IHTEC 2017

2nd International Hydrogen Technologies Congress

March 15-18, 2017
Çukurova University,
Adana, Turkey

ABSTRACT BOOK

EDITORS
İbrahim DİNÇER
Adnan MİDİLLİ
Mehmet KARAKILÇIK

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EDITORS

Prof. Dr. İbrahim DİNÇER
Faculty of Engineering and Applied Science
University of Ontario
Oshawa, ON, Canada

Prof. Dr. Adnan MİDİLLİ
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Rize, Turkey

Prof. Dr. Mehmet KARAKILÇIK
Cukurova University,
Faculty of Engineering
Physics Department
Adana, Turkey

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WELCOMING MESSAGE

to Participants of 2nd International Hydrogen Technologies Congress

15 - 18 March 2017, Adana, 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 the Hydrogen Energy System. Hydrogen is the lightest, most efficient and cleanest fuel. Its use will produce no greenhouse gases, no ozone layer depleting chemicals, little or no acid rain ingredients, no oxygen depletion and pollution.

Around the world, there is extensive r&d work on Hydrogen Energy. Internal combustion engines are being modified for hydrogen fuel. Many types of fuel cells - to convert hydrogen efficiently to electricity - are being developed. Vehicle manufacturers have built several experimental cars and buses. Hyundai, Toyota, Honda and Mercedes companies started selling hydrogen fueled cars. Many bus companies are selling hydrogen fueled buses. Siemens Company is selling hydrogen fuel cells powered submarines. Hydrogen fueled appliances based on catalytic combustion have been built. There is research and development work on hydrogen hydride refrigeration and air conditioning systems. Aircraft manufacturers are working on hydrogen fueled subsonic and supersonic transport planes.

Scientists and Engineers from many countries of the world will gather at the IHTEC2017 Conference to present their papers covering the recent advances in hydrogen energy and in hydrogen technologies. All these will no doubt speed up the conversion to hydrogen economy, eliminate global environmental problems, and provide the humankind with higher living standards. I congratulate the organizers of this Congress and wish all the participants a very fruitful meeting and pleasant days in beautiful Adana, Turkey.

T. Nejat Veziroğlu

Honorary Chair, IHTEC2017

President, International Association for Hydrogen Energy

MESSAGE FROM THE PRESIDENT

Organizing the Second International Hydrogen Technologies Congress (initially started as the National Hydrogen Technologies Congress) is another milestone in Turkey's hydrogen energy activities under the leadership of the National Hydrogen Energy Association. Due to the increasing interest in carbon free alternatives hydrogen energy technologies appear to be the central point to formulate energy solutions for all sectors, ranging from industrial to transportation. The past climate change conference in Paris, France a year ago made it 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.

It is also important to note that the National Hydrogen Energy Association was able to secure one of the next organizations of the 24th World Hydrogen Energy Congress first time in 2022, in Istanbul, Turkey. This is 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. It requires great efforts from the 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 second congress in the area of hydrogen technologies, after organizing the first one in Istanbul, in Cukurova University in Adana, which aims to bring researchers, scientists, engineers and practitioners, who are working in the subject matter area, to provide a forum to exchange ideas, disseminate new research developments and discuss latest advances, new directions and priorities for a carbon-free future with hydrogen. We are happy to have numerous leading researchers here to share the newest ideas and latest technologies and developments. Over 120 technical papers will provide an ample opportunity to learn about a wide range of topics with distinguished presenters from over ten countries. Furthermore, 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 and prepare this conference. As the Association President, I would like to register my sincere appreciation to the Organizing Committee, Executive Organizing Committee, and the honorary chair, Dr. T. N. Veziroglu, the congress chair, Dr. Mehmet Karakilcik and secretary general Dr. Adnan Midilli. Also, I would like to acknowledge the assistance, support and coordination of 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

MESSAGE FROM THE CHAIR

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Mehmet Karakilcik
Congress Chair, IHTEC2017

