates. Pursuant to pressure differences and design results, HT-PEMFC stack were manufactured. The performance of HT-PEMFC stack were tested by pure H_2 and reformate gas supply. The study results shown that performance and efficiency of HT-PEMFC stack were increased and pressure differences were decreased with pure H_2 supply, but these differences can be ignored considering the advantages of reformate gas usage and the importance of fuel cell widespread commercialization. This study supported as part of 1001 project, as a part of number 214M301 research project by The Scientific and Technological Research Council of Turkey (TUBITAK).

Keywords: High Temperature fuel cell, PBI, flow analysis, stack production, performance tests

[**Abstract:0119**]

Numerical Analysis of Hydrogen Enriched Gasoline Combustion in a Constant Volume Vessel

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Future of conventional internal combustion engines (ICEs) is under discussiton by new stringent and restrictive emission regulations. Hydrogen, having lower lean operational limit, faster burning rate and lower emissions than common fuels opens new aspects in usage limits of ICEs. Studies on using hydrogen blended fuels demonstrate significant improvements on performance and emissions of ICEs as they can be used in temporal period in transition to pure hydrogen engines. In this regard, hyrogen enriched gasoline has potential of reducing hazardous emissions of spark ignition engines while improving thermal efficiency and power output. This study focuses on combustion of hydrogen added gasoline in a constant volume vessel which has similar ambient conditions of ICEs. It is intended to reveal emission and combustion performance of hydrogen blended homogenuous fuel mixtures that have 0%, 5%, 10%, and 20% hydrogen volumetric ratios. Gasoline fuel was represented by gasoline surrogate (PRF-85) that has 85% iso-octane (C_8H_{18}) and 15% n-heptane (C_7H_{16}). Reduced kinetic mecanisms of gasoline surrogate were used in numerical calculations. Results were analysed by comparing temperature and emission distributions of different hydrogen blended fuels. It is shown that, except NO_x, emissions of hydrogen added mixtures were improved. The results show that hydrogen addition has significant improvement on emission and combustion performance of gasoline fuel, which can play a key role on use of ICEs in near future.

Keywords: Hyrogen enrichment, spark-ignition engine, numerical modelling, constant volume vessel

ORAL ABSTRACTS

[**Abstract:0120**]

Enhancement of the Photoelectrochemical Performance of Titania Nanorod array for Hydrogen Production by Cerium Doping

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Among various energy sources hydrogen is considered as the prominent and efficient one because of its high energy per mass content, easy transport, reduced harmful emissions and clean electricity production1. However the industrial scale production of hydrogen is still dependent on fossil fuel combustion (steam reforming of methane). Green alternatives that uses only water as hydrogen source are under progress. Thus the use of photoelectrochemical cells for light driven water splitting is considered to be the most promising replacement. Among various photoanodes used in photoelectrochemical cells one-dimensional Titania (TiO_2) nanorods arrays have received extensive attentions because of their superior charge collection, reduced electron and hole recombination's and superior photo electronic properties. However the wide band gap (3.2 eV) of TiO_2 have limited its application in the visible region of the solar spectrum. In the present work one dimensional TiO_2 nanorod array have been prepared by hydrothermal method on transparent conductive substrate (FTO). In order to enhance the photo response of the synthesized nanorod in the visible region doping was done using Cerium metal salt. Photoelectrochemical results suggest that cerium doping in the TiO_2 nanostructures enhances the photoelectrochemical performance as compared to the pristine TiO_2 nanorod arrays. Linear sweep voltammetry results show that cerium doped TiO_2 nanorod arrays show a maximum current density of ~2.8 mA / cm^2 at 0.6 V in 0.5M Na_2SO_4 electrolyte solution under illumination of simulated solar light (100 mW / cm^2 from 150 W xenon lamp coupled with an AM 1.5G filter).

Keywords: Photoanodes, Ce-doped titania nanorod arrays, hydrothermal method, hydrogen generation, photocurrent, water oxidation/splitting

[**Abstract:0125**]

Investigation of the Performance of a Direct borohydride Fuel Cell with Low Pt/C Catalyst Loading

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With the ever-growing technology, the use of fossil fuels in energy production has started to leave its place to renewable energy sources. Particularly, fuel cells in mobile energy production are very promising solution. Among the low temperature fuel cells, the PEM has gained an attraction but because of hydrogen storage problems, the direct borohydride fuel cells rose among as alternatives to such solutions. In this work, a direct borohydride loaded with a low catalyst on the anode and cathode sides was run at different fuel feeding flow rates and at different temperatures. The effect of these parameters on the fuel cell performance is examined. Pt/C catalyst loadings are 0.32 mg/cm^2 on the anode side and 0.36 mg/cm^2 on the cathode side. The active area of the fuel cell is 25 cm^2. The fuel composition contains 1M $NaBH_4$, 3M NaOH and the fuel was fed to single cells at 0.5, 1 and 5 ml/min flow rate. The fuel cell temperature was maintained at 60, 70 and 80 oC. As oxidant, humid O_2 was used and fed at a fixed flow rate of 0.3 l/min. One of the results obtained is shown in Figure 1. When all the results of the study were evaluated, it was seen that the highest current and power values were obtained at a feed rate of 1 ml/min at 80 °C. The highest power is 498.988 mW at a working voltage of 0.401 V.

Keywords: Direct borohydride fuel cells, Pt/C catalyst, fuel cells, renewable energy sources

[**Abstract:0129**]

Investigation of the Performance of a Direct Borohydride Fuel Cell with Low Pd/C Catalyst Loading Under Different Operating Conditions

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With the ever-growing technology, the use of fossil fuels in energy production has started to leave its place to renewable energy sources. Particularly, fuel cells in mobile energy production are very promising solution. Among the low temperature fuel cells, the PEM has gained an attraction but because of hydrogen storage problems, the direct borohydride fuel cells rose among as alternatives to such solutions. As such, this research consists of a direct borohydride fuel cell with low level Pd/C catalyst load and a study on different operation parameter performances. The research found that the power generated and the performance of the cell increase as the operation temperatures increase. Also, the fuel feed flow should be adjusted according to catalyst load. High fuel feed flows lead to the fuel to not react and leave as waste, as well as low fuel feed flows lead to low or partial utilization of the catalyst. With the aforementioned operation parameters and components, this study concludes the highest power was obtained using 60 Celsius degrees of temperature and 1 ml/min fuel feed flow.

Keywords: Direct borohydride fuel cell, low Pd/C catalyst, fuel cells, renewable energy sources

[**Abstract:0130**]

Design and Implementation of Hydrogen Generation and Liquation Economy Using Artificial Neural Network on Field Programmable Gate Array

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In this study, econımic analysis of hydrogen generation and liquefaction system has been modeled using Multi Layer Feed Forward Artificial Neural Network (MLFFANN) and implemented on Field Programmable Gate Array (FPGA). Firstly, the 100X6 data set has been created to be used in the ANN-based modeling of the system using the Engineering Equation Solver (EES) program. This data set has been divided into two data sets as 80X6 for training and 20X6 for testing. The structure of the ANN-based economic analysis of hydrogen generation and liquefaction has been composed of 3 neurons in input layer, 10 neurons in the hidden layer and 3 neurons in the output layer. Elliott-2-based TanSig transfer function and Pureline transfer function have been used in the neurons of the hidden layer and the output layer, respectively. Then, the ANN-model has been trained and tested using the Matlab program. After getting the successful results from training and testing phases, economic analysis of hydrogen generation and liquation system have been modeled in VHDL using bias and weight values located in the constructed ANN-based system using Matlab. The modeling has been performed in Xilinx ISE Design Tools program using 32-bit IEEE-754-1985 floating point number standard. Then, the modeled ANN-based economic analysis of hydrogen generation and liquation system has been implemented on Xilinx Virtex-6 FPGA chip by performing Place&Route process. The chip statistics and the maximum operating frequency of the ANN-based Hydrogen Generation and Liquation Economy system implemented on FPGA have been presented.

Keywords: Hydrogen generation, hydrogen liquefaction, economic analysis, artificial neural networks, field programmable gate array, VHDL.

[**Abstract:0131**]

Combustion and Emissions Investigation of Syngas Fuels

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In this study, the turbulent combustion of methane/air and syngas fuels have been numerically investigated at the same thermal power. In the syngas combustion, the effects of H_2/CO volume ratio on flame pattern and emissions have studied. Additionally, the results have compared with methane combustion. The results show that the flame temperature of each syngas mixture is higher than that of methane. Also, the increase in the H_2 / CO volume ratio increases the flame temperature. This is the reason why NO_x emissions are also on an upward trend. Moreover it is determined that the amount of N_2 in the syngas also affected the NO_x emission level.

Keywords: Syngas, syngas composition, syngas emissions, H_2/CO

[**Abstract:0137**]

A Process Simulation Study on Direct Light Olefin Synthesis from Hydrogen Rich Syngas

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In this work, a thermodynamic simulation analysis of a chemical reactor process for direct light olefin synthesis of syngas coming from a gasifier unit was carried out. Equilibrium analysis of an olefin reactor process was performed to search some operational parameters. This work was carried out by using Aspen HYSYS chemical process simulation software. Preliminary results of the simulation work are given. The temperature effect on the equilibrium conversions and concentrations for the light olefin products were investigated at constant operating pressures. CO conversion to ethylene is increasing while it is decreasing for propylene at constant operating pressure. The pressure and H_2/CO ratio effects have also been discussed at constant temperature values. These process parameters are very important to select desired operation conditions of the olefin reactor.

Keywords: Hydrogen, syngas, light olefins, process, simulation.

ORAL ABSTRACTS

[Abstract:0138]

Investigation of an Experimental Hydrogen Production System for 2 kWe PEM Fuel Cell MicrocogenerationUnit

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In this study, an experimental programme for a hydrogen production unit (HPU) using natural gas was conducted. This unit has been designed to use with a 2 kWe PEM fuel cell microcogeneration process. The thermodynamics of the whole process was first simulated with ASPEN HYSYS simulation software to determine the hydrogen production yield at equilibrium conditions. The HPU consists of authothermal reformer, high/low temperature water gas shift (HTS, LTS) and preferential oxidation reactors (PROX). The first HPU experiments were performed to determine the effects of reactor temperatures, S/C ratio and O_2/C ratios. The on-line experimental measurements were carried out for the reactor outlet gas compositions. The first results show that the approximate outlet compositions at the dry outlet last stream (PROX3 out) are 40.78% H_2, 14.21% CO_2, 2.59% CH_4, 0.49% O_2, 41.92% N_2 and 15 ppm CO. The full hydrogen production capacity was achieved succesfully to feed a 2 kWe PEM fuel cell unit (produced inhouse at TUBITAK MAM Energy Institute premises).

Keywords: Hydrogen, process, simulation, experimental, fuel cell, microcogeneration

[Abstract:0142]

Enhanced Photoelectrochemical Activity of Reduced Graphene Oxide Decorated CdxZn1-xS Photocatalyst for Hydrogen Production

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In this study, CdxZn1-xS have been synthesized through thermal sulfurization method by using elemental sulfur as sulfur source for CdxZn1-xS decorated with RGO. The photoelectrodes were obtained by spin coater technique and characterized by X-ray diffraction (XRD), Raman spectroscopy (RS), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS) and UV-Vis diffuse reflectance spectroscopy (DRS) techniques. Then, the photoelectrodes were tested in PEC system.The photoelectrodes exhibited high photostability and photocurrent response in the presence of visible light irradiation. Among the RGO-CdxZn1-xS composites, RGO-CdS photoanode yields an extremely high photocurrent density of 6.5 $mAcm^{-2}$. This value is almost 89% of its theoretical photocurrent density value (7.3 $mAcm^{-2}$ estimated from its band gap 2.41 eV) at applied potential of 0.542 V vs. RHE. Applied bias photon-to-current efficiency (ABPE) is 2.67 % at zero bias potential (Vbias =0) while it has photostability almost the same as the rest of RGO-CdxZn1-xS electrodes. This is the maximum attained photocurrent density in comparison with related literature of ITO/RGO-CdS.

Keywords: Photocatalyst, hydrogen production, solar energy, photo-electrodes, photoelectrochemistry

ORAL ABSTRACTS

[**Abstract:0143**]

Biological Hydrogen Production by Using Co-Cultures of PNS Bacteria

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Biological hydrogen production is a renewable, carbon-neutral and clean route for hydrogen production. Purple non-sulfur (PNS) bacteria have the ability to produce biohydrogen via photofermentation process. The type of the bacterial strain used in photofermentation is known to have an important effect on hydrogen yield. In this study, the effect of different co-cultures of PNS bacteria on photofermentation process was investigated in search of improving the hydrogen yield. For this purpose, growth, hydrogen production and substrate utilization of single and co-cultures of different PNS bacteria (*R. capsulatus* (DSM 1710), *R. capsulatus* hup- (YO3), *R. palustris* (DSM 127) and *R. sphaeroides* O.U.001 (DSM 5864)) were compared on artificial H_2 production medium in 150 mL photobioreactors under continuous illumination and anaerobic conditions. In general, higher hydrogen yields were obtained via co-cultivation of two different PNS bacteria when compared with single cultures. Further increase in hydrogen yield was observed with co-cultivation of three different PNS bacteria. Co-cultures of two different PNS bacteria have resulted in up to 1.4 and 2.1 fold increase in hydrogen yield and hydrogen productivity. Whereas co-cultures of three different PNS bacteria have resulted in up to 1.6 and 2.0 fold increase in hydrogen yield and hydrogen productivity compared to single cultures. These results indicate that, defined co-cultures of PNS bacteria produce hydrogen at a higher yield and productivity, due most probably to some synergistic relationship. Further studies regarding the physiological and molecular changes need to be carried out for deeper understanding of the mechanism of hydrogen production in co-cultures.

Keywords: Purple non-sulfur bacteria, co-cultivation, biological hydrogen production

[**Abstract:0144**]

Photoelectrochemical-Photocatalytic Dual Hydrogen Production System

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In this study, the main aim was to study hydrogen production in photoelectrochemical-photocatalytic dual hydrogen evolution reaction (PEPCHER) system as a combination of photocatalytic hydrogen evolution reaction (PCHER) and photoelectrochemical hydrogen evolution reaction (PECHER) systems. The photocatalysts as a semiconductor material chosen in this research were RGO-Cd1−xZnxS and Pt doped RGO-Cd1−xZnxS synthesized by sulphurization/solvothermal method. Finally, the photoelectrochemical and photocatalytic hydrogen production tests were performed to determine hydrogen production performance in PEPCHER system.

Keywords: Photoelectrochemical hydrogen production, photocatalytic hydrogen production, metal chalcogenides, solar energy.

ORAL ABSTRACTS

[**Abstract:0147**]

Development of a Novel Renewable Energy Based Integrated System for Hydrogen Production

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The present study develops a renewable energy based integrated system, comprising double flash steam cycle, absorption cooling system, Rankine cycle, a solar-driven system, a wind farm, and hydrogen production units. The system is designed to generate five outputs namely, power, cooling, heating, hydrogen and domestic hot water. Geothermal power plants emit high amount of hydrogen sulfide (H_2S). The presence of H_2S in the air, water, soils and vegetation is one of the main environmental concerns for geothermal fields. In this paper, AMIS (AMIS® - acronym for "Abatement of Mercury and Hydrogen Sulphide" in Italian language) technology is used for abatement of mercury and producing of hydrogen from H_2S. The system is assessed both energetically and exergetically. In addition, the energetic and exergetic efficiencies and exergy destruction rates for the whole system and its parts are defined. The overall energy and exergy efficiencies are calculated to be 52.97% and 55.69%, respectively.

Keywords: Hydrogen production, solar energy, geothermal energy, hydrogen sulphide, exergy, efficiency

[**Abstract:0153**]

Comparison of Emission and Fuel Consumption Values of a Gasoline Fuelled and Gasoline + Hydrogen Fuelled SI Engine Powered Light-Duty Vehicle in New European Driving Cycle

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In the performed study, firstly, performance and emission values of only gasoline fuelled engine, and gasoline + hydrogen fuelled engine were obtained. Hydrogen which was produced with an alkaline electrolyser was used as supplementary fuel. By using AVL Boost Software, engine maps (emissions and fuel consumption) were acquired with the use of obtained test results. Lastly, a vehicle model was developed using Matlab/Simulink Software. The selected light duty vehicle was analysed according to NEDC (New European Driving Cycle) and CO, HC and NOx emissions and fuel consumption values were obtained. According to results, produced hydrogen using alkaline electrolyser had a positive effect on emissions and fuel consumption. However, the rise in NOx emissions with alkaline electrolyser could not be prevented. Nevertheless, by using a three way catalytic convertor or operating engine in extremely lean conditions, the dramatic rise can be prevented.

Keywords: SI engine, hydrogen, NEDC, vehicle model, alkaline electrolyser

ORAL ABSTRACTS

[**Abstract:0154**]

On Vehicle Comparison of Gasoline Fueled SI Engine, Hydrogen Fueled SI Engine and Hydrogen Fueled SI Engine + Microbial Fuel Cell Powered Systems

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In this study, fuel consumption and emission (HC, CO and NOx) values of only gasoline fueled, only hydrogen fueled and hydrogen fueled engine + microbial fuel cell powered system are obtained by a theoretical model. Then, a vehicle model which is developed by Matlab Simulink is applied to a reference light duty vehicle. The reference vehicle is run on WLTC driving cycle. The fuel consumption and HC, CO, NOx emission values obtained with driving cycle data are compared with each other. According to the results, with the use of pure hydrogen in SI engines, a significant improvement is achieved in emissions except NOx. Also, it can be seen that it is possible to meet the micro energy need of the vehicle with the use of energy obtained by microbial fuel cell systems, so decrease in fuel consumption and emission values are acquired. Furthermore, it is foreseen that it is possible to overcome the dramatic increase in NOx emission by working with hydrogen fuel in extremely lean combustion conditions.

Keywords: SI engine, microbial fuel cell, hydrogen, WLTC, vehicle model

[**Abstract:0157**]

Exergy Analysis of A Solar Based Hydrogen Production System

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Hydrogen production can be realized from the variety of sources with different methods due to the ability of hydrogen to exists in combination with both organic and inorganic compounds in form of water, ammonia and hydrocarbon in nature. Considering conventional hydrogen production methods, the full benefits of hydrogen as a clean, versatile and efficient fuel can be revealed providing that it is produced from renewable energy sources. Among these sources, solar energy has prominent advantages to produce hydrogen due to its potential as the most abundant resource on Earth. Therefore, in this study, the performance of a solar based hydrogen production system is analysed and discussed with the thermodynamics approach. In order to perform analysis, a solar photovoltaic (PV) system with 5kWp average peak power and 11.8% average efficiency, consisting of 20 modules connected in series, a DC–DC converter (95% efficiency), a Proton Exchange Mebrane (PEM) electrolyzer (5 kW, 65% average efficiency) is modelled. Each module employed in the present study has a maximum power of 250 Watt (W) and maximum current of 7.88 Ampere (A) as well as a maximum voltage of 31.73 Volt (V). As a result, considering local standard meteorological data, this modeling shows that proposed system can meet energy demand for a residential use, providing the hydrogen production of 1400 Nm^3 in a year, and corresponding to an average efficiency of 4.1% for converting solar energy into hydrogen.