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Mithat Özsan Amphitheater (HALL - A)	
08:00-09:30	Registration
09:30-10:00	**Opening Talks**
10:00-10:50	**Overview Talk on Novel Hydrogen Production Technologies** ***Ibrahim Dincer***
10:50-11:00	**Coffee Break**
11:00-11:50	**Keynote Speaker** - ***Tayfur Öztürk*** "Development of rare earth free metal hydrides for elecrochemical hydrogen storage"
12:00-13:30	**LUNCH** *(Ç.U. Center Cafeteria)*
13:30-14:00	**Invited Speech - *Halime Paksoy*** "Energy Storage - Key Technology For Sustainable Future"
14:00-15:40	**Session 1** - Biological hydrogen production and technologies **Chair: *Fikret Kargı***
14:00:14:20	[8] Biohydrogen Production with C. intestinale in Lignocellulosic Substrates ***Serpil Özmıhçı, Gülsün Gizem Taylan, Merve Özlem Vurmaz***
14:20-14:40	[18] Biohydrogen Production by Extracted Fermentation from Sugar Beet ***Serkan Eker, Burcu Erkul***
14:40-15:00	[21] Hydrogen gas production from food wastes by electrohydrolysis using a Statical design approach ***Ebru Çokay***
15:00-15:20	[192] Effects of Land Use and Microbial Technology to Obtain Biomass from Salty and Marginal Lands in Turkey ***Ali Khalvati, N. Javani***
15:20-15:40	[54] Effects of Process, Operational and Environmental Variables on Biohydrogen Production Using Palm Oil Mill Effluent (POME) ***Bidattul Syirat Zainal, Shaliza Ibrahim, Ali Akhbar Zinatizadeh, Nuruol Syuhadaa Mohd***
15:40-15:55	**Coffee Break**
15:55-17:35	**Session 4** - Pyrolysis, gasification and plasma hydrogen production **Chair: *Tayfur Öztürk***
15:55-16:15	[2] Performance Investigation of Zirconium Hydrogen Phosphate / Sulphonated Polysulfone Composite Membrane Based DMFCs ***Mustafa Ercelik, Yagmur Ozdemir, Adnan Ozden, Yilser Devrim, Can Ozgur Colpan, Feridun Hamdullahpur***
16:15-16:35	[66] Synthesis of La-Mg-Ni-Co Hydrogen Storage Alloys by Electro-deoxidation ***Alanur Binal Aybar, Mustafa Anik***
16:35-16:55	[87] Co-gasification of Çan Lignite with Kenaf Hydrolysate: Effects of Temperature and Flow rate ***Açelya Seçer, Nilgün Küçet, Arif Hasanoğlu***
16:55-17:15	[88] Comparison of Silica and Alumina Based Catalysts in Hydrogen Production From Biomass ***Birce Pekmezci Karaman, Nurbanu Çakıryılmaz, Hüseyin Arbağ, Nuray Oktar, Gülşen Doğu, Timur Doğu***

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17:35-17:50	**Coffee Break**
17:50-18:30	**POSTER Session 1**
18:30-21.30	**COCKTAIL** *(Ç.U. Kayıkhane)*

Mithat Özsan Amphitheater (HALL - B)	
13:30-14:00	**Invited Speech** - ***Kadir Aydın*** "Future of Hydrogen Usage in Automotive Industry"
14:00-15:40	**Session 2** - Renewable hydrogen production and technologies **Chair:** ***Adnan Midilli***
14:00:14:20	[90] Investigation of Hydrogen Production Performance of a Reactor Assisted by a Solar Pond by Photoelectrochemical Method ***Mehmet Karakilcik, Mustafa Erden, Muzeyyen Cilogullari, Ibrahim Dincer***
14:20-14:40	[122] Thermodynamic assessment of combined geothermal energy based hydrogen production and liquefaction system ***Yunus Emre Yuksel, Murat Ozturk, Ibrahim Dincer***
14:40-15:00	[132] Hydrogen Production Potential From Solar Energy in Kayseri ***Gamze Genc, Seyfettin Gurel***
15:00-15:20	[146] A Parametric Study on A Run-of-the River Mini Hydropower Plant Integrated Hydrogen Production ***Adnan Midilli, Mert Özsaban***
15:20-15:40	[148] Assessment of a Geothermal Based Integrated System For Power and Hydrogen Production ***Hatice Karakilcik, Mustafa Erden, Mehmet Karakilcik***
15:55-17:35	**Session 5** - Hydrogen fuel cells **Chair:** ***Hikmet Karakoç***
15:55-16:15	[85] A Rewiew on Novel Flow Field Designs For Pem Fuel Cells and Systematic Comparison of Designs ***Erman Çelik, Irfan Karagöz***
16:15-16:35	[101] Affective Factors Improving Catalyst Layers of PEM Fuel Cell ***Gokce S Avcioglu, Berker Ficicilar, Inci Eroglu***
16:35-16:55	[102] Three-Dimensional Nonisothermal Model Development of High Temprature PEM Fuel Cells ***Berna Sezgin, Dilara Gülçin Çağlayan, Yılser Devrim, Inci Eroğlu***
16:55-17:15	[131] Parametric investigation of 3D geometrical design of pem fuel cells ***Muhammed Mücahit Toprak, Mehmet Utku Badak, Suha Orçun Mert***
17:15-17:35	[133] Electrochemical Property of Nano-Composite Electrolyte for Fuel Cells ***Shalima Shawuti, Ahmet Deniz Benli, Mehmet Ali Gulgun***

İ. Akif Kansu Congress Hall (HALL - C)	
14:00-15:40	**Session 3** - Hydrogen transportation, distribution, security, strategies and policies **Chair:** ***Özgür C. Çolpan***

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14:00:14:20	[10] Cost and Productivity Analysis of Storage and Distribution Processes of a Solar Driven Hydrogen Production Plant ***Murat Emre Demir, İbrahim Dinçer***
14:20-14:40	[80] Numerical modelling of hydrogen-natural gas mixtures flows in looped networks ***Zahreddine Hafsi, Sami Elaoud, Lamjed Hadj Taieb***
14:40-15:00	[126] Optimal Design of a Hydrogen Refueling Station Powered by Wind-PV Hybrid Power System ***Murat Gökçek, Cihangir Kale***
15:00-15:20	[137] Parametric investigation of direct catalytic conversion of synthesis gas to dimethyl ether ***Hatice Merve Can, Zeynep Ilsen Önsan, Ahmet Kerim Avci***
15:20-15:40	[139] Catalytic reforming of glycerol to hydrogen in wall coated microchannels ***Amin Delparish, Ahmet Kerim Avci***
15:55-17:35	**Session 6** - Hydrogen separation and cleaning technologies **Chair: *Birgül Yazıcı***
15:55-16:15	[12] Boron based hydrogen storage technologies and synthesis of some metal borohydrides ***Gözde Bayazit, Şadan Özcan, Mükerrem Şahin***
16:15-16:35	[30] Oxygen Production on Asymmetric Terminal Alkynyl Zinc Phthalocyanines and Modified Electrodes Using Click Electrochemical Technique ***Duygu Akyüz, Atıf Koca***
16:35-16:55	[70] Thermodynamic Modeling and Optimization of a Hydrogen Liquefaction System Using Geothermal Energy ***Ceyhun Yılmaz***
16:55-17:15	[96] Synthesis and Characterization of IrxRu1-xO2 Catalysts for the Oxygen Evolution Reactions ***Mehmet Fatih Kaya, Nesrin Demir, Ayşe Bayrakçeken Yurtcan***
17:15-17:35	[161] Optimization of Operation Conditions of Solar Thermal Water Splitting Process ***Ezgi Yavuzyılmaz, Deniz Üner, Serkan Kıncal***