Keywords: Hydrogen production, solar PV, PEM electrolysis, thermodynamic analysis

ORAL ABSTRACTS

[Abstract:0158]

Highly Durable Phosphonated Graphene Oxide Doped Polyvinylidene Fluoride (PVDF) Composite Membranes

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The aim of this study is to increase the proton conductivity of the PVDF membrane by doping phosphonated graphene oxide to its structure and investigate the improvement of the membrane. Before the membrane synthesis process, graphene oxide was phosphonated by phosphoric acid (H_3PO_4, 99.99%) and the phosphonation degree was calculated as 60% phosphonation degree. Afterwards, different amounts of phosphonated graphene oxide (0.5%, 1% and 1.5% w/w) were doped to PVDF on the purpose of synthesizing proton exchange composite membranes. Characterization tests, i. e; water uptake, swelling property, ion exchange capacity, proton conductivity, fuel cell performance of the synthesized membranes were carried out. The proton conductivity values of PVDF composite membranes increased with increasing amount of phosphonated graphene oxide addition. The proton conductivity values of composite PVDF membranes change from $22.4x10^{-3}$ S cm^{-1} (0.5%, w/w, graphene oxide doped) to $86.7x10^{-3}$ S cm^{-1} (1.5 %, w/w, graphene oxide doped). The effect of graphene oxide doping concentration on fuel cell performance was also studied. Membrane electrode assemblies (MEAs) were prepared by gas diffusion layer spraying method. The fuel cell performance experiments were carried out in a stoichiometric H_2-dry air atmosphere at 80 °C. The dry air and hydrogen were humidified before they were fed to the fuel cell. After conditioning of the MEA, the current values were measured at different potentials. The power density values of PVDF/1.5GO and PVDF/0.5GO are 346 Mw cm^{-2} and 323 Mw cm^{-2} at 0.6 V cell potential and 100% relative humidity at 80 °C. The power density and proton conductivity results of the synthesized membranes indicate that phosphonated graphene oxide successfully enhanced the characteristic properties of PVDF for fuel cell applications. The results demonstrate the importance of phosphonated graphene oxide addition on polyvinylidene fluoride composite membrane.

Keywords: Proton exchange membrane, Graphene oxide, polyvinylidene fluoride, PEMFC, Membrane synthesis

[Abstract:0160]

Simplified Model for Stabilized Premixed Flame in Porous Media

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Motivated by the fuel hydrogen applications in porous combustors, as well as hydrogen production in syngas porous devices, this work shows a simplified steady state one dimensional heat and mass transfer model for stabilized premixed flames in porous inert media. The model has three conservation equations, describing the heat transfer in the solid and fluid phases and the mass transfer in the reacting flow. The model considers a plug flow and is solved numerically by using the finite volume method. The results are compared with benchmark data, depicting the superadiabatic flames and the heat recirculation process. A parametric analysis of the model reveals the effects of the porous media and of the Lewis and Peclet numbers on the heat and mass transfer process.

Keywords: Porous media, premixed flame, superadiabatic

ORAL ABSTRACTS

[**Abstract:0161**]

An Overview of Hydrogen as a Fuel for Internal Combustion Engines

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In this study, some prominent fuel properties of hydrogen have been briefly investigated when using it in internal combustion engine vehicles. Three main titles were defined to make this investigation: positive features, negative features, and further developments according to the literature survey. It can be concluded that conventional gasoline and diesel fuels stand for their lower cost properties while hydrogen fuel come to the fore with its unlimited fuel reserves and emission benefits.

Keywords: Hydrogen, vehicles, internal combustion engine.

[**Abstract:0162**]

Hydrogen Evolution Behavor of Nickel coated TiO_2

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In this study, nickel modified titanium dioxide nanotubes (TiO_2-NTs/Ni) and TiO_2-NTs composite electrocatalysts are investigated for hydrogen evolution reaction (HER). TiO_2-NTs are prepared by using anodization method during one and two hours at a constant voltage of 60 V. Small amount of Ni is successfully deposited over TiO_2-NTs via electroplating method. Hydrogen evolution activities of TiO_2-NTs/Ni and TiO_2-NTs are investigated in 1 M KOH solution at room temperature (~25 °C). Characterization of prepared nano-structured electrocatalysts are analyzed with scanning electron microscopy (SEM) and cyclic voltammetry (CV) and electro-activties are determined through cathodic current-potential curves and electrochemical impedance spectroscopy (EIS). Hydrogen volumes of prepared electrocatalysts are also measured under constant voltage of 3 V for 30 min. Obtained results showed that hydrogen evolution activity increased with the modification of TiO_2-NTs by nickel. High current density, hydrogen volume and small polarization resistance are obtained on TiO_2-NTs/Ni. So, TiO_2-NTs/Ni as an electrocatalyst is suggested to use in water splitting.

Keywords: Hydrogen evolution reaction, nickel, titanium dioxide, electrodeposition

[**Abstract:0164**]

Exergy Analysis of Direct Methanol Fuel Cell System

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Direct methanol fuel cells (DMFCs) are a convenient alternative energy conversion device because they can be operated with liquid methanol at low temperatures. Using liquid methanol solution as feed brings important advantages such as easy storage and transportation. However, heat and water management are crucial challenges as well as methanol permeation. The DMFC system that is considered in this study consists of two main parts: DMFC stack and balance of plant components (condenser, pumps, mixing vessel, blower, and methanol tank). This study presents exergy analysis for this system. For this purpose, the thermodynamic properties are conducted in a previous study. Exergy balance equations are applied to the control volumes enclosing the system components. These equations are solved using EES. Finally, exergy destructions of system components and exergetic efficiency of the DMFC system are investigated for variable working conditions.

Keywords: DMFC, DMFC system, exergy, thermoeconomic, cost

[**Abstract:0165**]

The Thermal and Structural Analyzes of Torispherical Head Cryogenic Pressure Vessel For Liquid Hydrogen Using FEA

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In this study, cylindrical cryogenic pressure vessel with torispherical heads has been considered. The vessel is modelled and simulated using Finite Element Analysis (FEA). Structural and thermal analyzes of torispherical head pressure vessel have been done using FEA and temperature distribution, heat flux, structural stress distribution and strains have been invesigated.

Keywords: Pressure vessel, liquid hydrogen, FEA, torispherical head

[**Abstract:0166**]

The Thermal and Structural Analyzes of Torispherical Head Cryogenic Pressure Vessel For Cryo-compressed Hydrogen Using FEA

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In this paper, thermal and structural analyzes of pressure vessel for cryo-compressed hydrogen are presented. Cylindrical with torispherical heads cryogenic pressure vessel is considered. The vessel is modelled and simulated using Finite Element Analysis (FEA). By using FEA temperature distribution, heat flux, structural stress distribution and strains have been investigated.

Keywords: Pressure vessel, cryo-compressed hydrogen, FEA, torispherical head

[**Abstract:0167**]

The Thermal and Structural Analyzes of Elliptical Head Cryogenic Pressure Vessel For Liquid Hydrogen Using FEA

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In this study, thermal and structural analyzes of pressure vessel for liquid hydrogen have been done. Cylindirical cryogenic pressure vessel with elliptical heads has been considered. The vessel is modelled and simulated using Finite Element Analysis (FEA). Temperature distribution, heat flux, structural stress distribution and strains have been investigated using FEA.

Keywords: Pressure vessel, liquid hydrogen, FEA, elliptical head

ORAL ABSTRACTS

[**Abstract:0168**]

The Thermal and Structural Analyzes of Elliptical Head Cryogenic Pressure Vessel for Cryo-Compressed Hydrogen Using FEA

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This paper presents thermal and structural analyzes of cryogenic pressure vessel for cryo-compressed hydrogen. Elliptical head cylindirical cryogenic pressure vessel is considered. The vessel is modelled and simulated using Finite Element Analysis (FEA). Temperature distribution, heat flux, structural stress distribution and strains have been investigated using FEA.

Keywords: Pressure vessel, cryo-compressed hydrogen, FEA, elliptical head

[**Abstract:0170**]

FO-PI Speed Control of the BLDC Motor Which Parameters of the Controller Determined by MSA Optimization and Which Energized by PEM-FC

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Brushless Direct Current (BLDC) motor has high efficiency, high power/volume ratio, low maintenance requirement, stable operation over a wide speed range and similar advantages. Thus, BLDC motors is use in robotic applications, electric vehicles, space technology and many similar fields. If a conventional type of battery is used for energizing a DC motor, these batteries have disadvantages like short cycle life, over-charge and over-discharge sensitivity, and self-discharge. Thus, Polymer Electrolyte Membrane Fuel Cell (PEM-FC) which an energy source that less harmful to the environment, low volume and longer life was used as the power supply of the BLDC motor. The closed-loop control structure which generally used PI type, Fuzzy and ANN based controllers was used for a stable operation of the BLDC motor. Recently, traditional PI controllers have been replaced by Fractional Order PI (FO-PI) controller which has higher performance. Since the parameters of this type controller are difficult to determine analytically, optimization methods are generally used. Moth Swarm Algorithm (MSA) which is one of the new optimization algorithms and which is suitable for controller design is used. Also, the PSO algorithm which commonly used in similar applications is used and the results were compared. After the mathematical model of the PEM Electrolyzer which will provide the required hydrogen to the system was created in MATLAB / Simulink, the PEM-FC model was integrated into the system. The MATLAB / Simulink model of the BLDC motor was added to the system and the system was operated with FO-PI controller as a closed loop for variable speed and torque reference values. The results showed that the BLDC motor, which is energized with PEM-FC, operates as high performance and stable for different speed and torque values.

Keywords: BLDC motor, PEM-FC, PEM electrolyzer, FO-PI, MSA, optimization

ORAL ABSTRACTS

[**Abstract:0171**]

Hydrazine Borane Synthesis for Hydrogen Storage Applications

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Hydrazine borane has recently attracted much attention as a chemical hydrogen storage material owing to its theoretically high hydrogen storage capacity (15.4% by mass) and its stability at optimum conditions. The traditional synthesis method of hydrazine borane involves the reaction of the hydrazine hemisulfate salt and sodium borohydride in dioxane, but the reaction may take a very long time to reach acceptable yields (approximately 3-6 days). Therefore, this study has been focused on the development of the reaction kinetics by increasing the yield and decreasing the reaction time. Accordingly, the amount of the reaction solvent was changed to monitor the yield of hydrazine borane as a function of time. The research work has proved that the amount of the solvent has been one of the critical parameters that influences the rate of a liquid phase reaction and the increase in the amount of the solvent reduced the reaction time by %70-80, while the reaction yield would not be affected so much. In addition to this, the effect of two types of catalysts (TiO_2 and Ru/TiO_2) on the reaction rate and reaction time was examined. Lab tests performed at different temperatures and times demonstrated that titanium dioxide was found to provide the highest catalytic activity in this reaction and the maximum yield of 95% was obtained at room temperature with the presence of TiO_2 catalyst. The results reported here includes the characterization of the synthesized hydrazine borane by using Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Powder Diffraction (XRD) and Nuclear Magnetic Resonance (NMR). Furthermore, the catalytic hydrolysis experiments were conducted to investigate the hydrogen release performance of hydrazine borane by using $RuCl_3$ catalyst. This study also shows how boron-based materials can help hydrogen production to support the development of hydrogen storage applications for low-carbon energy systems.

Keywords: Hydrazine borane, hydrogen, chemical hydrogen storage, hydrolysis

[**Abstract:0172**]

The Stability Region Analysis of Fractional-Order PI Controller for Fuel Cell Micro grid with Time Delay

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Renewable energy sources are often used as an alternative electrical power production unit in a modern power system. The increasing penetration of renewable energy sources has provided many advantages to power systems. However, when these resources are used alone or in conjunction with traditional production units, new problems have emerged, such as whether the system can operate decisively. Therefore, this study focuses on the stability analysis of a fuel cell micro grid with time delay as a realistic case. This paper investigates the delay and fractional integral order(α)-dependent stability of a fractional PI (FOPI) controller fuel cell micro grid system. For this, stability boundary curves are obtained depending on the fractional integral order (α) and time delay (τ) values of the fuel cell micro grid. For this purpose, a graphical-based technique called as the stability boundary locus method is used in the paper to obtain the stable parameters space of FOPI controller gains. Stability of closed region computed on parameters space is determined from roots of characteristic equation of system. Furthermore, the stability of the system that is either under or over the delay margin is examined by generalized modified Mikhailov criterion. The stability results obtained have been confirmed numerically in time domain. It is demonstrated that the proposed controller for delayed micro grid system provides more flexibility on delay margin according to integer-order PI controller.

Keywords: Fuel cell microgrid, fractional order pi controller, stability boundary locus, time delay system, generalized modified Mikhailov criterion

[**Abstract:0173**]

Hydrogen production and storage analysis of a system by using trnsys

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In this study, hydrogen production and storage were investigated. The design and optimization of a system, that produces hydrogen from water and the produced hydrogen is stored in the compressed gas tank, was made by using TRNSYS. Electrical energy produced in photovoltaic panels was used to electrolyze water. The system was simulated for three cities (Istanbul, Izmir, Ankara) located in different climatic zones of Turkey. The electrical energy produced in the photovoltaic panels, the hydrogen and oxygen amounts produced, the efficiency of the electrolyzer, the gas and pressure levels in the hydrogen tank were compared.

Keywords: Hydrogen production, hydrogen storage, TRNSYS

[**Abstract:0174**]

Effect of Channel Depth on Fuel Cell Performance of a Proton Exchange Membrane Fuel Cell with a Serpentine Flow Channel

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A new design of diminishing depth flow field was developed in single serpentine flow field pattern for proton exchange membrane (PEM) fuel cell. The channel depth is varied of inclination from inlet to outlet of the bipolar plate. Single Serpentine with 1mm inlet depth and 0.25 mm outlet depth was produced. These diminishing depth flow field are compared with a conventional single serpentine having 1 mm constant channel depth for an active area of 50 cm^2. Experimental results were showed that the distribution of reactants on the active zone is more hoogenous, the pressure drop is lower relative to standart serpentine, but the ability to drain water is worse than normal Serpentine.

Keywords: Fuel cells, PEM fuel cell, serpentine flow channel

ORAL ABSTRACTS

[**Abstract:0177**]

Eupergit CM Supported Co-Mn-B Nanoparticles as Catalyst for the H_2 Production from NH_3BH_3 Methanolysis

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A high-density and low-cost hydrogen generation technology is required for the hydrogen energy system. Non-noble trimetallic Co-Mn-B nanoparticles can be a good catalyst because of its low cost and its ability to produce hydrogen gas during the catalytic methanolysis process. This work reports the synthesis, characterization, and the use of Co-Mn-B catalyst supported on Eupergit CM (Co-Mn-B/Eupergit CM) as a very active and reusable catalyst for the generation of hydrogen from the methanolysis of ammonia borane (AB). Solid materials were characterized by X-ray Diffraction (XRD), Energy Dispersive X-ray Spectroscopy (EDS) and Scanning Electron Microscopy (SEM). Rates of hydrogen generation were used to determine the kinetics of methanolysis reaction. The parameters examined; the percentage of NaOH, the percentage of the support material, the amount of catalyst particles, the AB concentrations and temperatures were 1-5 wt.%, 5-10 wt.%, 5-50 mg, 0.5-3 mmol and 30-60 °C, respectively. Hydrogen generation rate (HGR) and Ea were obtained at 25 °C as 17324 mLmin-1g-1 (3 mmol AB and 5 mg Co-Mn-B/Eupergit CM) and 43.936 kJmol-1, respectively.

Keywords: Hydrogen generation, ammonia-borane, methanolysis, trimetallic

[**Abstract:0178**]

Synthesis and Characterization of Nanostructured Co-Fe-B Using Different Support Materials for Ammonia Borane Hydrolysis

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This study includes the preparation of Al_2O_3, MWCNT and Eupergit CM supported Co-Fe-B nanoparticles, and investigation of their catalytic activity in hydrogen production from catalytic hydrolysis of ammonia-borane (AB). Characterization of prepared catalysts were obtained by inductively coupled plasma-optical emission spectroscopy (ICP-OES), X-ray powder diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). Co-Fe-B nanoparticles/Al_2O_3, MWCNT and Eupergit CM were prepared in a simple and reproducible way that the typical chemical reduction method during the hydrolysis of AB. Among the support materials Co-Fe-B/Eupergit CM exhibited the high Hydrogen Generation Rate (HGR) as 4538 $mLmin^{-1}g^{-1}$ (1 mmol AB and 40 mg at 25 °C) according to Co-Fe-B/Al_2O_3 and Co-Fe-B/MWCNT, 4373 $mLmin^{-1}g^{-1}$ and 3294 $mLmin^{-1}g^{-1}$, respectively. In addition, in the hydrolysis of an alkaline AB aqueous solution, catalytic properties such as the amount of catalyst, AB concentration and percent metal ratios were investigated using Co-Fe-B/Eupergit CM catalyst. The results displayed that Eupergit CM can be a promising support for promoting the hydrolysis of AB for onsite hydrogen supply.

Keywords: Hydrogen generation, ammonia-borane, hydrolysis, polymer, nanoparticles

[**Abstract:0179**]

CeO_2 Supported Multimetallic Nano Materials as an Efficient Catalyst for Hydrogen Generation from the Hydrolysis of $NaBH_4$

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Metal alloys prepared using suitable support materials are commonly applied in various catalytic reactions. For example, for the dehydrogenation reaction, the efficiency of the release of hydrogen can be significantly increased by the use of the appropriate catalyst. In this study, the dehydrogenation of sodium borohydride ($NaBH_4$) was chosen as a model reaction to study the effect of Co-Cr-B/CeO_2. The catalysts were synthesized by typical sodium boron hydride reduction method and characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM) with energydispersive X-ray (EDX) spectroscopy analysis, X-ray Photoelectron Spectroscopy (XPS), Brunauer–Emmett–Teller (BET) and Fourier Transform Infrared Spectroscopy (FTIR) analysis. The optimized catalyst of Co-Cr-B/CeO_2 exhibited an excellent hydrogen generation rate (HGR) 7835.2 $mLmin^{-1}g^{-1}$ with low activation energy (Ea) of 36.21 kJ mol^{-1}. The strong catalytic performance of Co-Cr-B / CeO_2 is based on the synergistic effect between multimetallic nanoparticles and the effective charge transfer interactions between metal and support.

Keywords: Hydrogen generation, sodium borohydride, hydrolysis, support material

[**Abstract:0180**]

Hydrogen Production by Methanolysis of $NaBH_4$ with a Plasma-Effective Co-Cu-B Catalyst

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Today, there is still no suitable method to store large amounts of energy. Hydrogen can be stored physically in carbon nanotubes or chemically in the form of hydride. In this study, sodium borohydride ($NaBH_4$) was used as the source of hydrogen storage. The alcoholysis reactions of $NaBH_4$ have faster reaction kinetics. Therefore, the hydrogen release reaction was carried out in methanol solution by Co-Cu-B catalyst. In the study, an inexpensive and useful catalyst was synthesized and characterized by X-ray Diffraction (XRD), Energy Dispersive X-ray Spectroscopy (EDS), Scanning Electron Microscopy (SEM), Brunauer–Emmett–Teller (BET) and Fourier Transform Infrared Spectroscopy (FTIR) to produce hydrogen from $NaBH_4$ in the reaction with methanol. In addition, after synthesizing the catalysts, the catalytic activity was increased by irradiation in the plasma and microwave effect. It was determined that the plasma medium is more active on hydrogen production rate.The maximum hydrogen production rate in the presence of 2.5 wt.% $NaBH_4$ is 110 mL $g^{-1}min^{-1}$ for catalyst irradiated in the plasma. In addition, it was observed that the activation energy of the catalyst irradiated in the plasma (Ea= 38.95 $kJmol^{-1}$) was significantly lower than the non-irritable catalyst (Ea=68.18 $kJmol^{-1}$).