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Mithat Özsan Amphitheater (HALL - A)	
	Chair: ***Mohamed Hamed***
09:00-09:45	**Keynote Speaker** - ***İnci Eroğlu*** "Development of renewable hydrogen energy systems"
09:45-10:30	**Keynote Speaker - *Fikret Kargı*** "Hydrogen gas production by electrohydrolysis of organic wastes"
10:30-10:45	**Coffee Break**
10:45-12:25	**Session 7** - Biological hydrogen production and technologies **Chair: *Mehmet Suha Yazıcı***
10:45-11:05	[60] Dark fermentative hydrogen gas production from waste peach pulp in a pilot scale reactor ***Hidayet Argun, Siaka Dao***
11:05-11:25	[86] Determining the effect of trace elements on biohydrogen production from fruit and vegetable wastes ***Tugba Keskin Gündoğdu, Kübra Arslan, Haris Nalakath Abubackar, Gozde Duman, Koray Akarsu, Jale Yanık, Nuri Azbar***
11:25-11:45	[144] The Effect of Bacteriologically Generated Carbohydrates on Electrocatalytic Oxidation and Hydrogen Efficiency ***Güray Kılınççeker, Mehmet Karakilcik, Eren Caglar, Mustafa Kemal Sangun***
11:45-12:05	[153]Evaluation of waste paper towel for hydrogen gas production by dark fermentation ***Hidayet Argun, Gülizar Onaran***
12:05-12:25	[123] High Yield Hydrogen Production From Sodium Borohydride By Non-Catalytic Steam Reforming: A Parametric Study ***Meryem Sena Akkuş, Hatice Begüm Murathan, Derya Öncel Özgür, Gülay Özkan, Göksel Özkan***
12:25-13:30	**LUNCH** *(Ç.U. Center Cafeteria)*
13:30-14:15	**Keynote Speaker - *Sema Z. Baykara*** "Hydrogen: Sources and Production"
14:15-15:55	**Session 10** - Hydrogen production and micro process technologies **Chair: *Sema Z. Baykara***
14:15-14:35	[11] Preparation of nickel and bismuth deposited titanium dioxide nano-tubes and investigation of electrochemical hydrogen production performance ***Başak Doğru Mert, Mehmet Erman Mert, Birgül Yazıcı Devrim***
14:35-14:55	[22] Hydrogen Production by Aluminum, Copper Doped Zinc Oxide Semiconductor ***Bulut Hüner, Esra Telli, Murat Farsak***
14:55-15:15	[89] Various Amine Compounds Stabilized Pd(0) Nanoparticles: Synthesis, Identification and Catalytic Use in the Dehydrogenation of Dimethylamine-Borane ***Ebru Köktepe, Sibel Duman***
15:15-15:35	[103] Palladium Based Electrocatalysts for Ethylene Glycol Fuel Cells ***Özlem Gökdoğan Şahin, Hilal Demir Kıvrak***
15:35-15:55	[115] Copper-covered AA6013-T6 Al Anode(Al/Cu) for Al-Air Battery ***Rasiha Nefise Mutlu, Birgül Yazıcı***

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15:55-16:10	**Coffee Break**
16:10-17:10	**POSTER Session 2** *(Mithat Özsan Amphitheater Foyer Area)*
18:30-21:00	**GALA DINNER** *(Nezihe Yalvaç Uygulama Oteli)*

Mithat Özsan Amphitheater (HALL - B)	
10:45-12:25	**Session 8** - Thermochemical and photochemical hydrogen production and technologies **Chair: *Filiz Karaosmanoğlu***
10:45-11:05	[7] Performance Evaluation of a Photoelectrochemical Hydrogen Production Reactor under Concentrated and Non-Concentrated Light ***Yusuf Biçer*, *İbrahim Dinçer***
11:05-11:25	[61] Investigation the effect of annealing atmosphere and time on photoelectrochemical (PEC) properties of α-Fe2O3 photoanode ***Selim Demirci*, *Cevat Sarıoğlu***
11:25-11:45	[129] Energetic and Economic Analysis of On-board Hydrogen Production System in SI Engine Vehicle ***Habib Gürbüz, Hüsameddin Akçay, Ismail Hakkı Akçay, Selim Demirtürk***
11:45-12:05	[149] Transport Limitations of Oxygen Exchange in Solar Thermochemical Hydrogen Production: An Experimental Study on Co3O4 ***Atalay Çalışan*, *Serkan Kıncal, Deniz Üner***
12:05-12:25	[165] Investigation of Magnetic Field Effect on Hydrogen Production Performance by Aqueous Methanol Electrolysis ***Emrumiye Arli, Zeynep Baz, Hatice Karakilcik, Mehmet Karakilcik, Güray Kılınçeker***
12:25-13:30	**LUNCH** *(Ç.U. Center Cafeteria)*
14:00-16:15	**Session 11** - Hydrogen fuel cells **Chair: *Birgül Yazıcı***
14:15-14:35	[3] Investigation of Working Temperature Effect on Micro-Cogeneration Application of Proton Exchange Membrane Fuel Cell ***Yağmur Budak*, *Yağmur Özdemir, Yılser Devrim***
14:35-14:55	[4] Fabrication of cross-linked Polybenzimidazole membranes for high temperature PEM fuel cells and investigation of the amount of cross-linker used on membrane performance ***Yağmur Özdemir*, *Necati Özkan, Yılser Devrim***
14:55-15:15	[5] A comparative study on the modelling of flow plates with different channel design in PEM fuel cell / ***Elif Eker Kahveci*, *İmdat Taymaz***
15:15-15:35	[42] Production of CVD Graphene Electrocatalyst for Oxygen Reduction Reaction ***Mehmet Akif Azder*, *Ömer Salihoğlu, M. Suha Yazıcı***
15:35-15:55	[43] CVD Graphene Doping for Fuel Cell Electro-catalyst Development: Literature Survey / ***Mehmet Suha Yazici***
15:55-16:15	[109] Hydrogen production from municipal solid wastes by hydrothermal gasification ***Jale Yanik*, *Gözde Duman, Koray Akarsu, Tugba Keskin Gündoğdu, Kübra Arslan, Nuri Azbar, Haris Nalakth Abubackar***

İ. Akif Kansu Congress Hall (HALL - C)	
10:45-12:25	**Session 9** - Electrolytic hydrogen production and technologies **Chair:** ***Kemal Sangün***
10:45-11:05	[99] High-Yield Hydrogen Production Through Aqueous-Phase Reforming of Biomass Hydrolysate Over Carbon Nanotube Supported Pt Catalysts ***Burçak Kaya Özsel, Bahar Meryemoğlu, Berna Niş, Arif Hasanoğlu***
11:05-11:25	[100] Effect of SiC formation on sustainability of H2 production in the presence of Ni core-shell microsphere catalysts ***Gamze Gunduz Meric, Levent Değirmenci***
11:25-11:45	[110] Hydrogen Productionfrom the Methanolysis Ofammonia Borane BY Pd-Co/Al2O3 Coated Monolithic Catalyst ***Hatice Begüm Murathan, Gülay Özkan, Meryem Sena Akkuş, Derya Öncel Özgür, Göksel Özkan***
11:45-12:05	[111] Hydrogen Generation From the Dehydrogenation of Ammonia Borane By Using Amberlyst-15 Supported Catalysts ***Derya Öncel Özgür, Tayyibe Şimşek, Göksel Özkan, Meryem Sena Akkuş, Gülay Özkan***
12:05-12:25	[119] Grain Boundaries Contribution on Ionic Conductivity of Oxide Semiconductors ***Musa Mutlu Can, Shalima Shawuti, Mehmet Ali Gülgün, Ayşe Zehra Aroğuz, Harun Cerit***

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Mithat Özsan Amphitheater (HALL - A)	
08:30-10:05	**Session 12** - Hydrogen applications and technologies **Chair:** ***Sema Z. Baykara***
08:30-08:50	[45] Electrochemical preparation and characterization of NiPd deposited Ni-modified carbon felt electrodes and their application for hydrogen evolution reaction in alkaline solution ***Ramazan Solmaz***
08:50-09:05	[113] Two New Bio-inspired Distributed and One Side Inlet Honeycomb Flow Field Designs for PEM Fuel Cells and Performance Investigation of Models via CFD Tools ***Erman Çelik, Irfan Karagöz***
09:05-09:25	[124] Thermodynamic analysis of the carbon dioxide cycles driven by geothermal power system with hydrogen production ***Yunus Emre Yuksel, Murat Ozturk***
09:25-09:45	[143] Investigation of Hydrogen Production by using Silver Covered Platinum Electrode in Base Media ***Guray Kilincceker, Mehmet Karakilcik, Refik Cetin, Mustafa Kemal Sangun***
09:45-10:05	[75] Reduced graphene oxide assembled bimetallic PdM (M = Fe, Ag, Au) alloy nanoparticles as high-performance electrocatalysts for direct borohydride fuel cells ***Önder Metin, Melike Sevim, Marta Martins, Biljana Šljukić, Diogo M.f. Santos***
10:05-10:20	**Coffee Break**
10:20-12:00	**Session 14** - Biological hydrogen production and technologies **Chair:** ***Canan Acar***
10:20-10:40	[44] Preparation of MoPd deposited carbon felt electrodes and investigation of their electrochemical activity for hydrogen ***Derya Dilek Demir, Abdullah Salcı, Ramazan Solmaz***
10:40-11:00	[64] Investigation on part-load performance of a hydrogen-blended gasoline rotary engine at two speeds ***Teng Su, Changwei Ji, Shuofeng Wang, Lei Shi, Jinxin Yang, Xiaoyu Cong***
11:00-11:20	[156] Synthesis of Polymer Supported Ni (II) - Schiff Base Complex and Its Usage as a Catalyst in Hydrogen Generation From NaBH4 Hydrolysis ***Dilek Kilinç, Omer Sahin***
11:20-11:40	[172] Bonding Strength and Fuel Sealing Tests For Crofer®22 APU Solid Oxide Fuel Cell Metallic Interconnects ***Bülent Öztürk, Alparslan Topcu, Sultan Öztürk, Ömer Necati Cora***
11:40-12:00	[177] Study of the electronic properties of titanium oxide thin films for water photolysis and hydrogen production ***Cebrail Gumus, Yuksel Ufuktepe***