Keywords: Hydrogen generation, sodium borohydride, methanolysis, plasma

ORAL ABSTRACTS

[**Abstract:0183**]

Modelling and Simulation of a Hybrid Electric Air Vehicle

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Aviation industry is facing off an electric propulsion generation depending on higher fuel consumption thus; energy researches on aviation have turned to renewable energy sources providing electric propulsion. Fuel cells are one of the most popular power sources for electric vehicles in terms of being greener, more reliability and higher efficiency. Among fuel cells, the most attractive option for flight is polymer electrolyte membrane fuel cells (PEMFC) due to low operation temperatures, partly higher power density, rapid response to load changes, good load following ability, and short warm-up time. This paper aims to generating a dynamical control of conceptual a hybrid system on a lightweight aircraft for more electric aircraft concept. For this purpose, first, conceptual a hybrid propulsion system was designed for the prototype aircraft. The fuel-cell hybrid system which proposed for this paper is consists of PEMFC with hydrogen gas tank, a pack of Lithium-ion (Li-ion) batteries, brush-less dc motors and dc/dc converters. Secondly, the hybrid system modeled with MATLAB / Simulink program and analysis were done for as hydrogen consumption, the state of charges of the batteries, the overall system efficiency etc. As a result, this study contributes to the literature especially subjects in hybrid electric aircraft's modelling and controlling manner, for more electric aircraft researches.

Keywords: Hybrid electric aircraft, PEMFC, li-ion battery, modelling, simulation

[**Abstract:0184**]

A Solar Air Heating System Integrated with Hydrogen Energy for Low Energy Buildings

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In order to meet international obligations on greenhouse emissions, countries need to decarbonize the supply of heat and electricity. Decarbonizing heating is considerably more difficult than decarbonizing the electricity grid. One of the solutions is the use of hydrogen energy in space heating. Residential fuel cells appear to be ideally suited for use in micro-combined heat and power applications in buildings. In these applications 3 to 10kW electricity can be generated by a fuel cell, and the produced heat can be used to cover part of the buildings heat demand. However, mostly electricity-led mode of operation results in a low thermal output from fuel cell heating systems. The remaining heat requirement of the building should be covered by an additional heating system, preferably from another renewable source such as the Sun. In general, there are two options for solar heating systems; one system is water-based i.e. hydronic, using radiators or coils in a concrete slab. The other system is air-based and would consist of a solar air heater, fan and thermal storage. However, despite their high thermal efficiency, solar air heating systems are not considered in most of the studies because of their low popularity. This study included a review of solar air heating technologies that can be combined with fuel cells which are particularly suitable for buildings with a low space heating requirement, such as low-energy or nearly zero-energy buildings.

Keywords: Solar air heating, fuel cells, low-energy building

ORAL ABSTRACTS

[Abstract:0185]

Evaluation of Hydrogen Production in Electrodialysis Process Treating Industrial Saline Wastewater

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In this study, industrial saline wastewater with different initial pH (3, 5, 7, and 8) values are treated with the bipolar membrane electrodialysis (BPMED) process while producing acid and base, simultaneously. The hydrogen production capacity of the BPMED process is evaluated to reduce system energy requirement and system operational cost. Na2SO4 solution (0.1 M) is used as an electrolyte at the anode and the cathode compartments to supply conductivity between anode and cathode compartments. The rates of hydrogen production for the various system operating conditions are evaluated both energetically and exergetically to monitor the effect of system variables on the wastewater treatment efficiency and hydrogen production. Regarding to BPMED process operational conditions, the best desalination results are obtained while the pH of wastewater is adjusted to 8. At this point 96% desalination, 6% energy and 0.2% exergy efficiencies are obtained when the initial pH of the wastewater adjusted to 8. The hydrogen production rate is calculated as 11.6 mmole/h with a 100% Faraday efficiency.

Keywords: Electrodialysis, saline wastewater, hydrogen production, energy recovery, efficiency

[Abstract:0187]

Hydrogen and Chlorine Productions with Electrolysis of Waste Acid and Base Generated in Metal Plating Industry

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Hydrochloric acid and sodium hydroxide solutions are polluted with iron and aluminum in metal plating industry and generally they are neutralized to discharge. In this paper, a new electrochemical reactor using anion exchange membrane which allows the cathode and the anode to operate simutaniously in acidic and alkaline conditions without any catalysts is designed, built and tested to treat polluted HCl and NaOH while producing H_2 at the cathode and Cl_2 at the anode. Although anion exchange membranes exhibit excessive hydrophilicity, a pretreatment and perselectivity of Cl^- at the anode with 1 M of NaCl and NaOH improves the permselectivity with Cl_2 and H_2 current efficiency of 59.3% and 93%, respectively. The electrochemical reactor yields current densities of 2.8-17 mA/cm^2 using TiO_2 nanoparticles coated on the anode. Also, the overall energy and exergy efficiencies are 49% and 78% for acidic medium, 37% and 63% for the alkaline medium, which contributes to a practically feasible electrochemical process. Also the maximum hydrogen production is 28 ml/min while chlorine gas production is 4 ml/min.

Keywords: Hydrogen, chlorine, energy and exergy analysis, acid and base treatment

ORAL ABSTRACTS

[**Abstract:0192**]

Advantages of Microwave Environment From Non-Applied Microwave Environment By Catalytic Effect of Ni-B Catalyst Production of Hydrogen from Sodium Boron Hydride

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In this study, in the microwave environment of nickel boron catalyst was studied to produce hydrogen generation from the hydrolysis of the sodium borohydride solution to release H_2. The catalytic activity of the Ni-B catalyst for the experiments was measured by hydrogen production from the hydrolysis of sodium borohydride. The catalytic properties of the Ni-B catalyst applied in the microwave environment were investigated on the basis of NaOH concentration, $NaBH_4$ concentration, amount of catalyst and the relationship between the temperature and the microwave power. As a result, the hydrogen production experiments of hydrolysis of sodium borohydride solution made with Ni-B catalyst both in external and microwave systems were compared. In the experiments, in the microwave system, the best result was the release of hydrogen gas from the Ni-B catalyst by applying 100 watts of microwave energy at 40 °C. Non-applied microwave, the production of hydrogen from the Ni-B catalyst was completed in 60 minutes, while the production with microwave energy was completed in only 15 minutes. Microwave energy is a high frequency, very short wavelength electromagnetic wave, composed of electric and magnetic fields, emitted by magnetron and klystrons. Because of this feature, microwave energy was caused by the effect of water on the dipole moment and increasing the activity of the catalyst. In addition, the microwave energy and the Ni-B catalyst resulted in lower activation energy for the production of hydrogen from the hydrolysis of sodium borohydride.

Keywords: Sodium borohydride, nicel-boron catalyst, hydrolysis, hydrogen generation

[**Abstract:0193**]

The Catalytic Effect of Co-La-Cr-B Catalyst on the Release of Hydrogen in $NaBH_4$ solution

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Catalyzers are generally used in reactions which are operated to manufacture products in chemical industry. The main reason for this is that the reactions of the catalyst are realized in a shorter time, with higher efficiency and less energy consumption. In the current century, one of these sources, which can be used in the future and is environmentally-friendly, is hydrogen. One of the basic parameters that determine the efficiency of hydrogen production and reaction process by hydrolysis of sodium boron hydride is the type of catalyst. The hydrolysis of sodium borohydrate are a catalytic reaction and the speed of the hydrogen produce depends on the amount of the catalyst, the temperature and the NaOH concentration in the solution environment, so all these parameters need to be examined separately. In this study, a new synthesized Co-La-Cr-B catalyst was used for the production of hydrogen from sodium boron hydride. In addition, BET surface analysis, SEM, EDS and XRD characterizations of these catalysts were examined. It was determined that the Co-La-Cr-B catalyst was hydrogenated in 40 minutes by hydrolysis of sodium boron hydride in the presence of 2.5% NaOH, 2.5% $NaBH_4$ at room temperature. In the current century, one of these sources, which can be used in the future and is environmentally-friendly, is hydrogen. This reaction is a catalytic reaction and the speed of the hydrogen produce depends on the amount of the catalyst, the temperature and the NaOH concentration in the solution environment, so all these parameters need to be examined separately.

Keywords: Sodium borohydride, La, Co, hydrolysis, hydrogen generation, catalyst

[**Abstract:0195**]

Production of Electricity Production from Methane by Microbial Fuel Cell System

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In recent years, the increase in the use of fossil fuels to meet energy needs has accelerated environmental problems, and the demand for renewable energy sources and technologies has gradually increased. In the Microbial Fuel Cells (MFC) used for renewable energy recovery, the amount of electricity produced has not yet reached the desired levels. Besides the treatment of wastewater, MFC is the system where electricity energy is produced simultaneously. A classical MFC consists of two compartments, the anode and the cathode, and the proton exchanger membrane separating these two compartments. MFC is a device that converts chemical energy from organic compounds, such as simple carbohydrate or organic waste materials, to electricity by using bacteria as biocatalyst. Among natural resources, oceans, termites and wetlands account for about 36% of global CH_4 emissions. Methane is a raw material that is easily produced from both natural and anthropogenic sources. The remainder of the CH_4 emission (64%) is mainly anthropogenic, including the use, production and transport of fossil fuels. In addition, small amounts are released from various sources such as agriculture, landfills and dairy farms. Due to these uses, the atmospheric CH_4 levels have doubled over the last 150 years. Furthermore, according to the ICCP 5th Assessment Report, the global warming potential of the commodity is 28 times higher than that of carbon dioxide. This has led to the use of natural gas for electricity generation. However, the increase in electricity demand, the current decline in electricity generation, has led to a renewable and sustainable process for CH_4 improvement and appraisal. Therefore, the production of value-added products using CH_4 in place can help minimize losses due to storage leaks and shipping. Methane can be converted to liquid fuels or electricity by conventional technologies such as chemical conversion or gas turbines. These technologies require billions of dollars in capital investment as well as a large area of land for operation. The direct use of CH_4 to generate electricity in fuel cells is challenged due to the high heat treatment (650–1100°C) requirement and the instability of the catalyst. Thus, the biological conversion of CH_4 to methanol, electricity or polyhydroxyalkanoates to value-added products seems to be an interesting and promising option. Therefore, this study provides an overview of the transformation of CH_4 to bioelectricity. A two-stage process, which is based on the conversion of methanol from methane via methanotrope into BMP (Biochemical Methane Potential) bottles and then generating electricity using methane in methanol, will produce a two-stage process that will generate bioelectronics from methane.

Keywords: Microbial fuel cell, methane, renewable energy

[**Abstract:0196**]

Safety Measures for a Weather Forecasting Balloon Filled with Hydrogen

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Hydrogen is one of the cleanest energy carriers that is being considered as a unique solution for sustainable energy production. However, hydrogen is highly explosive, and a careful handling is inevitable. In this study specifications for safety measures are determined considering a meteorological balloon filled with hydrogen gas. Mechanical properties of the balloon are taken into consideration to determine the gas pressure inside. Possible hazards to surrounding buildings and human are evaluated based on phase duration and overpressure. For the considered balloon with 1.6 m diameter filled with more than 170 gr hydrogen, safe distance to prevent buildings and people from minor and major impacts is evaluated to be 8 meters from the balloon center. Inside this range there are risks such as ear and lung blast, and even fatality under certain conditions.

Keywords: Hydrogen, safety, hydrogen explosion, overpressure, phase duration

ORAL ABSTRACTS

[**Abstract:0207**]

Catalytic Performance of Silica Covered Nickel-Iron Bimetallic Core-Shell Microspheres for Hydrogen Production

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Supported nickel-iron catalysts with core/shell structures (Ni-Fe/SiO_2 and Ni/SiO_2-Fe Imp) were synthesized by sol-gel microencapsulation and sol-gel microencapsulation-impregnation methods, respectively. Catalysts were tested in dry reforming of methane (DRM) reaction. This reaction was especially selected to provide a comprehensive utilization of methane and carbon dioxide, which has been investigated systematically. Rapid catalyst deactivation due to carbon deposition was the main problem in reaction [1]. Nickel-based catalysts have been investigated because of their low cost yet high activity but these catalysts were prone to deactivation due to carbon deposition [2]. It was reported that, by coating with mesoporous silica, Ni-based core-shell catalysts showed an improvement in catalytic activity and durability [3,4]. Consequently, in this study, we focused on a core–shell structure, which has Ni-Fe coated with silica layer. Ni coated with Fe containing silica layer was also synthesized for comparison. These catalysts were investigated to determine their effect on improvement of catalytic activity and preventing coke formation. The number of studies reported on the utilization of SiO_2 covered Ni-Fe core-shell microspheres by using these methods were scarce and an important contribution will be provided with this study. The catalytic activity tests were carried out at 750°C and at atmospheric pressure, using a stainless steel, temperature controlled tube reactor. The effects of catalyst compositions (Ni/Fe ratio), comparison of catalyst preparation procedure on the activity and coke formation were investigated. After 3 hours of reaction, Ni-Fe/SiO_2 bimetallic core-shell microsphere catalysts with Ni/Fe ratio of 4/1 and 2/1 indicated the highest CH_4 conversions (74% and 65%, respectively) and H_2/CO (0,72 and 0,69) ratios. Evaluation of XRD, SEM, TGA and Raman spectroscopy analyses revealed comparable [5] suppression of carbon deposition with Fe addition to catalyst structure.

Keywords: Sol-gel microencapsulation, core-shell microspheres, bimetallic nickel- iron, hydrogen production

[**Abstract:0208**]

The Effect of Co-Y Catalyst on Hydrogen Production by Hydrolysis Reaction of Potassium Borohydride

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In this study, hydrogen was produced by hydrolysis of potassium borohydride (KBH_4) using Co-Y catalyst which prepared by chemical reduction of cobalt chloride and yttrium nitrate salts with sodium borohydride. In the hydrolysis of potassium borohydride, the most suitable catalyst composition was determined molar ratio of Co to Y is 1:0.03. The effect of Co-Y catalyst on potassium borohydride hydrolysis was investigated at different temperatures (20-60 °C), catalyst amounts, pH values, and KBH_4 concentrations, separately. The degree of hydrolysis of KBH_4 in the presence of Co-Y catalyst is found 0.9 by using n.th order reaction rate and the activation energy was calculated as 29.87 kJ/mol. The maximum hydrogen production rate in the solution containing 5% NaOH, and 2.5% KBH_4 at 30 °C was calculated 12847 mL H_2.g cat^{-1}.min^{-1}, which is more than 10 times the value of yttrium-free Co catalyst. The results show that the use of Co-Y alloy catalyst increases the rate of production of hydrogen from KBH_4.

Keywords: Hydrogen production, hydrolysis, potassium borohydride, cobalt, yttrium, catalyst

[**Abstract:0211**]

A Study on Hydrogen Generation from $NaBH_4$ Solution Using Co-Loaded Resin Catalyst

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In this work, Co-based complex catalyst obtained by adsorption of Co metal to Amberlite IRC-748 resin was tested for hydrogen production from alkaline $NaBH_4$ via hydrolysis process. Its catalytic activity and microstructure were investigated. Process parameters affecting the catalytic activity, such as NaOH concentration, Co percentage and catalyst amount, as well as $NaBH_4$ concentration and temperature were investigated. Furthermore, characteristics of this catalyst were carried out via SEM, XRD and FT-IR analysis. Hydrogen production rate equal to 21305.4 ml.min-1 gcat-1 could be obtained with this Co based complex catalyst efficiently. The activation energy of the catalytic hydrolysis reaction of $NaBH_4$ was calculated as 462.604 $kJ.mol^{-1}$ from the system consisting of 3% Co, 10 wt% $NaBH_4$ and 7 wt% NaOH as well as 50 mg catalyst dosage. It can be concluded that Co-based resin as a catalyst for hydrogen production is an effective alternative with higher rate.

Keywords: Hydrogen, $NaBH_4$, resin, catalyst

[**Abstract:0212**]

Hydrogen Generation from Hydrolysis of $NaBH_4$ Using Co-Loaded Resin Catalyst

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In this paper, the Co-based complex catalyst obtained by attaching Co to a commercial resin, Dioion CRII, was tested for hydrogen generation from the hydrolysis reaction of sodium borohydride ($NaBH_4$). The hydrolysis of $NaBH_4$ with Co-based complex catalyst was investigated depending on several parameters such as NaOH concentration, catalyst amount, percentage of Co content, $NaBH_4$ concentration and temperature. The obtained complex catalyst was characterized by XRD, FT-IR and SEM techniques and evaluated for its activity for the hydrogen generation from the hydrolysis reaction of $NaBH_4$. The results suggested that the optimal percentage of Co-based complex catalyst is 3% Co. The maximum hydrogen production rate from hydrolysis of $NaBH_4$ with cobalt-based complex catalyst compared to the pure cobalt catalyst is increased from 4416 ml. $min^{-1}.gcat^{-1}$ to 20885 ml. $min^{-1}.gcat^{-1}$. As a result, it can be mentioned that Co-based resin as a catalyst for hydrogen production is an effective alternative with higher rate.

Keywords: Hydrogen, $NaBH_4$, catalyst, resin

ORAL ABSTRACTS

[**Abstract:0213**]

Facile Synthesis of NiPt Bimetallic Nanocatalyst on Hybrid Support Materials for PEMFC Application

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Several chemical synthesis techniques required for the production of PEM fuel cell nanocatalysts use harsh reaction conditions and high amount of reducing agents which are costly and not environmentally-friendly. In this study, platinum-nickel bimetallic nanocatalyst was synthesized without any reducing compound directly on the carbon black (CB) and graphene nanoplatelets (GNP) (50:50) hybrid support material by using a mild organometallic synthesis method. PtNi/CB-GNP nanocatalyst was characterized by using TEM, SEM, XRD, XPS, CV, LSV and PEM fuel cell performance was tested at the cathode. TEM images revealed homogeneous, well-distributed spherical nanoparticles (NPs) were observed on the support with the mean size diameter of 2±0.5 nm. SEM and EDX analyses showed that the nanocatalyst was composed of $Ni_{48}Pt_{52}$. Effective chemical surface area (ECSA) was calculated by using CV curve and mass activity was calculated by using LSV curve where these values were 113 $m2/gPt^{-1}$ and 265 $mA.mg^{-1}Pt$, respectively. Maximum power density was 578 mW/cm^2, which was higher than those of both the model electrocatalyst Pt/CB having the same amount of platinum metal (377 mW cm^{-2}) and the commercial Pt/CB catalyst (40 wt. % Pt) (560 mW/cm^2).