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Mithat Özsan Amphitheater (HALL - B)	
08:30-10:05	**Session 13** - Hydrogen transportation, distribution, security, strategies and policies **Chair:** ***Tanay Sıdkı Uyar***
08:30-08:50	[164] Approach to Design of Control Electronic on Energy Storage Systems of Hydrogen Fuel Cell Vehicles ***Yakup Hameş, Kemal Kaya, Ömer Türksoy, Arzu Türksoy***
08:50-09:05	[138] Role of Hydrogen in 100 % Renewable Energy Systems of the Future ***Tanay Sıdkı Uyar***
09:05-09:25	[158] Analysis of Control Strategies for Fuel Saving in the Hydrogen Fuel Cell Vehicles ***Yakup Hameş, Kemal Kaya, Ertuğrul Baltacıoğlu, Arzu Türksoy***
09:25-09:45	[159] Nuclear-based Hydrogen Production Cost Evaluation for Two Possible Nuclear Power Plants ***Fatih Sorgulu, Ibrahim Dincer***
09:45-10:05	[81] Future of the Hydrogen Energy at the light of Transatlantic Trade and Investment Partnership – ''TTIP '' between the USA and EU ***Sudi Apak, Erhan Atay, Duygu Erdoğan, Güngör Tuncer***
10:05-10:20	**Coffee Break**
10:20-12:00	**Session 15** - Hydrogen storage materials and technologies **Chair:** ***Güngör Tuncel***
10:20-10:40	[32] Methods of Hydrogen Storage in Energy Conversion Systems ***Muhittin Bilgili***
10:40-11:00	[41] Comperative analysis of two mobile cooling systems with solar source and energy storage in off-grid areas ***Ümit Deniz Akyavuz, Hasan Özcan***
11:00-11:20	[134] Experimental investigation of Ni-doped multi-walled carbon nanotubes for Hydrogen storage at different temperatures ***Songül Kaskun, Muhammet Kayfeci***
11:20-11:40	[53] Daily Performance Assessment of an Integrated Thermal System on Hydrogen Production ***Ayhan Atiz, Mustafa Erden, Müzeyyen Cilogullari, Mehmet Karakilcik***

12:00-13:30	**LUNCH (Cafeteria)**
14:00-18:00	**TARSUS TAŞKUYU CAVERN ve Eshab-ı Kehf**
18:00-19:00	**DEPARTURE**
19:00-21:00	**DINNER (ATOSEV Restoran)**

March 18, 2017

Mithat Özsan Amphitheater (HALL - A)	
09:00-11:00	**Session 16** - Modeling, energy and exergy analysis **Chair:** ***Canan Acar***
09:00-09:20	[52] Energetic and Exergetic Investigations of an Innovative Light-based Hydrogen Production Reactor / ***Canan Acar, Ibrahim Dincer***
09:20-09:40	[147] Investigation of the Underground Hydrogen Storage Structures ***Hatice Karakilcik***
09:40-10:00	[56] Estimation of required hydrogen flow rate for PEMFC by using artificial neural network ***Mehmet Seyhan, Yahya Erkan Akansu, Mustafa Sarioglu***
10:00-10:20	[57] Investigation of Effect of Spark-Plug Plasma Synthetic Jet Actuator on Pem Fuel Cell Performance ***Yahya Erkan Akansu, Mehmet Seyhan, Cihan Yesildag, Vuralcan Hammutoglu***
10:20-10:40	[166] Enhancement of Efficiency on Hydrogen Network via Pinch and Exergy Analysis ***Fatma Alyer, Zehra Özçelik***
10:40-11:00	[171] An investigation on exergetic performance of hydrogen gas flowing through the annular curved duct. / ***Adnan Midilli, Haydar Kucuk, Ugur Akbulut***
11:00-11:15	**Coffee Break**
14:00-16:00	**PANEL (Türkiye'nin Sürdürülebilir Kalkınmasında Temiz Enerji Çözümleri ve Hidrojenin Rolü)**

Mithat Özsan Amphitheater (HALL - B)	
09:00-11:40	**Session 17** - Modeling, energy and exergy analysis **Chair:** ***Ramazan Solmaz***
09:00-09:20	[17] Performance Assessment of Calcium Bromide Thermochemical Cycle for Hydrogen Production / ***Fatih Yilmaz, Reşat Selbaş***
09:20-09:40	[24] Optimization of Particle Number, Substrate Concentration and Temperature of Batch Immobilized Reactor System for Biohydrogen Production by Dark Fermentation ***Pelin Gökfiliz Yıldız, İlgi Karapınar***
09:40-10:00	[181] Modelling of Hydrogen Production From Hydrogen Sulfide in Geothermal Power Plants / ***A. Karapekmez, Ibrahim Dincer***
10:00-10:20	[62] Biohydrogen Production from Acid Hydrolyzed Waste Wheat in a Continuously Operated Packed Bed Reactor / ***Betul Kirli, Ilgi Karapinar***
10:20-10:40	[79] Thermodynamic analysis of OTEC based hydrogen production system ***Murat Öztürk, Fatih Yilmaz, Reşat Selbaş***
10:40-11:00	[188] A Numerical Analysis of an Ejector for Micro Combined Heat and Power Systems Based on 1 kw Solid Oxide Fuel Cell ***Omer Genc, Serkan Toros, Mohammad Ziauddin Chowdhury,***
11:00-11:20	[189] Numerical Investigation of the Effect of Channel Width to Land Ratio on PEM Fuel Cell Performance / ***Mohammad Ziauddin Chowdhury, Omer Genc, Serkan Toros***
11:20-11:40	[151] Parametric Analysis of Hydrogen Storage Taking into Account of Three Different Metal Hydride Materials ***Ümran Elmas, Fevzi Bedir, Muhammet Kayfeci***