Keywords: Bimetallic nanocatalyst, PEMFC, hybrid support, organometallic synthesis, Platinum, Nickel

[**Abstract:0214**]

Hydrogen Generation from Sodium Borohydride, Ammonia Borane And Their Mixtures Using Ni-B-Zr In-Situ Catalyst

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In this study, catalytic hydrolysis of sodium borohydride, ammonia borane and their mixtures were investigated. In order to catalyze hydrolysis reaction, a novel tri-metallic and in situ produced catalyst is used. Experiments were comprised of two steps. In the first step, diluted $NiCl_{2.6}H_2O$ and $ZrCl_4$ solution in three-neck round-bottom flask on hot plate with constant stirring was reduced with sodium borohydride solution, and thus the catalyst Ni-B-Zr was formed in situ. Then in the second step, more sodium borohydride and ammonia borane were fed to the same reactor at a constant flow rate and hydrolysis reaction took place. Hydrogen generation rates were measured. Experiments conducted in five different reactant ratios (pure $NaBH_4$, pure NH_3BH_3, NaBH4:NH_3BH_3 molar ratio 2, $NaBH_4$:NH_3BH_3 molar ratio 4, $NaBH_4$:NH_3BH_3 molar ratio 8) in order to obtain the effect of ratio of two reactants on hydrogen generation. In addition, all molar ratio experiments were conducted in three different temperatures (25°C, 35°C, 45°C) and activation energies were calculated. According to those experiments, sodium borohydride/ammonia borane molar ratios of 4 and 8 provide higher rate and yield compared to pure sodium borohydride and pure ammonia borane at 25°C and 35°C. Moreover, as temperature increases, reaction rate and percent yield was increased. At 45°C and sodium borohydride/ammonia borane molar ratio 4, 93,6 % yield was achieved. Activation energies of hydrolysis reactions of pure $NaBH_4$, pure NH_3BH_3, $NaBH_4$:NH_3BH_3 molar ratio 2, $NaBH_4$:NH_3BH_3 molar ratio 4, $NaBH_4$:NH_3BH_3 molar ratio 8 are calculated as 45.23 kJ/mol, 69.04 kJ/mol, 33.84 kJ/mol, 41.35 kJ/mol, 25.21 kJ/mol, respectively.

Keywords: Dehydrogenation, catalytic hydrolysis, ammonia borane, sodium borohydride, kinetics

[Abstract:0217]

Low Cost Preparation of Bimetallic PtCu Nanoparticles Supported with Graphene Nanoplatelets and Carbon Black Hybrid as an Effective Electrocatalyst for PEM Fuel Cells

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Polymer electrolyte membrane fuel cells (PEMFC) are a promising solution for a clean and sustainable electricity source. Fuel cells directly convert the chemical energy of oxygen and fuel to electricity and release heat and water as the only by-products. However, PEMFCs are not extensively commercialized due to their cost and stability issues. The preparation of an ideal low-cost electrocatalyst in terms of electrocatalytic activity, selectivity, and stability is vital for the development of the fuel cell applications. In this regard, we reported a facile direct synthesis at low temperature and solid-state of a novel binary $Cu_{58}Pt_{42}$/CB-GNP NPs to be utilized as electrocatalysts for oxygen reduction reaction (ORR) at the cathode in PEMFC. TEM results displayed very small, homogeneous and well-dispersed NPs on the hybrid support with the mean size diameter of 1.7 nm and 2.5±0.3 for Pt/CB-GNP and $Cu_{58}Pt_{42}$/CB-GNP, respectively. Electrocatalysts were also characterized by XRD, XPS, EDX and CV techniques. Electrochemically active surface area (ECSA) studies indicated better activity for $Cu_{58}Pt_{42}$/CB-GNP electrocatalyst with $101 m^2 g^{-1}$Pt compared to that of Pt/CB-GNP with $55 m^2 g^{-1}$Pt where platinum was used as the only metal a monometallic electrocatalyst. In parallel, with the addition of Cu, ORR mass activity of $Cu_{58}Pt_{42}$/CB-GNP increased at least three times compared to that of our model monometallic electrocatalyst, Pt/CB-GNP, from 120 mA mg^{-1} to 392 mA mg^{-1}.Unlike the electrochemical activity, slightly lower PEM fuel cell performance of $Cu_{58}Pt_{42}$/CB-GNP (power output: $303 mWcm^{-2}$) compared to that of Pt/CB-GNP (power output: $377 mWcm^{-2}$) shows the corrosion effect of copper on the hybrid support. We believe that further optimization of such bimetallic electrocatalyst in an attempt to lower the corrosion in the system and increase the catalytic activity is necessary to achieve low cost PEMFC catalysts.

Keywords: Platinum, copper, bimetallic, PEM fuel cell, Vulcan XC-72, graphene nanoplatelets

[Abstract:0220]

Preparation of GO Based Co-Cu-B and Investigation of Hydrogen Production Performance

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In this study, GO based Co-Cu-B nanocatalysts were produced to catalytic efficiency of hydrogen generation from $NaBH_4$ hydrolysis reaction. The characterization was achieved by SEM, XRD, BET and ICP-OES analysis. Co-Cu-B/GO trimetallic nanoparticles provide an initial hydrogen production rate of 12440 $mL g^{-1} min^{-1}$ (3 wt% $NaBH_4$) and activation energy 36.76 $kJmol^{-1}$ at room temperature that shows higher catalytic activity than most of the recently reported noble metal based a heterogeneous catalyst that is used in the reaction of hydrolytic dehydrogenation of sodium borohydride. The excellent hydrolysis performance of Co-Cu-B/GO can be attributed to both synergistic effect and high surface area of graphene oxide. The development of efficient and low-cost Co-Cu-B/GO catalysts enhances the applicability of sodium borohydride as a chemical hydrogen storage material, which may find application in a hydrogen fuel-cell based economy.

Keywords: Hydrogen generation, sodium borohydride, hydrolysis, graphene oxide, nanoparticles

ORAL ABSTRACTS

[**Abstract:0222**]

Al_2O_3-Supported Nanoparticles for Catalyzing The Hydrolysis of Ammonia Borane

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Al_2O_3 supported multimetallic nanoparticles were prepared through chemical reduction and investigation of their catalytic activity in hydrogen production from catalytic hydrolysis of ammonia-borane (AB). The morphology and microstructure of the nanocomposite were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), inductively coupled plasma-optical emission spectroscopy (ICP-OES) analysis. Compared with unsupported (560 $mLg^{-1}min^{-1}$) Co-Cu-B particles, this nanocomposite 10 wt% Al_2O_3 supported (7000 $mLg^{-1}min^{-1}$) Co-Cu-B showed greatly increased catalytic activity for ammonia borane hydrolysis. The maximum hydrogen production rate was obtained 14000 $mLg^{-1}min^{-1}$ at a temperature of 60 degrees. A low activation energy of was obtained; this energy is much lower than those reported previously. The simple preparation method and excellent performance of this catalyst make it promising for on-demand hydrogen generation for fuel cells.

Keywords: Hydrogen generation, ammonia-borane, hydrolysis, Al_2O_3

[**Abstract:0226**]

Dark Fermentative Biohyrdogen Production From Thermal Pretreated Wastewater Treatment Sludge

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The study aimed to determine the significant factors that affect biohydrogen production from wastewater treatment sludge by dark fermentation. The waste aerobic sludge was first pretreated than the products of pretreatment as solid phase (sludge) and liquid phase (filtrate) were subjected to dark fermentation for biohydrogen production. Heat pretreatment was applied to waste sludge and the conditions were optimized by using 3 level-2 factor factorial statistical experimental design method. The factors were hydrolysis temperature (T=60°C, T=100°C and T=135°C) and the hydrolysis period (t=30 mins, t=45 mins and t=60 mins). The initial aerobic waste sludge concentration was 33±1 g L^{-1} (in dw). COD, TOC, total sugar, NH_4N, PO_4P and protein concentrations before and after pretreatment were determined. The average organic matter concentrations in the liquid phase were TS=54 mg L^{-1}, COD=750 mg L^{-1} and TOC=193 mg L^{-1} before the pretreatment and they increased to COD=9800 mg L^{-1}, TS= 1338 mg L^{-1} and TOC=2300 mg L^{-1} after heat application at T=135°C for t=60 mins. The high hydrolysis temperature (T=135°C) affected the NH_4N concentration negatively. Protein concentration was substantially affected by hydrolysis tempertaure and period. It reached to maximum level (1 g L^{-1}) at T=135°C and t=60 min. Statistical analysis of the results indicated both tempereture and hydrolysis period are significant and they have positive effect on the concentrations of organic substances and protein. The hydrogen production results were evaluated in terms of yield and rate. The maximum yield in the filtrate was 12.1 mmol g^{-1} glucose (300 ml g^{-1}glucose^{-1}) when sludge was hydrolyzed at t=45 min and T=60° C. The highest yield from sludge was 10 mmol g^{-1} glucose^{-1} (248 ml g^{-1} glucose^{-1}) obtained form the sludge hydrolyzed at T=60°C and t=60 min. The yield of hydrogen formation in filtrate was higher in most of the cases compared to that of sludge.

Keywords: Biohydrogen, dark fermentation, waste sludge, pretreatment.

ORAL ABSTRACTS

[Abstract:0229]

PEM Fuel Cell Performance with Solar Air Preheating

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Proton Exchange Membrane Fuel Cell (PEMFC) have proven to be a promising energy conversion technology in various power applications and since it was developed, it has been a potential alternative over fossil fuel-based engines and power plants, all of which produce harmful by-products. The inlet air coolant and reactants has an important effect on the performance degradation of the PEMFC and certain power outputs. In this work, a theoretical model of a PEM fuel cell with solar air heating system for preheating PEM fuel cell to mitigate the performance degradation when the fuel cell operates in cold environment, is proposed and evaluated by using energy analysis. Considering these heating and energy losses of heat generation by hydrogen fuel cells, the idea of using the transpired solar collectors (TSC) for air preheating to increase the inlet air temperature of the low-temperature fuel cell could be a potential development. The aim of the current article is applying a method for solar air preheating for the hydrogen fuel cells system combined with the TSC and analyzing the system performance. Moreover, deployment of solar air heating together with hydrogen fuel cell systems could be useful for coping with fossil fuel based power supply systems.

Keywords: PEM fuel cells, fuel cell air preheating, solar air heating, transpired solar collectors, low-temperature fuel cell

[Abstract:0230]

Performance Assessment of Geothermal Power System Design for Hydrogen Generation and Liquefaction

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Due to increasing energy consumption of humankind new technologies start to be necessary in order to meet increasing needs. The multigeneration systems offer high performance and efficiency compared to traditional energy systems. Because of the importance as future energy carrier of hydrogen, it is selected for the main product of proposed multigeneration system. The useful products of proposed multigeneration system are hydrogen, electricity, heating and cooling, drying and hot water. The aim of this study is to investigate the performance assessment of geothermal power system targeting hydrogen production and liquefaction. To determine the performance of the proposed multigeneration system, thermodynamic analysis and parametric analyses have been performed to multigeneration system and its sub-systems. The overall energy and exergy efficiencies of multigeneration system have been found as 38.41% and 42.57%, respectively. Moreover, parametric analyses show that how variables affect the system performance.

Keywords: Geothermal energy, hydrogen, liquefaction, thermodynamic.

ORAL ABSTRACTS

[**Abstract:0231**]

Thermodynamic Analysis and Assessment of a Combined Biomass Gasification-SOFC Plant for Compressed Hydrogen Generation

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Because of the advantages of hydrogen as energy carrier, hydrogen production and storage are getting more importance. Hydrogen is a clean alternative if only it is produced from renewables. This study presents a comprehensive thermodynamic analysis and assessment of a combined biomass gasification-solid oxide fuel cell plant for hydrogen production and compression. Integrated energy system consists of the biomass gasification unit, solid oxide fuel cell, fresh water unit, proton exchange membrane electrolyzer, hydrogen compression unit and Rankine cycle. The useful products of proposed integrated energy system are the electricity, hydrogen, cooling-heating and fresh water. To investigate the thermodynamic performance and efficiencies of proposed system, the energy and exergy analyses have been performed. To determine the effects of some variables, parametric analyses have been utilized. According to the analysis results, the overall energy and exergy efficiencies of proposed integrated system have been found as 56.17% and 52.83%, respectively. In addition, the parametric analysis results indicate that the most effective parameters on system performance are the gasifier and combustor temperature.

Keywords: Biomass gasification, SOFC, compressed hydrogen, thermodynamic.

[**Abstract:0233**]

Biomass Gasification Modeling by Aspen Plus Within Waste-to-Energy Concept

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Thermal methods have gained value due to it's increasing development and rapid applications. Further more, with the development of computer-aided modeling applications these technologies are becoming widespread all across the world. Aspen Plus is widely used by both researchers and commercial firms in the design of gasification processes. The aim of this study is to investigate the gasification performance of various waste types with the Aspen Plus software program, which works on the principle of thermodynamic equilibrium. The most important step in the study is the monitoring of the gas form and the optimization of the hydrogen gas, which constitutes the content of the synthesis gas produced, which are rich in thermal value. As a result of the gasification of the selected waste types, the variety of the products obtained and the composition of these products were analyzed and the thermal value of the synthesis gas obtained was calculated. It has been determined that H_2 gas is formed in the range of 22-55% and thermal value is between 2000 and 2900 kcal/m^3 depending on the characteristics of selected wastes.

Keywords: Hydrogen, gasification, waste-to-energy, Aspen modeling.

ORAL ABSTRACTS

[**Abstract:0235**]

Investigation of the Effects of Dry Air and Pure Oxygen on Gasification Products

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The aim of this study is to investigate the effect of the gasification agent's flow rate, and agent types on the gasification performance using the Aspen Plus software program, which works on the principle of thermodynamic equilibrium. Further more, depending on agent flow rate and the type of the synthesis gas produced from agent types; the monitoring of the gas forms that are rich in thermal value, as well as the calculation and making comparisons of thermal value of the synthesis gas obtained are significant focal points of this study. Thus, from the result obtained in this work, it was determined that working under the same conditions, and same flow rates of the agent, the thermal value and the synthesis gas content, reached higher values when pure oxygen was used as the agent and with the increases of agent flow rate, it was observed that the synthesis gas yield and thermal value decreased. In the study, at the intervals where the agent flow rate was 0.005 L/h, it was found that the volume of hydrogen gas reached 60% and the thermal value to 3000 kcal/m^3.

Keywords: Hydrogen energy, gasification, waste-to-energy, Aspen Plus, modelling.

[**Abstract:0240**]

Selection and Prioritization of Fuel Cell Types for Propulsion Systems of Small Unmanned Aerial Vehicles

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The use of UAVs for military, civil and scientific purposes is increasing rapidly all over the world, so it is thought that this issue will create more agenda in the coming years. The propulsions of the UAVs used for this purpose are generally provided by electric motors. Although power is supplied to the motors by the batteries, the performance of the batteries is not at the desired level. Fuel cells are the best solution to this problem for now. Since there are different types of fuel cells, it is an important decision problem, which is more suitable for use in UAVs. Fifteen criteria under the three main criteria and six fuel cell type alternatives form the structure of this decision problem. In order to solve the problem, AHP is used in multi-criteria decision making methods. Analytic Hierarchy Process is used as a multi-criteria decision making method in the solution of the problem. As a result, Polymer Electrolyte Membrane Fuel Cells (PEMFC) were found to be the most suitable fuel cell for use in Small UAVs.

Keywords: Fuel cell, unmanned aerial vehicles, multi criteria decision making, analytic hierarchy process

ORAL ABSTRACTS

[**Abstract:0241**]

Performance Analysis of a Hydrogen Fuel Cell Hybrid System for Unmanned Aerial Vehicle

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This paper presents performance analysis of unmanned aerial vehicle (UAV), which has hydrogen fuel cell hybrid system (HFCHS) as a power source. Hydrogen fuel cell hybrid system consists of a polymer electrolyte membrane fuel cell (PEM-FC) stack, 7S LiPo battery, an external hybrid circuit and 2L hydrogen cylinder with pressure regulator. Conceptual UAV is designed based on weight, volume, energy and power limitations of HFCHS. This paper describes UAV's design and components selection. Furthermore, flight performance measurements and ground tests have been done. The results of this study will be used to improve and retrofit for UAV design and HFCHS integration for long endurance UAV applications.

Keywords: Fuel cell, hydrogen, hybrid power system, unmanned aerial vehicle, electric propulsion

[**Abstract:0242**]

Investigation of Hydrogen Gas with Graphical Method

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It is the absolute thermodynamic temperature scale that forms the basis of all scientific temperature measurements. The temperature scale developed by Lord Kelvin shows the minimum temperature that can be physically reached and the point where atoms can no longer move. This point represents the absolute temperature of 0 K, which means the beginning of the temperature scale (-273.15°C). Absolute temperature is considered to be the most appropriate scale for the construction of physical theories. Kelvin applied (P-T), V=const. or (V-T), P=const. graph to the gas phase of a matter to determine absolute temperature and reported the presence of a fundamental point in the solid phase of the substance. In practice, hydrogen is taken as a thermometric gas with international agreement, and hydrogen is used in the gas thermometer as a temperature scale. By using the ideal gas equation, it is possible to say the empirical temperature scale to the scale generated for hydrogen.

In this case, two issues need clarification.

1. Why did Kelvin apply (P-T), V=const. or (V-T), P=const. graphs to the gas phase of matter to determine absolute temperature?
2. Is it reasonable to use hydrogen gas in the gas thermometer as the temperature scale to determine the absolute temperature?

Keywords: Absolute temperature, hydrogen, graphical method, gas phase, gas thermometer

ORAL ABSTRACTS

[**Abstract:0243**]

Development and Performance Assessment of Parabolic Collector Based Combined System for Compressed Hydrogen Production

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In this study, the multi-generation energy system is designed and integrated with the solar collector cycle, distillation cycle, hydrogen production and compression cycle, Kalina cycle, organic Rankine cycle and ejector cooling cycle for power, heating-cooling, hot water and compressed hydrogen. In this study, the multi-generation energy system is designed and integrated with the solar collector cycle, distillation cycle, hydrogen production and compression cycle, Kalina cycle, organic Rankine cycle and ejector cooling cycle for power, heating-cooling, hot water and hydrogen. Also, the hot and cold thermal energy storage sub-systems are connected with the integrated system for continuously useful outputs production aim. The Engineering Equation Solver is employed as a software tool for solar plant modeling. The whole system energetic and exergetic efficiency of integrated system are calculated as 59.34% and 56.51%, respectively. In addition to that, different additional outputs about the plant efficiency are defined, submitted and discussed in this study.

Keywords: Multigeneration, compressed hydrogen, integrated energy system, solar energy.

[**Abstract:0244**]

Adsorption Kinetics of Methane Reformer Off-Gases On Aluminum Based Metal Organic Framework

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Aluminum based metal organic frameworks (Al-TPA) are synthesized with solvothermal and hydro-solvothermal methods. The Al-TPA produced by solvothermal synthesis has the highest surface area (1270 m^2/g). Diffusion of Steam Methane Reformer off gas components on the Al-TPA was carried out at different flow rates (80, 168 and 175 mL/min), temperatures (34, 70 and 100 °C) and concentrations (15 and 28%). The high value of parameter L demonstrated that the system was under kinetic control. The diffusivity values were found to be ranging from 5.73×10^{-13}-8.04×10^{-13} for CO_2, 5.03×10^{-13}-6.64×10^{-13} for CH_4, 1.36×10^{-12}-1.56×10^{-12} for H_2 and 1.01×10^{-13} -5.03×10^{-13} m^2/g for CO respectively with increasing temperature.

Keywords: Adsorption, hydrogen, diffusion, MOF

ORAL ABSTRACTS

[**Abstract:0246**]

Methane Decomposition over Fe-Based Catalysts

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Due to CO_x free product gas, catalytic methane decomposition can be considered as a promising process for hydrogen production. In the present study, catalytic methane decomposition was performed using Fe-based catalysts, and catalytic tests were carried out in a tubular reactor at 500 mL/min flow in the temperature range of 700-850 ˚C. Reaction products were analyzed by a mass spectrometer. All catalysts were prepared via sol-gel method, and yttria (Y_2O_3) and alumina (Al_2O_3) were used as support material. Fresh and spent catalysts were characterized with X-ray powder diffraction (XRD), scanning electron microscopy (SEM), temperature programmed reduction (TPR), thermogravimetric Fourier transform infrared spectrometry (TG-FTIR) and Brunauer, Emmett and Teller (BET) surface analysis techniques. In the presence of Fe_2O_3/Y_2O_3 and $Fe_2O_3/Y_2O_3/Al_2O_3$ catalysts, methane conversions of 29% and 4% were achieved at the temperature of 750 ˚C. Adding alumina into Fe_2O_3/Y_2O_3 catalyst leads to the formation of garnet type crystal structure which reduces catalytic activity.

Keywords: Methane decomposition, hydrogen production, catalyst

[**Abstract:0247**]

Synthesis of Monodisperse CoPt/KB Nanocomposites and Their Catalytic Performance in the Dehydrogenation of Ammonia-Borane

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Hydrogen has been considered as one of the best alternative energy carriers to satisfy the increasing demand for an efficient and clean energy supply [1]. Although hydrogen has been used as energy carrier in some daily life applications, safe storage and controlled delivery of hydrogen is still the biggest challenge in front of hydrogen economy. Various scientific approaches have been developed to overcome these hurdles; among these approaches, chemical hydrogen storage is the most promising and applicable for on-board systems[1, 2]. Among the chemical hydrogen storage materials, it can be concluded that ammonia borane (AB, H_3NBH_3) is one of the most promising hydrogen storage materials owing to its advantageous properties such as being stable, high solubility (33.6 g H_3NBH_3/100 g H_2O) [3], and non-toxic[4] along with its high hydrogen content (19.4 wt.%). AB is a highly stable compound in aqueous solution and, therefore, a suitable catalyst is needed to dehydrogenate it and release 3 moles of hydrogen gas per one mole of AB. In this study, we report the synthesis of monodisperse nanoparticles (NPs) and their catalytic activity in the hydrolytic dehydrogenation of AB for use in chemical hydrogen storage. This is the first example of synthesis of CoPt alloy NPs, their assembly on a commercially available high surface area Ketjen Black (KB), and catalysis of yielded KB-CoPt nanocatalyst in the hydrolytic dehydrogenation of AB at room temperature. The KB- CoPt nanocatalyst showed high activity in hydrogen generation form the hydrolysis of AB. The catalyst was characterized by using X-ray diffraction (XRD), transmission electron microscopy (TEM), X-Ray Photoelectron spectroscopy (XPS), inductively couple plasma mass spectrometer (ICP-MS).

Keywords: Alloy nanoparticles, ammonia-borane, hydrogen storage

ORAL ABSTRACTS

[**Abstract:0249**]

Hydrogen Economy and Energy Use Efficiency of Rice Production in Turkey's İpsala Region

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Because of industrialization and increse of the population rate energy consumption also increasing day by day.Generally,energy demand comes from fossil fuel oriented energy.But, in this case we have two problems one is that kind of energy is going to finish in the next coming years and the other is terrible environmental pollution which nowadays we see it as a climate problems. Hopefully,today all researchers related to the energy subject deals with renewables energy sources and especially hydrogen economy.Rice cultivation requires intensive workmanship and technology. Most of the enterprises used in rice farms are small size.We can apply an economic policy to adjust the pattern of rice farmland use to attain sustainable development. In 2020, the rice trade volume is expected to reach 41 million tons and 30% more than in 2006.In this regard,1.5 billion hectares of agricultural land around the world, approximately 160.26 million area of rice farming is done as of 2011. The main purpose of this study was to measure technical energy efficiency and investigate factors affecting technical energy inefficiency of rice production level in Turkey. In this respect, for the sustainable development we propose to use hydrogen energy in rice production as an input for renewable energy source as technical efficiencies especially Ipsala town in Edirne /Turkey.

Keywords: Trakya area, hydrogen economy, renewable energy, Turkey, rice.

[**Abstract:0250**]

Hydrogen Production and Storage in Natural Gas Pressure Regulation Stations

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After the producing of the natural gas, which is one of the energy sources and classified as fossil fuels, natural gas compressor stations are pressurized. At these stations, natural gas coming from high pressure is reduced to the appropriate pressures by means of expansion valve and by reducing the pressure to 12-19 bar. Since this reduction is carried out under the influence of Joule-Thomson, there is no energy generation during the process, so that a considerable amount of electrical energy can be wasted. In this study, instead of expansion valve to type A pressure reduction stations, expansion turbine which can install to radial type flow rates is considered. Using the energy generated by the expansion turbine, hydrogen production and storage by the electrolysis of water is considered. It is intended to provide electricity to the system at appropriate time intervals using PEM fuel cells.

Keywords: Hydrojen, turboexpander, PEM, storage

ORAL ABSTRACTS

[**Abstract:0252**]

Experimental Investigation of Hydroxyl Gas Production by Using Distilled and Ultra-Pure Water

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In recent years, the development of hydrogen energy, which has widespread use in alternative energy sources, has gained a great importance. In addition, many studies are being carried out to obtain high yields in hydrogen production and to determine the optimum parameter values. Two sets of experiments are carried out in the scope of this research. An equal amount of KOH (25% m/m) was used in both experiments to observe the effect of the liquid electrolyte. During the first set, standard water distillation unit was used to produce water at a certain level purity. Second set of experiments was obtained by using high quality ultrapure water. Temperature range was same and experiments conducted between ambient temperature and 80°C. The electrochemical differences and electric conductivities affected the amount of hydroxyl gas produced. A dry cell is used which consisting of 13 plates and with 196 cm^2 surface area each. A 24 volts 30 amperes power supply was used to create electrical potential difference. All data recorded to an ELIMCO P100 brand Data Logger simultaneously. Results showed that there were differences in the heating times and the amount of HHO produced. The results showed that the first electrolyte type was absorbed the heat more than the other but the average HHO production amount was 26% higher. However, in both case, production efficiency has decreased between 70-80 degrees.

Keywords: Ultra-pure water, hydrogen, electrolyte, electrolysis, dry cell

[**Abstract:0253**]

CoRh Thin Coatings as Electrochemically Active Materials for Hydrogen Evolution Reaction in Alkaline Solution

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Electrodeposition of thin films of CoRh alloys and their catalytic properties were studied. The cyclic voltammetry measurements using glassy-carbon electrode were conducted to determine the deposition parameters of the alloys. Fabrication of the alloys was performed from chloride solutions on the copper substrates. The different composition of coatings was achived by applying the different deposition potentials in the range from -0.5 to – 0.9 V vs SCE. Obtained alloys were characterized by the X-ray fluorescence technique and their crystalline compositions were determined by X-ray diffraction. SEM observations with EDS analysis allows to characterization the morphology of the coatings. The hydrogen evolution activities of the electrodes were examined in an alkaline solution (6 M KOH) by the current-potantials curves (Tafel) and electrochemical impedans spectroscopy (EIS) techniques.The SEM results showed that the surface morphologies of electrodes were changed by the applied different potantials. by the comparing with the copper, lower hydrogen onset potential and charge transfer resistance as well as higher current density were observed at all prepared electrodes.

Acknowledgements

This study was supported by the Polish National Center of Science (NCN) under grants: 2016/21/N/ST8/00222. The e-Minds training schools of COST Action MP1407 (trainee scholarship D.K, A.S, A.M.K, K.K-S) are appreciated for providing extensive knowledge on basics and current research concercing electrochemical processing methods.

Keywords: Electrodeposition, cobalt-rhodium alloys, hydrogen evolution, noble metals alloys

ORAL ABSTRACTS

[**Abstract:0254**]

Pd Activated Binary MoCu Electrocatalysts for Alkaline Water Splitting

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The binary MoCu coatings were electrochemically fabricated on carbon felt (C) substrates and activated with Pd. The fabricated electrodes were characterized using scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX) techniques. The water splitting activity of the electrodes was investigated in 1 M KOH solution with the help of cathodic current-potential and electrochemical impedance spectroscopy (EIS) measurements. It was found that porous, homogenously distributed and adherent Pd could be fabricated over the formerly coated binary MoCu layers. Electrochemical measurements showed that the co-deposition of small amounts of Mo and Cu exhibits good hydrogen production activity in alkaline solution. On the other hand, modifying the surface with a small amount of Pd enhances water splitting activity. The water splitting activity and stability of the Pd activated binary CuMo electrocatalysts were assigned to enlarged real surface area, synergistic effect between the metals and good surface structure.

Acknowledgments: The author is greatly thankful to Bingöl University Scientific Research Projects Coordination Unit for financial supporting. The author also would like to thank to Bingöl University Central Laboratory for characterization measurements and Chemistry Department for electrochemical measurements.

Keywords: Hydrogen energy, electrolysis, carbon felt, electrochemical deposition, Pd-activated MoCu electrocatalyst

[**Abstract:0262**]

A Policy on Sectoral Hydrogen Energy Utilization

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The main objective of this study is to develop a policy on the sectoral hydrogen energy utilization. For this purpose, it is assumed that hydrogen from non-fossil fuels are used in various sectors as arranged below. In this regard, the following important impact ratios have been defined and are taken into consideration for calculating the sectoral hydrogen utilization impact ratio: i) Residential hydrogen utilization impact ratio, ii) Industrial hydrogen utilization impact ratio, iii) Hydrogen utilization impact ratio in transportation, iv) Agricultural hydrogen utilization impact ratio, v) Technological hydrogen utilization impact ratio, vi) Non-energy hydrogen utilization impact ratio, vii) Total hydrogen loss ratio. Considering these impact ratios, renewable hydrogen-based-sectoral energy sustainability is parametrically investigated. Consequently, the utilization of hydrogen from non-fossil fuel sources increases the renewable hydrogen-based-sectoral energy sustainability and reduces the harmful effects resulting from the fossil fuels consumption. The main findings are really encouraging in a way that renewable hydrogen utilization appears to be one of most significant players for better sectoral energy sustainability.

Keywords: Renewable hydrogen, sustainability, residential hydrogen utilization, industrial hydrogen utilization, agricultural hydrogen utilization, technological hydrogen utilization.

ORAL ABSTRACTS

[**Abstract:0263**]

Microstructural Investigation of Electrospraying Parameters in LSCF Films Coated on GDC Electrolyte

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Intermediate temperature solid oxide fuel cells (IT-SOFC) require an effectively functioning cathode layer whose performance depends largely on their microstructures. Thin cathode layer deposited on dense Ce0.9Gd0.1Ox (GDC) provides improved electrochemical performance. Further improvements are possible when the microstructure is designed to optimize both the oxygen reduction reaction (ORR), triple phase boundaries (TPB) and the diffusion pathway for fast ion diffusion through the cathode layer. Electrolytic spray deposition (ESD) method is employed in this study to investigate how electrospraying parameters affect cell performance. Factors like nozzle to electrolyte distance, applied voltage, feed rate, solution concentration are investigated to optimize the desirable microstructure. Via ESD, a wide range of layers can be obtained. Since microstructures of coated layers have a great impact on SOFC performance, optimum deposition morphology must be found to improve SOFC performance. In this study, gadolinium doped ceria substrates are deposited with a polymeric precursor of LSCF symmetrically. The use of new type of solvents in precursor solution lead to promising results on microstructure of deposited layer.

Keywords: ESD, electrospray deposition, SOFC, cathode, electrolyte, thin film

[**Abstract:0274**]

Effect of Ultrasonic Frequency on Sonic Hydrogen Production

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Sonoreactors are still designed and optimized for conventional and large scale operation. Hence, the aim of this article is to ultimately provide guidelines for the design of sonoreactors that can operate in a stable and safe manner using a wide range of operating conditions for the sake of producing hydrogen. The acoustic pressure distribution is one of the most important parameters that affect the efficiency of the sonoreactor for hydrogen production which is rarely considered in the literature. Results showed that the maximum magnitude of negative pressure takes place in the range of 60 to 80 kHz, this means more bubbles will be formed within this range and consequently more hydrogen will be produced. Varying the ultrasonic frequency results in altering the wave interactions and hence the acoustic pressure and the sound pressure levels. The results of this research provides some useful guidelines for acoustic field design of high-intensity ultrasonic apparatus.

Keywords: Ultrasonic hydrogen production, sono-hydro-gen, sonochemistry, power ultrasound

ORAL ABSTRACTS

[Abstract:0275]

KBH_4 Hydrolysis Reaction for Hydrogen Generation via Palladium Complex Catalyst

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Hydrogen generation and storage methods that based on the solid materials have been thought as one of the best way to carry out the hydrogen-based energy systems. Alkali (Li, Na and K) metals have the capacity to be developed as borohydrides, $M(BH_4)n$, hydrogen production and storage material. Due to high activation energy and enthalpy of $NaBH_4$ in hydrogen generation system, the scientists begin to research different borohydrides. In this area KBH_4 provides the desired conditions among the most notable nominees to meet expectations with the high gravimetric hydrogen capacity as exceeds 7.4 % H and the good hydrolytic characteristic. This work reports the studies conducted on the synthesized of 5-Amino-2, 4-dichlorophenol-3, 5-ditertbutylsalisylaldimine-Pd complex as a catalyst in KBH_4 hydrolysis for H_2 production. Pd-Schiff Base complex catalyzed KBH4 hydrolysis was studied in different experimental set-ups that can be defined as concentration of KBH_4, concentration of KOH, temperature, percentage of Pd complex and amount of catalyst. Also the catalyst was caracterized with several analysis methots Finally the kinetic calculation of potssium borohydride hydrolysis reaction were studied at 30 ℃-50 ℃ and it seen that Pd(II)-Schiff Base complex was an effective catalyst for KBH_4 hydrolysis reaction.

Keywords: Complex, H_2 generation, KBH_4

[Abstract:0276]

Performance of Zn-Schiff Base Complex Catalyst in $NaBH_4$ Hydrolysis Reaction

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Hydrogen is a wonderful energy source and a notable clean energy carrier, attracting great interest all over the world. In addition, it is able to reduce greenhouse gas emissions with H_2 using as fuel in effective fuel cells. That's why to improve the hydrogen economy, scientists make an effort to find effective hydrogen storage materials with provide safe and green hydrogen production techniques. Recently, H_2 is mainly stored in a lot of form like metal hydrides, liquefied hydrogen, organic hydrides, etc. $NaBH_4$ is considered to be the most studied chemical due to its non-flammability, high hydrogen capacity (10.8%) and occurred non-toxic products in hydrolysis reaction. It was indicated that the hydrogen generation from sodium borohydride with reaction (1): This study presents results from investigation of, synthesis of 4,4-methylenebis(2,6-diethyl)aniline-3,5-di-tert-butylsalisilaldimine-Zn complex and its used as a catalyst for $NaBH_4$ hydrolysis to H_2 generation. Zn(II) complex catalyzed $NaBH_4$ hydrolysis reaction was investigated based on different temperatures and different material concentration. Additionally the kinetic parameters were studied and it seen that Zn(II)-Schiff Base complex was highly efficent catalyst in $NaBH_4$ hydrolysis to H_2 generation.

Keywords: $NaBH_4$, schiff base complex, H_2

[**Abstract:0283**]

Synthesis and Hydrogen Storage Performance of Zn Doped MWCNTs

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Hydrogen storage is still one of the most important problems to improve hydrogen energy usage widespread. New materials capable of storing hydrogen with high efficiency have to be introduced to overcome this problem. In recent years, metal addition to multiwalled carbon nanotubes (MWCNTs) has been generally used for hydrogen uptake studies to enhance adsorption property of the nanotubes. In this study, Zn doped MWCNTs have been produced as new reversible hydrogen storage materials, and we have investigated characteristics of the nanotubes by SEM, XRD, TEM and BET analysis. Then, Zn doped MWCNTs were subjected to hydrogenation step by Sieverts like apparatus under pressure of 5 to 50 bar. The hydrogen uptake capacities of sample under different pressure were measured gravimetrically. Consequently, the hydrogen uptake of the sample was achieved to be 2,7091 wt% under pressure of 50 bar as maximum.

Keywords: Hydrogen storage, Zinc nanoparticles, multi walled carbon nanotubes,physical adsorption

[**Abstract:0283**]

Synthesis and Hydrogen Storage Performance of Zn Doped MWCNTs

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Hydrogen storage is still one of the most important problems to improve hydrogen energy usage widespread. New materials capable of storing hydrogen with high efficiency have to be introduced to overcome this problem. In recent years, metal addition to multiwalled carbon nanotubes (MWCNTs) has been generally used for hydrogen uptake studies to enhance adsorption property of the nanotubes. In this study, Zn doped MWCNTs have been produced as new reversible hydrogen storage materials, and we have investigated characteristics of the nanotubes by SEM, XRD, TEM and BET analysis. Then, Zn doped MWCNTs were subjected to hydrogenation step by Sieverts like apparatus under pressure of 5 to 50 bar. The hydrogen uptake capacities of sample under different pressure were measured gravimetrically. Consequently, the hydrogen uptake of the sample was achieved to be 2,7091 wt% under pressure of 50 bar as maximum.

Keywords: Hydrogen storage, Zinc nanoparticles, multi walled carbon nanotubes,physical adsorption

ORAL ABSTRACTS

[Abstract:0286]

A New Approach to Improve the Performance of PEM Fuel Cells: APTES Polymer Modification of the Catalyst Layer

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The increasing energy demand has made alternative and renewable energy resources important in recent years. Polymer electrolyte membrane (PEM) fuel cells are one of the most popular alternative energy conversion devices. This study provides innovative approaches to improve the performance of fuel cells. Water management is a very important issue for fuel cells. In particular, the excess water produced in the cathode electrode adversely affects the fuel cell, causes mass transfer limitations and water flooding in the electrode. For this reason, the surface was improved by adding the 3-aminopropyl triethoxysilane (APTES) polymer to the catalyst layer of the PEM fuel cell. Prepared gas diffusion electrodes were physically characterized by SEM, FTIR and contact angle measurements and electrochemically characterized by cyclic voltammetry and PEM fuel cell tests.

Keywords: PEM fuel cell, APTES, water management, catalyst layer

[Abstract:0288]

An Investigation on $CoCl_2$ Activated Hydrogen Generation by Hydrolysis of MgH_2 for Portable Applications

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Hydrogen as a form of clean energy fulfil the expectations with its unique features in terms of high-power density, renewability, environmental protection and many developed countries actively deploy hydrogen-based energy strategies. Hydrogen generation based on the hydrolysis of metal hydrides is an interesting issue due to provide pure hydrogen gas production for energy systems. Among metal hydrides, magnesium hydride (MgH_2) is one of the few that meet the hydrogen delivery criteria of DOE. Hydrolysis of MgH_2 in presence of water and activating agent presents 6.5 wt.% high hydrogen capacity. During hydrolysis reaction, the surface of MgH_2 particles are passivated by formation of by-product $Mg(OH)_2$ that has low solubility in water and leads to decrase in hydrogen generation rate and incomplete of reaction. In present study, cobalt chloride ($CoCl_2$) was used to overcome this problem for activating hydrogen generation by hydrolysis of MgH_2. The hydrolysis of MgH_2 particles efficiently performed without any pre-treatment of hydride particles. Variety of aqueous $CoCl_2$ solutions (2.5-10 wt. %) were tested and theoretical amount of hydrogen generation achieved in presence of all $CoCl_2$ solutions. The addition of $CoCl_2$ improved the hydrogen generation kinetics and led to faster hydrogen generation. The experimental results indicated that 6.25 wt. % $CoCl_2$ solution activated MgH_2 particles and led to relased hydrogen with 18.55 ml $min^{-1}g^{-1}$ reaction rate at room. The change in $CoCl_2$ concentration after this value did not showed significant improving effect on hydrogen generation rate.The hydrolysis of MgH_2 was also performed at different temperatures (293-363 K) to see its effect on hydrogen generation. It was found that 6.25

Keywords: Magnesium hydride, hydrogen generation, hydrolysis, cobalt chloride

ORAL ABSTRACTS

[**Abstract:0289**]

Prevention of Substrate And Product Inhibitions by Using a Dilution Strategy During Dark Fermentative Hydrogen Production from Molasses

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Substrate and product inhibitions in dark fermentative hydrogen production significantly affect microbial activity. Especially fast formation of volatile fatty acids (VFA) reduces the pH to undesired levels. Therefore, strategies for VFA inhibition has great importance to maintain effective hydrogen production. In this context, VFA inhibition was tried to be eliminated by applying a dilution regime during the fermentation period. Box-Behnken statistical experiment design was established to analyze the effects of dilution time, dilution percentage and substrate concentration on hydrogen formation rate and yield. Maximum hydrogen yield (7.7 mL H_2/mLreactor) and rate 21. 47 mL H_2/h were obtained when 85 gCOD/L initial substrate concentration was subjected to 130% dilution at the third hour after the start of fermentation. A relevant dilution at a proper time enables the prevention of substrate and product inhibition and enables to work at higher sugar concentrations than 20 g/L.

Keywords: Dark fermentation, molasses, hydrogen, dilution strategy, product inhibition, substrate inhibition

[**Abstract:0293**]

Exergoeconomic Comparison of Various Geothermal Driven Power and Hydrogen Production Plants

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Geothermal energy is a sustainable source of energy to extract useful heat or power by considereding varius types of heat engines. Most of the geothermal power applications are in form of single flash power generation. Many other types have recently been proposed for more efficienct power generation. Cheap electricity proce and free fuel in geothermal driven power plants make them feasible options for hydrogen generation via electrolysis. In this paper three geothermal power plant configurations are integrated to PEM electrolysers and their thermal and economic characteristics are investigated. Binary plant shows the highest thermal efficiencies while lowest hydrogen cost belongs to single flash driven hydrogen plant.

Keywords: Hydrogen, geothermal, exergoeconomics, binary, single flash, double flash

ORAL ABSTRACTS

[**Abstract:0294**]

Effect of Hydrophobic PDMS-OH/CTAB Catalyst Layer Coating on Water Management in PEM Fuel Cell

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Improving some points in PEM fuel cell, which is a clean energy conversion device that converts directly chemical energy into electrical energy, will help to increase energy efficiency of these systems. Water management is one of these important points and still challenging issue for PEM fuel cells. There must be a sensitive water balance in PEM fuel cell system in order to maintain simultaneously both polymer membrane humidification and prevention of water flooding especially at the cathode electrode side. Generally hydrophobic materials have been mostly used in PEM fuel cell components for the facilitation of excess water removal. In this study, three hydroxyl terminated polydimethylsiloxane (PDMS-OH) chemicals having different viscosities were combined with cetyl trimethylammonium bromide (CTAB) surfactant to form a hydrophobic coating on catalyst layer. With this hydrophobic coating, it is thought that water management and thus fuel cell performance will be enhanced.

Keywords: Water management, hydrophobic, PDMS-OH, CTAB, PEM fuel cell

[**Abstract:0296**]

Performance Assessment of Boron Thermochemical Cycle for Hydrogen Production

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This study deals with a thermodynamic performance assessment of Boron thermochemical cycle for hydrogen production and examine the exergy efficiency of the thermochemical cycle based on complete reaction. Additionally, a parametric study of considered thermochemical cycle was conducted to determine the how the overall cycle performance is affected by changing the reference environment temperature and operating conditions. In this regard, the exergy efficiencies of the cycle are calculated and presented and also inlet, outlet exergy rates and exergy destruction rates are calculated and given for various reference environment temperatures. The results show that Boron thermochemical cycle offers a good potential due to exergy efficiencies based upon the conditions and parameters considered. In this regard, this cycle appears to be a promising thermochemical cycle which can be performed on-board of a vehicle if the technical and economic problems of the hydrogen storage and transportation find a possible solution.

Keywords: Boron, exergy, hydrogen production, thermochemical cycle

ORAL ABSTRACTS

[**Abstract:0298**]

Effects of PPy and PDMS Polymers Addition on GA as Electrical Conductivity and Hydrophobicity Improvment Agents

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Pt and Pt-based alloys are the most widely used catalysts in PEM fuel cells. However, limited resources and high cost of the Pt have resulted in forcing researchers to develop different catalyst materials. Another issue that needs to be considered about PEM fuel cell is the removal of excess water produced from the reaction at the cathode electrode side. Hydrophobic materials are preferred for easy removal of the liquid water. In this study, the graphene aerogel (GA) catalyst support material was modified with polypyrrole (PPy) and polydimethylsiloxane (PDMS) polymers in order to improve battery performance by means of increasing both electrical conductivity and hydrophobicity. The fewer amount of Pt catalyst may be used with this performance improvement way.

Keywords: Graphene aerogel, hydrophobic, polypyrrole, polydimethylsiloxane, PEM fuel cell

[**Abstract:0302**]

Satellite-Based Remote Sensing of Tropospheric Methane in Trakya Region

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Earth observation is a hot topic and it is becoming more efficient with the advanced satellite systems provided by the number of governmental and private companies. It is feasible to make atmospheric observations with these advanced professional devices and methods. In this paper, we have studied methane gas observation in troposphere that is the initial part of the atmosphere. We have selected methane gas due to the fact that hydrogen gas can be produced from the methane gas. The conversion of methane to hydrogen also positive contribution to the climate change. We have focused our studies over the Trakya region of Turkey. Two different satellites used in this study. One in situ data also have been used for the validation of results. All three observations acknowledge the sufficient amount of methane within Trakya region.

Keywords: Satellite observation, atmosphere condition, remote sensing, methane monitoring, hydrogen production.

ORAL ABSTRACTS

[Abstract:0303]

Comparisons between Natural Gas Carriers on Energy Consumption and Economic Analysis: LNG, Ammonia and Methanol

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In this paper, liquified natural gas (LNG), ammonia and methanol as natural gas energy carries are compared for long distances based on total energy consumption and cost analysis taking State of Qatar as case study. Producing LNG consumes lower energy compared to the other energy carries, hence liquefied form of natural gas is widely used for storing and transporting natural gas. However, storing and transporting of LNG are energy intensive specifically for long distances. Therefore, alternative energy carriers such as ammonia and methanol are studied for transporting energy to overseas. There are three plants considered for this study in Qatar: QatarGas produces LNG, QAFAC produces methanol and QAFCO produces ammonia. For the energy and cost analysis, the energy required to produce, to convert, to store and to ship LNG, ammonia and methanol is compared to evaluate which energy carrier has the lowest energy requirement and cost. Knowing the full supply chain for LNG, ammonia and methanol in regards with the cost and energy requirement will allow to perform an optimization for shipment of energy to overseas. The optimization formula is related to the market price of LNG, ammonia and methanol. For example, when the selling price of ammonia is higher than LNG and methanol per unit, greater amount of natural gas can be supplied to ammonia factory to increase the ammonia production, which results in higher profits. The optimization process on the three energy carriers will meet the Qatar National Vision 2030 for linking the industries to increase the country's income.

Keywords: LNG, ammonia, methanol, energy consumption, cost analysis.

[Abstract:0308]

Synthesis and Characterization of Co-doped CeO_2 Ceramic Electrolyte For IT-SOFC

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Ce0.8-x-yLa0xGdyO_2 nanocrystallline powders prepared via hydrothermal method. Phases indentification have been made X-ray diffraction, SEM-EDX, thermal and impedance analysis. XRD data show that all powders were obtained with cubic fluorit structure. When the surface images were examined, it was seen that the particle sizes were in micron scale. Impedance measurements of the pelletized sample were made. Increased conductivity value with increasing temperature. According to the findings obtained, the degree of electrical conductivity was low for applications in medium temperature solid oxide fuel cells.

Keywords: CeO_2, solid electrolyte, intermediate temperature solid oxide fuel cell

ORAL ABSTRACTS

[**Abstract:0309**]

Determination of Hydrogen and Methane Production from Biological Sludge Based on Energy Equivalence and Environmental Impacts

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Hydrogen is one of the significant promising green energy sources due to its end products as water and heat. In this study, energy conversion and sustainability of the bio-hydrogen and bio-methane production processes from biological sludge is investigated. Therefore, primary and waste sludge are used as substrate in dark fermentation and methanogenic fermentation. Theoretically, it is possible to produce 2 or 4 mol of hydrogen per mol glucose according to butyric acid and acetic acid pathways. However, COD removal and sludge stabilization cannot be achieved with only dark fermentation. Thus, two-stage of methanogenic fermentation supported after dark fermentation process can provide sludge stabilization and theoretically it has more energy potential per unit substrate. Biological hydrogen potential and methane potentials are determined with *Clostridium sp*. dominated mixed culture and granular sludge respectively. In that purpose, hydrogen and methane production of primary and waste sludge with two stage fermentation and direct methanogenic fermentation processes are compared due to energy feasibility, carbon footprint and treatment efficiencies.

Keywords: Bio-hydrogen, dark fermentation, sludge stabilization, anaerobic treatment

[**Abstract:0312**]

Evaluation of a Wind Energy Based System for Co-Generation of Methanol and Hydrogen Production

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A novel idea of wind energy based methanol and hydrogen production is proposed in this study. The designed system comprises of the major subsystems of wind turbines, proton exchange membrane (PEM) fuel cell, methanol production system and distillation unit. The Engineering Equation Solver (EES) and Aspen Plus are utilized for system modeling and comprehensive analysis. The proposed system is also investigated to operate under different wind speeds and different wind turbine efficiencies. Designed integration covers all the electric power required by the system. The industrial flue gas including CO_2 reacts with hydrogen to produce methanol. The designed system produces both methanol and hydrogen simultaneously. For the performance indicator, efficiencies of the overall system are calculated. The exergetic efficiency is found to be 41.9% while energetic efficiency is determined to be 43.7%. Furthermore, some parametric studies are conducted to investigate the distillation column performance, methanol and hydrogen capacities and exergy destruction rates.

Keywords: Wind energy, methanol, proton exchange membrane electrolyzer, hydrogen, energy

ORAL ABSTRACTS

[Abstract:0313]

Exergy Analysis of the Scimitar Engine at Mach 5

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Aviation is a fast growing industry and passengers demand reduced flight times. The Scimitar engine is an advanced hybrid propulsion system which can operate at a turbofan mode between 0.0-2.5 Mach speed, switching to a ramjet + air-turbo-rocket mode between 2.5 and 5 Mach and to an air-turborocket mode at Mach 5 during supersonic cruise. This engine is derived from the Synergistic Air-Breathing Rocket Engine, and it is expected to transform the aviation sector dramatically with its hypersonic cruise capability. Scimitar engine is a three-fluid system in which air and hydrogen are used as the oxidant and fuel, respectively, while helium is utilized to transfer heat from the hot incoming air after leaving intake to the hydrogen fuel. At design conditions, the engine produces a propulsive power of approximately 260 MW comparable to a medium sized thermal power plant, and determining the exergetic performance and the ways to improve the performance for such a system is a necessity. In this study, we performed a novel component-based and global exergy analysis for the Scimitar engine at Mach 5. We also investigated the effects of cruise speed and altitude together with air and fuel mass flow rates on the exergy efficiency of the engine. It is found that the combustion chamber is responsible for 51.95% of the overall exergy destruction at nominal operating conditions, the cruise speed has a significant impact on the exergetic performance of the engine and the exergy efficiency decreases by 3% with an increase of 0.2 Mach in cruise speed.

Keywords: Scimitar engine, hydrogen fuel, exergy efficiency, thermodynamic analysis

[Abstract:0314]

Solar-Driven Hydrogen Production and Injection in Lake Salt Natural Gas Storage Caverns

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This study deal with the integration of a solar-driven hydrogen production system with a conventional natural gas underground storage cavern located in Lake Tuz, Turkey. The primary focus is to transfer excess daytime photovoltaic overload to the electricity grid, to produce hydrogen as an energy carrier. The present study aims at developing a hydrogen storage system in the selected field and also to eliminate risks associated with sulphate or sulphur reducing bacteria in underground salt caverns. Bifacial photovoltaic modules and a megawatt-scale Proton Exchange Membrane (PEM) electrolyzer are considered as the hydrogen production system. Bifacial photovoltaic modules, conventional modules, different tilt angles, and different types of fields are considered as optimization parameters to be compared by their electricity and hydrogen production performance. The optimum photovoltaic modules, orientation, and field have been used in the case study that contains 3 MWp capacity bifacial photovoltaic plant. This plant supplies electricity to a region with 425 households (4270.5 MWh average electricity consumption per year). Excess electricity has been used in a 2 MW capacity PEM electrolyzer unit. Thereafter, obtained hydrogen has been mixed with natural gas whether for injecting to the underground storage caverns or to the pipelines. Results show that of 88.6 tonnes of hydrogen is produced by 2 MW capacity PEM electrolyzer unit.

Keywords: Bifacial photovoltaic, energy storage, hydrogen, natural gas, salt cavern, underground energy storage

ORAL ABSTRACTS

[**Abstract:0315**]

Feasibility of Biological Hydrogen and Alcohol Production from Sunflower Straw

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Lignocellulosic biomass consists mainly agricultural and forestry residues which are considered to be the most abundant, economical and substantial feedstock for renewable energy production. Therefore, it has low cost and does not compete with food chain and animal feed. Lignocellulosic biomass includes high amounts of carbohydrates, cellulose and hemicelluloses, which can be converted into various forms of energy such as bioethanol, biobutanol, biohydrogen and biogas. The amount of the cellulose and hemicellulose varies according to the type of material used. Sunflower straw has approximately 30% cellulose, 15% hemicellulose and 30% lignin content, making it a very suitable resource for energy production. Before hydrogen and alcohol production, pre-treatment methods which relatively increase the cost of manufacture processes should be applied to disrupt the complex structure of lignocellulose and convert the carbohydrate polymers into fermentable sugars. Although the pretreatment stages may seem to cause extra costs, agricultural wastes are the most feasible feedstock because of being a very cheap source, having a high energy potential, and the greenhouse gas emissions that are emitted to the environment are much lower than the fossil sources. This study evaluates that it is more feasible to produce hydrogen or to produce alcohol from lignocellulosic wastes in terms of environmental impact, energy efficiency and economics.

Acknowledgment

This study was supported by the Scientific Research Projects Coordination of Yıldız Technical University. Project number: FCD-2019-3544.

Keywords: Lignocellulose, biohydrogen, bioethanol, biobutanol, theoretical energy potential

[**Abstract:0316**]

Analysis of an Integrated System for Ammonia Production from Renewable Hydrogen in Istanbul

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This study presents an analysis and assessment investigation of an integrated system which has cryogenic air separation unit, polymer electrolyte membrane electrolyzer and reactor to produce ammonia in Istanbul, Turkey. A thermodynamic analysis of the proposed system illustrates that electricity consumption of PEM electrolyzer is 3411 kW and 585.5 kW heat is released from ammonia reactor. The energy and exergy efficiencies of the plant are found as 35.06% and 61.16%, respectively. The parametric studies are conducted to find out the effect of inlet air properties and ambient conditions on the system performance. The system has a capacity of 0.22 kg/s ammonia production. The mass flow rate of inlet air has a significant effect on ammonia production with respect to the variation of generated nitrogen.

Keywords: Ammonia, renewable hydrogen, electrolyzer, cryogenic air separation, energy, exergy

[**Abstract:0317**]

Analyses of an Ocean Current and Wind Energy Based Hydrogen Production and Desalination

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In this study, ocean current turbines and off-shore wind turbines are employed to produce electricity, hydrogen and fresh water. Fresh water and hydrogen are obtained by reverse osmosis unit and electrolysis process by employing produced electricity through current and wind turbines located in Bosphorus, Istanbul. Hydrogen storage and transportation options are discussed in terms of their costs. Parametric studies are conducted to evaluate the system with different variables including the turbine velocity, turbine blade radius, ocean, and wind velocities. The main purpose of this system is to provide a sustainable and renewable energy based system. This provides diversity in electricity production and safeguards the security of electricity supply. The overall energy and exergy efficiencies are calculated as 52.14 and 44.77%, respectively.

Keywords: Current energy, desalination, hydrogen, ocean, reverse osmosis, wind energy

[**Abstract:0318**]

Biohydrogen Production From Cotton Straws Using Different Pretreatment Methods: A Case Study

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A large quantity of agricultural biomass, which has a high bioenergy potential, is generated in Turkey after harvesting of main crops as stalks, straw, stems and leaves. Cotton straws, one of the mostly produced agricultural wastes in Turkey, are getting attention by not be consumed as animal feed or an industrial stock. Also there is a huge potential in the utilization of cotton straw biomass as a source of clean energy. This paper presents a case study which focuses on different types of pretreatment methods for conversion of cotton straw to sugar. By this way, biohydrogen potential of cotton straws was calculated as ~2100 kilotons H_2. This paper offers a concise scenario which contributing cotton straws in sustainable and renewable energy production.

Keywords: Agricultural wastes, cotton straw, pretreatment methods, biohydrogen potential

ORAL ABSTRACTS

[**Abstract:0321**]

Performance Assesment of Hydrogen Production with Iron Based Chemical Looping Fed by Coffee Waste

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In this study, iron-based chemical reactions looping fed by coffee waste is investigated and evaluated for hydrogen production thermodynamically. The system consists of four reactors, a torrefier, a drying chamber, an air separation unit, a heat exchanger, and auxiliary units as well. The dried and torrified coffee waste by the drying chamber and torrefier is sent to reactors to produce hydrogen. The energy and exergy efficiencies of the system are investigated as 75% and 59%, respectively. Entropy generation and exergy destruction rates are also evaluated. The highest entropy generation and exergy destruction rates are found out as 4670 kW/K and 116.7 MW for reactor 2, respectively. Under steady – state conditions, 8kg/s hydrogen can be produced via chemical reactions looping.

Keywords: Hydrogen production, iron based, chemical looping, coffee waste, exergy, energy

[**Abstract:0322**]

Development of an Integrated Ocean Thermal Energy Conversion Based Trigeneration System for District Cooling, Ammonia and Power Production

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In this study, a novel Ocean Thermal Energy Conversion (OTEC) based tri-generation system that produces ammonia, cooling and power is developed and energetically analyzed. The OTEC plant operates on the temperature differences that are inherently available in some geological locations in various oceans to drive an ammonia Rankine cycle. In this system, however, a two-stage Rankine cycle was used for power production, along with an Electrolytic Cation Exchange Module (E-CEM) for carbon dioxide and hydrogen production to feed the ammonia production system. The maximum net power output of the cycle was found to be 51.5 GW, with a fixed rate of district cooling of 69.0 GW. The maximum ammonia production rate was found to be 1.6 kg/s at a power input of 51.5GW. Three different cases for the overall energy efficiency were performed. Case 1: E-CEM reactor operates at its current efficiency with fuel production and district cooling being the only products, Case 2: E-CEM reactor operates at Proton Exchange Membrane (PEM) electrolyser efficiency, and Case 3: Only power was produced with no fuel. The maximum overall energy efficiency of the cycle was found to be 8.0, 8.7, and 7.3% for cases 1, 2 and 3, respectively.

Keywords: OTEC, ammonia, hydrogen, district cooling

ORAL ABSTRACTS

[Abstract:0323]

Conceptual Development and Analysis of Integrated Gas-Cooled Fast Nuclear Reactor and Copper-chlorine Cycle for Electricity and Ammonia

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This paper conceptually develops and analyses an integrated electricity and ammonia production system that is powered mainly by one of the latest nuclear Generation IV reactors, which is the gas-cooled fast nuclear reactor. The main components of the integrated system, other than the nuclear reactor, are an electro-thermochemical water splitting cycle, a four-step copper cholorine cycle, an ammonia production system, and a Rankine cycle. The electricity generated by the integrated system is produced by the Rankine cycle and the gas turbine, through which compresed superheated gas expands. The hydrogen produced from splitting water through the copper cholorine cycle is converted to ammonia. The proposed integeated system takes advantage of the recently proposed ammonia production system operating at a temperature around zero degrees celcius. The proposed integrated system is modelled and simulated with Aspen Plus process simulation software. The performance of the proposed integrated system is assessed through energy and exergy efficiencies.

Keywords: Hydrogen production, copper-chlorine cycle, thermochemical cycle, energy, exergy, gas-cooled fast reactor.

[Abstract:0326]

Design and Thermodynamic Analysis of Liquid Hydrogen Generation Processes Driven by Solar Energy

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In this study, an integrated energy system with concentrating parabolic dish solar collector series has been tried to be designed for multigenerational production, including the liquefied hydrogen generation. This investigated solar energy based integrated plant is consisted of the solar cycle, biomass gasification system, gas turbine cycle, hydrogen production and liquefaction system, Kalina cycle and single effect absorption cooling system with ejector. The main useful outputs from integrated solar plant are the power, liquid hydrogen, heating-cooling and hot water. To investigate the performance of integrated solar plant, the energetic and exergetic analyses of this plant are given. The energetic and exergetic performances of whole system are calculated as the 51.93% and 47.14%, respectively. Also, the parametric study is given to investigate the effects of reference temperature and solar radiation flux on the system performance.

Keywords: Integrated system, hydrogen production, solar energy

ORAL ABSTRACTS

[**Abstract:0327**]

Integrated Photoelectrochemical System for Enhanced Production of Hydrogen and Other Useful Commodities

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Hydrogen is a highly versatile energy carrier that may become one of the key pillars to support the future CO_2-free energy infrastructure. When fuel cells are used, the outputs are water and power with no emissions of greenhouse gases. For the H_2 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 H_2 production reactor that converts the by-products into valuable industrial commodities (i.e., Cl_2 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 unique integrated system can be listed as H_2, Cl_2, NaOH, heat, and electricity. The specific aim of this study is to demonstrate the optimum operating temperature, inlet mass flow rate, total photoactive area, and the environmental temperature to reach the maximum achievable H_2, Cl_2, heat, and electricity production as well as energy and exergy efficiencies while keeping the exergy destruction as little as possible. In this study, there are four case studies, and in each case study, one decision variable is optimized to get the desired performance results. Within the selected operating temperature, inlet mass flow rate, photoactive area, and the environmental temperature size intervals, all performance criteria (except exergy destruction) are normalized and ranked for proper comparison

Keywords: Energy, exergy, efficiency, hydrogen, multigeneration, sustainability

[**Abstract:0328**]

Numerical Investigation of Flameless Combustion in a Furnace Under High Temperature

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In this study, the flameless combustion behavior in a furnace under high temperature has been investigated numerically. The flameless combustion mode (mild flame) has simulated using different combustion techniques (including chemical kinetic mechanism and etc.) and turbulence models. Numerical results have been compared with experimental results. As a result of the simulations, the flame temperature has been found to be consistent with the experimental results. On the other hand, some of the combustion emissions vary depending on the combustion technique approach.

Keywords: Flameless combustion, chemical kinetic mechanism, Gri 2.11, EDC model, mild combustion

ORAL ABSTRACTS

[**Abstract:0330**]

Assessment of the Hydrogen Production System for Domestic Type Use

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In current, fossil-based energy generation systems continue to be used extensively. When the hydrogen energy showing a rising trend is examined, it is still seen that fossil fuel sources still continue to be used for conventional hydrogen production technology. However, the environmental impact of fossil resources and their unsustainability lead us to alternative energy sources. Hydrogen energy and energy storage systems show a rising trend in the studies on alternative energy sources. In this study, a low temperature hydrogen production system with solar energy is investigated. In this study, a thermodynamic analysis of a domestic type hydrogen energy system was carried out.

Keywords: Hydrogen production, thermal energy, renewable energy

[**Abstract:0332**]

Combinatorial Development of Active Materials for Energy Storage and Conversion

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Development of active materials in energy storage and conversion as in similar developments in other fields of materials research have largely followed Edisonian approach of focusing on one material composition at a time. The approach requires a careful preconsideration in selecting the material composition and the success of development efforts depends largely on the suitability of the initial choice made for the material. Combinatorial approach is an alternative method whereby a large number of samples each with different compositions are produced simultaneously and they are then screened in a fast manner to single out the material(s) with best performance. This approach is more efficient in terms both time and effort and yield more fruitful result. In this work, we describe a sputter deposition system which we specifically designed for combinatorial material development [Piskin et al 2015]. Currently the system incorporates sputter targets arranged in suitable manner with a sample magazine above it incorporating substrates which would allow simultaneous deposition of as many as 36 samples, each with different composition. We have made use of this system for three cases; i) Development of dual phase cathodes; (La, Sr) CoO_3(LSC113) and (La, Sr)2CoO_4(LSC214) for IT-solid oxide fuel cells [Sari et al 2018], ii) Development of hydrogen separation membrane in Ag-Ni-Pd ternary system [Piskin an Ozturk 2018] and more recently a work is in progress iii) to develop MnO_2 cathodes for alkaline batteries with improved 2e- rechargeability and improved voltage profile.

Keywords: Sputter deposition, combinatorial material science, IT SOFCs, hydrogen separation membrane, alkaline batteries

ORAL ABSTRACTS

[Abstract:0331]

Performance Improvement of a Fuel Cell Hybrid Electric Vehicle in Different Driving Cycles

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Transportation accounts for about 30% of the total global greenhouse gas emissions. Internal combustion engines are the main contributors of the emissions. Global warming, destructive effects of fossil fuels and air pollution are the major effects of using internal combustion engines. One of the methods to reduce emission is to use alternative fuels such as CNG, LNG, hydrogen and electricity. In this regard, fuel cell-electric hybrid vehicles are emerging technologies with no emissions in their operation phase which have received ample attention by automotive companies. In this research study, the dynamic transient behavior of a fuel cell-electric hybrid vehicle in different driving cycles is studied. A proton exchange membrane fuel cell (PEMFC) is used as main propulsion component and a 30 A/h battery pack with an electric motor have played the role of supportive propulsion source. For studying the dynamic transient behaviour of fuel cell-electric hybrid car two driving cycles are used namely New European Driving Cycle (NEDC) and FTP-75 driving cycle. A developed computational model in approach of improvement the vehicle mileage. Also fuel consumption and regenerative braking strategies are another considered parameters.

Keywords: Fuel cell-electric hybrid car, driving cycle, fuel consumption

[Abstract:0332]

Hydrogen Energy Research, Development and Innovation Activities in Turkey

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Hydrogen is recognised as one of the most important energy solutions for sustainable future, and there have been siginificant attempts worldwide to make a primary focus on hydrogen energy research, development and innovation activities in almost every developed and fast developing countries. In this regard, Turkey has been quite active in academia with many researchers through scholarly publications, projects, partnerships, conferences, etc. As a result of such activities over three decades, the National Hydrogen Technologies Association was established to play a critical role in moving into hydrogen era by bringing all parties together and mobilizing academia, industry and government agencies for a common goal, advocating for hydrogen economy, serving as a key shelter, coordinating the efforts, activities and events, reaching out to people and communities and serving them, liasioning for implementing hydrogen agreements, making a base in Turkey, and many more. In this paper, we present the results of comprehensive literature search through the online resources and data and information collection from various people, groups and organizations about hydrogen energy related research, development and innovation activities for a periof of nearly 50 years (from 1970 to present). Such compiled data and information results cover scholarly publications, books and book chapters, master and doctorate theses, patents received, projects completed, etc. from 1970 to 2019 inclusively. The results illustrated in the graphs appear to be interesting and showing really how diverse they are. They provide a hopeful picture about hydrogen economy and its role in Turkey's energy road map.

Keywords: Hydrogen energy, Research, Development, Innovation, Turkey

ORAL ABSTRACTS

[**Abstract:0334**]

Design and Assesment of a New Solar Integrated Ammonia Fuel Cell and Geothermal Based Energy System

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In this study, a new solar and geothermal based integrated system is developed for multigeneration of electricity, fresh water, hydrogen and cooling. The system also entails a solar integrated ammonia fuel cell subsystem. Further, a reverse osmosis desalination system is used for fresh water production and a proton exchange membrane based hydrogen production system is employed. Moreover, an absorption cooling cycle is utilized to provide cooling via available system waste heat. The developed system is analysed thermodynamically through approaches of energy and exergy analyses. The energy efficiency of the overall system is determined to be 47.7%. Also, the overall exergy efficiency is assesses and it is found to be 31.9%. Furthermore, the exergy destruction rates in system components are analysed and the flash chamber is found to have comparatively higher exergy destruction rate of 643.3 kW. In addition, the effects of varying system parameters are studied through a parametric analyses.

Keywords: Trigeneration, geothermal, ammonia fuel cell, energy, exergy, efficiency

[**Abstract:0334**]

Hydrogen Energy Research, Development and Innovation Activities in Turkey

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Hydrogen is recognised as one of the most important energy solutions for sustainable future, and there have been siginificant attempts worldwide to make a primary focus on hydrogen energy research, development and innovation activities in almost every developed and fast developing countries. In this regard, Turkey has been quite active in academia with many researchers through scholarly publications, projects, partnerships, conferences, etc. As a result of such activities over three decades, the National Hydrogen Technologies Association was established to play a critical role in moving into hydrogen era by bringing all parties together and mobilizing academia, industry and government agencies for a common goal, advocating for hydrogen economy, serving as a key shelter, coordinating the efforts, activities and events, reaching out to people and communities and serving them, liasioning for implementing hydrogen agreements, making a base in Turkey, and many more. In this paper, we present the results of comprehensive literature search through the online resources and data and information collection from various people, groups and organizations about hydrogen energy related research, development and innovation activities for a perior of nearly 50 years (from 1970 to present). Such compiled data and information results cover scholarly publications, books and book chapters, master and doctorate theses, patents received, projects completed, etc. from 1970 to 2019 inclusively. The results illustrated in the graphs appear to be interesting and showing really how diverse they are. They provide a hopeful picture about hydrogen economy and its role in Turkey's energy road map.

Keywords: Hydrogen energy, Research, Development, Innovation, Turkey.

POSTERS

[**Abstract:0032**]

Synthesis and Electrochemical Analysis of Transition Metal (Zn, Cu, Mn) Doped $Ba_{0,5}Sr_{0,5}Co_{0,8}Fe_{0,2}O_{3-\delta}$ Perovskite Structure for Hydrogen Evolution Reaction

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Studies on novel electrochemical catalyst synthesis for efficient hydrogen evolution reaction (HER) attract attention of researchers. Recently, the studies show that perovskite structures are promising candidates for efficient electrocatalysts for HER by Xu (2016). $Ba_{0,5}Sr_{0,5}Co_{0,8}Fe_{0,2}O_{3-\delta}$ (BSCF) perovskite structure is shown as a better electrocatalyst for water oxidation by Fabbri (2017). In general, changing of synthesis method and doping metal effects electrochemical activities of BSCF. In this study, we doped BSCF with three different transition metals. BSCF structure was synthesized by EDTA-citric acid method. Appropriate amount $Ba(NO_3)_2$ and EDTA were dissolved 0.1 M NH_4OH solution. Nitrate salts of other metals were dissolved in distilled water, then mixed with prepared $Ba(NO_3)_2$ solution. The mixture was stirred at 70 °C until gelation occured. The gelled samples obtained were baked in a drying oven at 250°C for 24 hours before being calcined at 1000 °C for 3 hours. Electrochemically active transition metal (Zn, Cu, Mn) doped BSCF structure show enhanced stability and slightly lower overpotential values for HER. The performance of electrochemistry of BSCF was investigated by cyclic voltammetry. BSCF was characterized by XRD, SEM and XPS.

Keywords: Perovskites, hydrogen evolution reaction, electrocatalysts

[**Abstract:0060**]

Modeling and Optimization of Hydrogen Charging in Metal Hydride-Based Storage Systems Using Heat Pipe

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The highly increasing energy demand and reduction of available fossil energy sources have made it important to develop new energy techniques. Hydrogen is being a good alternative source for the future. That is the reason why the storage of hydrogen as an absorbed element in metal hydride tanks (MHTs) has been studied. Enhancing heat transfer within the reaction bed improves the hydriding rate. The objective is to study the hydrogen charge process both experimentally and numerically in two cylindrical MHT configurations; a) tank cooled by natural convection, b) tank cooled using heat pipe. This study demonstrates the impact of using heat pipe for enhancing heat transfer inside $LaNi_5$ MHTs at varying hydrogen supply pressures (2-15 bars). The simulation results show a great agreement with the experimental results. Results show that heat pipes can enhance the hydrogen storage rates. The absorption time was reduced more than half with 10 bar hydrogen supply pressure.

Keywords: Hydrogen storage, heat transfer, heat pipe, hydriding rate, simulation

[**Abstract:0086**]

Hydrogen Production via Ethane Dehydrogenation in Microwave Heated Reactor over Mesoporous Alumina Supported Chromium Catalyst at Low Temperature

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Department of Chemical Engineering, Gazi University, Ankara, Turkey

In this study, hydrogen was produced by ethane dehydrogenation reaction over alumina supported catalysts in a microwave heated system. Mesoporous alumina (MA) was synthesized using a hydrothermal method. Chromium (5% by wt) was incorporated into the structure of mesoporous alumina catalysts by impregnation method. Prior to catalytic activity tests of the synthesized catalysts, some characterization techniques such as XRD, TPR, pyridine adsorbed DRIFT and N_2 adsorption-desorption analysis were performed to determine physicochemical properties of the catalysts. Multipoint BET surface area of MA and 5Cr@MA catalysts were 149 and 91 m^2/g, respectively. N_2 adsorption-desorption isotherms of the catalysts were consistent with Type IV isotherm, according to the IUPAC classification. XRD pattern of the 5Cr@MA catalyst showed that only characteristic peaks corresponding to γ-alumina structure was observed. Activity test studies were performed at 450°Cwith an ethane/argon molar ratio of 1/2. Ethylene, which is another product of ethane dehydrogenation reaction and an important raw material for the petrochemical industry. Ethylene to hydrogen ratio was obtained as 1 at 450°C in the activity test results. Almost similar hydrogen selectivity was obtained over MA and 5Cr@MA catalysts. However, incorporation of chromium into the structure of alumina catalyst increased ethane conversion from 24% to 44%. These results showed that chromium catalyst is a promising material with a high ethane conversion at low temperatures in the microwave heated reactor system.

Keywords: Ethane dehydrogenation, hydrogen production, mesoporous alumina, chromium, microwave reactor

[**Abstract:0087**]

Hydrogen and Ethylene Production by Ethane Dehydrogenation in Microwave Heated Reactor System: Effect of Reaction Temperature

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In the present study, the ethane dehydrogenation reaction was carried out in a microwave heated reactor and the temperature effect on hydrogen production and ethylene selectivity were investigated. Carbon nanofiber (CNF), a good microwave receptor, was used as support in the reaction. Chromium (Cr, 5% wt) was incorporated into the commercial CNF by impregnation method. The catalyst was characterized by XRD, N_2 adsorption-desorption, TPR and TG/DT techniques. In the XRD pattern of the catalyst, characteristic peaks corresponding to graphite carbon and metallic Cr were observed. Activity test was performed at different temperatures ranging from 400-700 °C with the ethane/argon molar ratio as 1/2. The activity test results showed that the ethane conversion and hydrogen selectivity increased with an increase in reaction temperature. Hydrogen to ethylene ratio was obtained as approximately 1 at 450 °C. Ethylene yield decreased at higher temperatures above 450 °C due to ethylene cracking reaction. Also, a small amount of acetylene was observed as a result of the side reactions at high reaction temperatures.

Keywords: Ethane dehydrogenation, hydrogen, ethylene, microwave heated reactor

[Abstract:0088]

Improved Fuel Cell Properties of Nano-TiO_2 Doped Polyvinylidene Fluoride and Phosphonated Poly(Vinyl Alcohol) Composite Blend Membranes for PEM Fuel Cells

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The search for alternative clean energy resource has been increasing day by day due to the depletion of fossil fuel reserves, and environmental/human health hazards. Hydrogen energy technologies have an important role in clean and renewable energy sources. Among the hydrogen energy systems, fuel cells are the most remarkable. Fuel cells are devices that convert directly chemical energy into electrical energy without harmful emissions and waste generation. Nowadays, it is a reliable technology used in many applications. One of the most remarkable types of fuel cells is PEM fuel cells that can operate at low temperatures and have high efficiency. Membranes are the most important components of the fuel cell and known as the heart of the fuel cell. Nafion is the most commonly used membrane for commercial fuel cells. But due to its high cost and high temperature performance problems, alternative membrane researches are underway. Therefore in this study, polyvinylidene fluoride (PVDF) - phosphonated polyvinyl alcohol (PPVA) blend membranes (90/10 by mass) were prepared with sol-gel method. Subsequently, nano-TiO_2 were added with varying mass ratios (2, 5, 8, 10, 15%) to improve the properties of the membrane. Characterization tests of prepared membranes, such as Fourier Transform Infrared (FTIR), water uptake capacity, ion exchange capacity, tensile strength, proton conductivity tests were carried out. As a result of the characterization experiments, the best values were obtained for the membrane containing 8% nano-TiO_2. Water uptake capacity (80°C), tensile strength, ion exchange capacity and proton conductivity values were found as 34 MPa, 1.23 meq/g and 0.246 S/cm, respectively. Based on these results, this membrane can be regarded as a promising candidate in fuel cells.

Keywords: PEM fuel cell, blend membrane, nano-TiO_2, polyvinylidene fluoride, phosphonated polyvinyl alcohol

[Abstract:0126]

Direct Synthesis of Dimethyl Ether on TPA Incorporated HZSM-5 Zeolites

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In presented study, HZSM-5 zeolites were synthesized for methanol dehydration reaction thereafter, tungstophosphoric acid (TPA), having different mass ratios (%5-25), was impregnated in order to increase catalysts surface acidity. Catalyst characterization tests were held by X-ray diffraction (XRD), N_2 adsorption-desorption analysis and DRIFTS analysis. XRD analysis results demonstrated that, TPA incorporated HZSM-5 catalysts has been successfully synthesized. Nitrogen physisorption results presented that the catalyst surface areas were between 307 m^2/g to 387 m^2/g. Activity of TPA impregnated HZSM-5 catalysts were tested at 5.0 MPa and 275 °C and results showed that the selectivity of DME increased with increasing the amount of TPA. Thermodynamically, maximum selectivity to DME and CO_2 are 66% and 33% respectively for direct synthesis of dimethyl ether. In this study, 25TPA@HZSM-5 catalysts yielded the highest DME selectivity with 57%. This result could be explained with side reactions observed in direct DME synthesis. Both CO hydrogenation and water gas shift reaction were activated by Cu based catalyst therefore CO_2 was the main side product for all catalysts. Acknowledgement: Turkish Scientific and Technical Research Council (TUBITAK) grant (115M377) and Gazi University Research Fund (06/2017-09 and 06/2018-23) were gratefully acknowledged.

Keywords: Dimethylether, Syngas, Tungustophosphoricacid, Direct Synthesis

[**Abstract:0128**]

Direct Synthesis of Dimethyl Ether from Syngas over Silicotungstic Acid Containing Catalyst

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In this study, commercial HifuelR-120 catalyst was used in methanol production and SBA-15 was synthesized by hydrothermal method for methanol dehydration reaction. Silicotungstic acid (STA), super acid, was incorporated into the structure of SBA-15 catalysts by impregnation method in order to enhance its surface acidity. DME was synthesized following a direct synthesis route from synthesis gas, using bi-functional catalyst mixtures, which was composed of a commercial Cu–ZnO-AI_2O_3 and a STA incorporated mesoporous SBA-15. Characterization studies of STA incorparated SBA-15 catalysts were conducted to determine their physicochemical properties. Multipoint BET surface area values of SBA-15, 5STA@SBA-15, 10STA@SBA-15 and 25STA@SBA-15 were 781, 551, 536 and 431 m^2/g, respectively. All of the synthesized materials were consistent with Type IV isotherms, according to the IUPAC classification, which was a good indication of ordered pore structure in the mesopore range. Low-angle XRD patterns of the SBA-15 showed typical patterns, corresponding to ordered mesopore structure of SBA-15-like materials. XRD and SEM analysis showed that STA was successfully loaded into the catalyst structure. Activity tests of catalysts were investigated at 50 bar and 275°C with feed composition of CO/H_2:1/1 molar ratio. Results showed an increase in DME selectivity and CO conversion with an increase in STA incorporation. Maximum CO conversion and DME selectivity values were obtained in the presence of 25STA@SBA-15 catalyst, as 41 % and 56.1 %, respectively.

Keywords: Dimethyl ether, syngas, direct synthesis, silicotungstic acid, SBA-15

[**Abstract:0146**]

A Density Functional Theory Study of Molecular Hydrogen Adsorption on Mg site in OFF Type Zeolite Cluster

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The idea of consuming hydrogen as an energy carrier of the future was important over the past three decades due to limited hydrocarbon resources. Hydrogen molecule adsorption was investigated on additional framework of Mg atom in OFF type zeolite (Offretite) by way of Density Functional Theory with the B3LYP-Hybrid formalism method Gaussian 09 software. For all atoms 6-31G(d,p) basis set was utilized in calculations. The electronegativity, HOMO and LUMO energy, chemical hardness, chemical potential, adsorption enthalpy and adsorption energy values have been calculated on a 8T zeolite cluster model ($[Si_6Al_2O_{24}H16]Mg$). and compared with those of Mg exchanged ERI, LTL and DFT zeolite structures. After the optimization of adsorbing molecule (H_2) and cluster, hydrogen molecule adsorption was examined on Mg-OFF cluster by EG calculation. Hydrogen adsorption enthalpy value was computed as -17 kJ/mol. In order to be able to remark that a material can be a possible applicant cryoadsorbent material for storage of hydrogen the enthalpy value for hydrogen adsorption on that material should be larger than the liquefaction enthalpy of hydrogen molecule. In view of that, if adsorption enthalpy value for hydrogen on Mg–OFF cluster is compared to the hydrogen molecule's liquefaction enthalpy (0.9 kJ/mol) and the available literature data, it can be seen that the enthalpy values of hydrogen adsorption involved for Mg–OFF structure is substantially larger than the liquefaction enthalpy of hydrogen and the literature values. Consequently, based on these data, Mg-OFF zeolite structure seems to be talented candidate cryoadsorbent material for hydrogen storage.

Keywords: Hydrogen adsorption, DFT, Mg atom, OFF zeolite, Offretite

[**Abstract:0150**]

Analysis and Modeling of a Membrane Electrode Assembly in a Proton Exchange Membrane Fuel Cell

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The manner is investigated in which various proton exchange membrane stacks are analyzed and designed with different stack components and configurations, as a contribution to the ongoing stack-level research and efforts for better commercialization of fuel cells. In this regard, a comprehensive set of analytical models has been built using MATLAB and EES software. The effect of membrane thickness to the total resistance, conductivity, ohmic loses, water content, voltage drops, water concentration of the membrane have been analyzed. Our analytical model results show that with increasing the membrane thickness, the cell voltage drops, the water concentration at the anode to decrease while causing the temperature to incrcease at the cathode with increase in the slop and the water diffusivity increases with increasing the temperature. It is observed that the stack performance is considerably affected by the size and the number of flow channels on bipolar plate.

Keywords: Fuel cell, proton exchange membrane, PEM, membrane electrode assembly, MEA, stack components.

[**Abstract:0151**]

Assessment of Gas Diffusion Layers in a Proton Exchange Membrane Fuel Cell: Design and Analysis

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This study investigates gas diffusion layer (GDL) of membrane electrode assembly (MEA) in proton exchange membrane fuel cells (PEMFCs). In this regard, the main design considerations and limitations of the GDL have been examined, along with a comprehensive review of currently available models. Also, the common materials used for the GDL have been explored, evaluating their properties. Furthermore, a case study of step-by-step modeling for an optimum GDL has been presented in-details. An experimental test has been carried out on a single cell under various compressions. Finally, a parametric study has been conducted with respect to many design parameters such as porosity, permeability, geometrical sizes and compression of the GDL to improve the overall performance of the fuel cell. The results are presented in this paper in order to help ongoing efforts to improve the efficiency of PEMFCs and facilitate their development further.

Keywords: Fuel cells, proton exchange membrane, membrane electrode assembly (MEA), gas diffusion layer (GDL)

[**Abstract:0175**]

Activity of Modified Sol-Gel Alumina Supported Ni Catalysts in Dry Reforming of Methane

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Biogas, a primarily mixture of CO_2 and CH_4 gases, can be converted to hydrogen rich syngas through dry reforming of methane. Syngas with a H_2/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 alumina supported nickel catalysts were tested in dry reforming of methane. Alumina support was synthesized using a modified sol-gel method. Ni was incorporated into the structure of alumina materials by impregnation and one-pot methods. The synthesized catalysts were characterized by XRD, N_2 adsorption/desorption, TPR, SEM-EDX, and TG techniques. Nitrogen adsorption/desorption analysis showed that synthesis materials posses uniform mesoporous size distribution (around 8 nm). BET surface of area of the bare alumina support is 213 m^2/g. Impregnation of Ni in to the structure of the catalysts decreased the BET surface area value due to closure of some of the pore with metal loading. In the XRD analysis pattern of the catalysts, diffraction peaks attributed to γ-Al_2O_3 was observed. All catalysts showed stable activity during 4 h activity test. Higher CO_2 conversion than CH_4 conversion was obtained, indicating that occurrence of reverse water gas shift reaction together with dry reforming of methane. SEM images showed that filamentous carbon was formed over the Ni catalysts.

Acknowledgements

TUBITAK 218M380 grant is gratefully acknowledged.

Keywords: Dry reforming of methane, hydrogen, syngas, modified sol-gel

[**Abstract:0197**]

The Synthesis and Characterization of Pt Based Hybrid Materials as an Efficient Nanocatalyst for the Dehydrogenation of Hydrazine-Borane in Water

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Hydrazine-borane ($N_2H_4BH_3$, HB) is one of the hydrogen dense derivatives of ammonia borane and has a gravimetric hydrogen capacity of 15.4 wt%, with 4Hδ+ and 3Hδ−. The release of hydrogen from HB can be obtained through either thermolysis or solvolysis. The first report on the synthesis and dehydrogenation of HB in water for hydrogen production was published in 2009. Hydrazine-borane can easily release its hydrogen at ambient conditions with suitable catalyst by dehydrogenation reaction in water as

Equation

$$N_2H_4HBH_3\,(aq) + 2H_2O \xrightarrow{\text{catalyst}} N_2H_5BO_2\,(aq) + 3H_2(g) \quad (1)$$

Heretofore, several catalytic systems for the dehydrogenation of hydrazine-borane were developed and their catalytic activities were tested. However, the development of new, efficient and reusable catalyst systems for the dehydrogenation of hydrazine borane in water is still of great importance. Here, we report the synthesis and characterization of Pt based hybrid materials as a very efficient and active catalyst for hydrogen generation from the dehydrogenation of hydrazine-borane in water at room temperature.

Keywords: Dehydrogenation, hybrid material, hydrazine-borane, platinum

[Abstract:0198]

Synthesis and Characterization of Extremely Active Polymer/Carbon Nanotube Based Platinum Nanohybrids for Hydrogen Evolution from the Hydrolysis of Methylamine-Borane

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Among the compounds containing B–N, the best known and most studied compound is ammonia-borane. Another B–N compound that has been studied over the last few years is methylamine-borane (CH_3NH_2-BH_3, MeAB). MeAB is an ammonia-borane derivative and it has been studied in hydrolysis reactions over the past years due to its high hydrogen density of 11.1%. 3 moles of H_2 can be obtained from the hydrolysis of MeAB 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 catalytic dehydrogenation in organic media. Herein, we prepared and characterized the polymer/carbon nanotube based Pt nanohybrids and to use them as an excellent catalyst for the hydrolysis of MeAB in room temperature. The prepared Pt nanohybrids was characterized by applying for TEM, HR-TEM, TEM/EDX, P-XRD and XPS. The prepared nanohybrid catalyzed the hydrolysis of MeAB in ambient conditions with an very high initial turnover frequency (TOF) of 170.57 min^{-1}.

Keywords: Hybrid material, hydrolysis, methylamine-borane, nanocatalyst, platinum

[Abstract:0203]

Activity of Iron and Yttrium Catalysts in CO_2 Reforming of Methane

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Hydrogen is a clean burning fuel as well as being one of the main building molecules in the synthesis of hydrocarbons. CO_2 reforming of methane, known as dry reforming of methane, converts two major greenhouse gases, CO_2 and CH_4, to valuable chemicals such as H_2 and CO. The H_2 and CO mixture, syngas, is suitable to produce liquid hydrocarbons through Fischer-Tropsch synthesis. In this study, performance of commercial alumina supported Fe and Fe-Y catalysts were investigated in dry reforming of methane. Fe and Y metals were incorporated into the structure of alumina materials by impregnation. The synthesized catalysts were characterized by XRD, N_2 adsorption/desorption, SEM-EDX, and TG techniques. Nitrogen adsorption/desorption analysis showed that Fe-Y catalyst had a mesoporous structure with a pore diameter of around 5 nm. BET surface of area of the Fe-Y catalyst is 80 m^2/g. SEM-EDX analysis indicated that Y/Fe molar ratio is around 1/4 in the structure of the alumina supported Fe-Y catalyst. Catalytic activity test of the catalysts were performed at 750°C and atmospheric pressure. During catalytic activity test, higher CO_2 conversion than CH_4 conversion was obtained over Fe and Fe-Y modified catalysts. TG analysis and SEM images of the catalyst showed that coke deposition of the Fe based catalyst is significantly high.

Keywords: Hydrogen, syngas, CH_4 reforming, Yttrium, Fe

[**Abstract:0205**]

Performance of Silica Supported Ni Catalysts in Steam Reforming of Biomass Derived Acetic Acid

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In the present study, Ni incorporated silicate catalysts (SBA-15 and MCM-41) were synthesized by impregnation and their catalytic performances were compared in steam reforming of acetic acid. In order to define physical and structural properties of the catalysts, XRD, N_2 adsorption-desorption, SEM, TEM and post reaction TG analysis were performed. N_2 adsorption-desorption isotherms of the synthesized catalysts were consistent with Type IV isotherms. Multipoint BET surface area values of 5Ni@SBA-15 and 5Ni@MCM-41 were 494 and 850 m^2/g, respectively. TEM images of the 5Ni@SBA-5 catalyst were consistent with the nitrogen adsorption/desorption analysis and proved the presence of ordered cylindrical mesopores. Catalytic activity tests of the catalysts were carried out with an $AcOH/H_2O$ feed molar ratio of 1/2.5 at temperature of 750°C. Although the performance of the 5Ni@SBA-15 and 5Ni@MCM-41 gave highly promising in terms of producing hydrogen, 5Ni@SBA-15 catalyst gave the best catalytic activity. 5Ni@SBA-15 catalyst showed complete acetic acid conversion with a high hydrogen selectivity (70%). Comparison of TGA result of the spent catalysts showed that coke deposition over the 5Ni@MCM-41 catalyst (36%) was higher than the 5Ni@SBA-15 catalyst (7%).

Keywords: Acetic acid, hydrogen, MCM-41, nickel, SBA-15, steam reforming

[**Abstract:0215**]

Investigation of Applicability of PVA Based Membranes Sulfated by Different Sulfonation Agents for DMFC

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Direct methanol fuel cell (DMFC) has been widely studied in the recent decades. It has emerging properties such as high efficiency, compact structure and ease in refueling among the other fuel cell types. Proton exchange membrane (PEM) is one of the basic components of DMFC to be improved. High proton conductivity and low methanol permeability are the most important properties of PEM to be utilized in DMFC. In this study, sulfated polyvinyl alcohol (S-PVA) based membranes as PEM material were investigated for applicability in DMFC. The polyvinyl alcohol (PVA) membranes were sulfated by sulfuric acid (SA) and sulfo succinic acid (SSA) respectively. S-PVA membranes had been used as catalytic membranes for membrane reactor applications in ester synthesis by authors. It wasn't found DMFC applications of these membranes in the literature. PVA was directly sulfated by sulfuric acid and crosslinked with maleic acid for preparing PVA/SA membranes. PVA/SSA membranes were prepared by homogenous sulfonation of PVA using sulfo succinic acid that was both sulfonation agent and crosslinking agent. All membranes were prepared by solvent casting method. The membranes were subjected to heat treatment to complete membrane preparation method. The related tests such as water uptake, ionic exchange capacity (IEC) proton conductivity and methanol permeability of the membranes were made. Molecular structure of the membranes were investigated by Fouirer Transform Infrared Spektrofotometer (FTIR). Changes in physical and chemical properties of the membranes by temperature were also investigated by Thermal gravimetric analysis (TGA). Proton conductivity tests as preliminary study showed that the S-PVA based membranes could be very good candidates for DMFC.

Keywords: Sulfated PVA, memebrane, fuel cell

[**Abstract:0216**]

Investigation of a Fe-Cl Thermochemical Cycle for Hydrogen Production

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Themochemical Water splitting is recognized as one of the promising pathways for hydrogen production. Fe-Cl cycle is one of the chlorine family thermochemical cycles where iron chloride is consumed for hydrogen production from water. The cycle is modelled by Aspen Plus softaware package and analyzed for performance investigation of each reaction step and system's components. The parameteric studies are also performed to assess the effect of operation conditions such as temperature, pressure and concentration on the reaction products and conversion rates. Results indicated that an in crease in temperature favors oxygen production in reverse deacon reaction and lowers the hydrogen production in the hydrolysis step. On the other hand, the effect of pressure on the reverese deacon reaction is not significant while an increase in pressure leads to an increase in hydrolysis products.

Keywords: Hydrogen production, thermochemical cycle, water splitting, ıron-chlorine

[**Abstract:0232**]

A New Model Proposal Based on Global Warming

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This study offers a new model depends on global warming for hydrogen economy. The largest contributing source of greenhouse gas is the burning of fossil fuels causes the emission of carbon dioxide (CO_2). Greenhouse gases give raise to green gas effect and it causes the global warming. Natural disasters show up on the world as a result of global warming. Number of the extreme temperature, storm (e.g. hurricane), fog, flood, landslide, wave action (e.g. tsunami), drought is increased owing to global warming. These are destructive disasters and also they destructive economically. Cost of natural disasters should be regarded when the cost of gasoline is identified. In this way, when hydrogen and gasoline are compared each other, the use of hydrogen as fuel in vehicles is cheaper cost over the long run although it seems expensive in the short term.

Keywords: Hydrogen economy, global warming, CO_2 emission

[**Abstract:0256**]

A Cost Model Approach on Sub Ground Salt Hydrogen Storage

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Low populated urbanization in Şırnak and Batman residential areas, This hydrogen salt production and storage can lead to safety in storage and low cost for limestone cave storage at subgrounds at low depths till 30m and other hydrological risky formations at an important geological risk. For this reason, active and passive risk areas should be identified, required ground water measurements and precautions were to be taken for these areas.The cost of sysmical investigations and storage impermeability must be determined by performing geotechnical investigations and stability analyses. Also transportation method of hydrogen salt without contaminating fresh water resource in the area should be designed. Regarding those model a cost feasibility making decisions on storage and land alternatives. The fields, especially in low-risk areas should be allowed in cost of construction. Finally, the various districts in the coal mining sites in the province of Şırnak, the cost active and potential storage areas could be evaluated for low cost, and co- operated with mining conducted.

Keywords: Cost model, sub ground storage, salt hydrogen, hydrogen storage

[**Abstract:0329**]

Conventional and Enhanced Exergy Analysis of a Hydrogen Liquefaction System

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In this study, conventional and advanced exergy analyses were applied to the cryogenic liquefaction process of hydrogen gas. Hydrogen liquefaction unit include very component such as hydrogen compressor and booster compressor-turbine and heat exchanger block. The exergy destruction affecting the exergy efficiency of the hydrogen liquefaction unit was investigated in detail. This study suggests an advanced exergy analysis to a cryogenic liquefaction system. These analyses provide information about the origin of irreversibility and also determine the amount of unavoidable exergy destruction of the hydrogen liquefaction system. According to the results of the convectional exergy analysis, exergy efficiency of the whole liquefaction process are 32.22%.

Keywords: Cryogenic liquefaction unit, hydrogen liquefaction, advanced exergy

[**Abstract:0333**]

$BaZr_{0.80}Y_{0.20}O_3$ - $SrCe_{0.95}Yb_{0.05}O_3$ Dual Phase Perovskite Oxides for Hydrogen Separation

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This study focuses on the development of proton conducting oxides that enable on-site hydrogen purification during hydrogen production (e.g. methane reformation, coal gasification, burning of the wastes, etc.). The study also comprises the extraction of high-purity hydrogen from the gas mixtures obtained via burning of the wastes which is common in Turkey. The study deals with the composite structures to be formed of $BaZr_{0.80}Y_{0.20}O_{3-\delta}$ (BZY) - $SrCe_{0.95}Yb_{0.05}O_{3-\delta\delta}$ (SCY) oxides and aims to identify the most suitable composition among these composites using combinatorial approach. The proton conducting oxides would be evaluated by a combinatorial approach for the first time by the current work, which involves the simultaneous deposition of BZY-SCY oxides via magnetic sputtering, yielding a large number of thin films with different compositions, and the subsequent characterization based on their proton-electron conductivity. 18 different compositions would be produced in a single experiment by magnetron sputtering system designed in the study. Subsequently, thin film composites will be subjected to pre-evaluation by electrochemical impedance method and the compositions exhibiting higher proton conductivity would be identified. Even though the project based on thin films, the candidate compositions would be also produced in the form of bulk discs (30-100 μm) and hydrogen permeability performance tests will be performed. It is aimed to develop composites that will provide at least 1 $ml.cm^{-2}.min^{-1}$ hydrogen flux, as a requirement for industrial applications, between 600-800 °C by the approach adopted in the study.

Keywords: Proton conducting oxides, hydrogen separation, thin film, magnetron sputtering

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