POSTERS / *Chair: Uğur Akbulut*

AbsRef	Abstract Title
0029	Preparation of electrochemically Mo-deposited carbon felt electrodes for alkaline water electrolysis: Optimization of pH, current and metal amount Derya Dilek Demir, Abdullah Salcı, Ramazan Solmaz
0046	Hydrogen production by alkaline water electrolysis at activated Cu/NiCuZn electrodes: Metal ratio, deposition current density and thickness optimizations Ramazan Solmaz, Gülfeza Kardaş
0047	The effect of diameter of three-dimensional silver nanodomes on electrochemical hydrogen production Handan Yüksel, Ayşe Özbay, Mehmet Kahraman, Ramazan Solmaz
0058	Graphene Aerogel supported Platinum catalyst for formic acid electrooxidation Mehmed Selim Çögenli, Ayşe Bayrakçeken Yurtcan
0067	Effect of Temperature on Catalytic Gasification of Biomass for Hydrogen Production Bahar Meryemoğlu, Mehtap Kurtuluş, Ihsan Demirci, Sibel Irmak, Arif Hasanoglu
0068	Low Temperature-Steam Phase Catalytic Gasification of Biomass Hydrolysates Arif Hasanoğlu, Bahar Meryemoğlu, Ihsan Demirci, Sibel Irmak
0074	Catalytic activity of PtRu/C, PtPd/C and PtSn/C bimetalic catalysts toward methanol oxidation reaction Mehmed Selim Çögenli, Ayşe Bayrakçeken Yurtcan
0084	Photoelectrochemical Activity of ZnO Nanorods: Synthesis and characterization Fatih Tezcan, Asad Mahmood, Gülfeza Kardaş
0091	Hydrogen Release from Dehydrogenation of Ammonia Borane by Isolable And Reusable In Situ Generated Oleylamine Stabilized Nickel(0) Nanoparticles Sibel Duman
0094	Bimetallic PdM (M: Au, Fe) Alloy Nanoparticles Assembled on Reduced graphene oxide as Highly Efficient Catalysts for Hydrogen Evolution Reaction Melike Sevim, J.a.s.b Cardoso, D.s.p. Cardoso, D.m.f. Santos, Önder Metin
0097	Synthesis of CoB Nano-Powder as Electrode Material Nilüfer Küçükdeveci, Mustafa Anık
0098	Electrocatalytic Hydrogen Production on GCE/RGO/Au Hybrid Electrode Didem Balun Kayan, Merve Ilhan, Derya Koçak
0105	Noble Metal-Free Oxides for the Oxygen Evolution Reactions Prepared by Adam's Fusion Method Nesrin Demir, Mehmet Fatih Kaya, Mehmed Selim Çögenli
0107	Monodisperse Pd Nanoparticles assembled on rGO-Fe3O4 nanocomposites as a high-performance electrocatalyst for borohydride fuel cells Buse Sündü, Melike Sevim, Marta Martins, Biljana Šljukić, Diogo M.f. Santos, Önder Metin
0116	Development of Tungsten or Ceria Incorporated Mesoporous Alumina Supported Nickel Catalysts for Hydrogen Production through Diesel Steam Reforming Reaction Arzu Arslan Bozdağ, Arife Derya Deniz Kaynar, Naime Aslı Sezgi, Timur Doğu
0117	Sorption Enhanced Steam Reforming of Ethanol with Ceria-SBA-15 Supported Nickel Catalysts Merve Sarıyer, Arzu Arslan Bozdağ, Naime Aslı Sezgi, Timur Doğu
0130	Fabrication, characterization and hydrogen evolution activity of three-dimensional nickel nanodomes Bedia Semra Taşçı, Handan Yüksel, Ramazan Solmaz

SCIENTIFIC PROGRAM

0136	Bimetallic nanoparticles for alcohol oxidation Hilal Demir Kıvrak, Özlem Gökdoğan Şahin
0140	Utilization of N-doped carbon materials obtained from ZIF as catalyst support for PEM fuel cell Niyazi Özçelik, Ayşenur Öztürk, Gamze Bozkurt, Mehmed Selim Çögenli, Ayşe Bayrakçeken Yurtcan
0145	Performance Analysis of a Conceptual Hydrogen Fueled Ramjet Engine: Exergetic Perspective Yasin Şöhret, Selçuk Ekici, T. Hikmet Karakoç
0154	Diamond like carbon (DLC) coated on TiO2-NT-Ag electrode by MW ECR plasma system for hydrogen production Evrim Baran, Zeynep Baz, Ramazan Esen, Birgül Yazıcı
0162	Steam reforming of triolein as a model compound of edible oil for H2 production via thermodynamic analysis Ömer Faruk Gül, Şeyma Özkara Aydınoğlu
0163	Hydrogen Storage Capacity of Palladium Doped Multi Wall Carbon Nanotubes Prepared via Supercritical CO2 Depostion Method Ebru Erünal, Fatma Ulusal, Deniz Kaya, Mustafa Y. Arslan, Bilgehan Güzel, Deniz Üner
0167	Preparation of a Novel Composite Hydrogel Loaded Cobalt and Hydrogen Production from Hydrolysis of NaBH4 Duygu Alpaslan, Tuba Ersen Dudu, Nahit Aktas
0168	The preparation of a composite-catalyst system and Hydrogen Production from Hydrolysis of NaBH4 Tuba Ersen Dudu, Duygu Alpaslan, Nahit Aktas
0169	The Preparation of p(DMAAm-co-APTMACl) Hydrogel and Their Use as Catalyst for Hydrogen Generation from Hydrolysis of NaBH4 Duygu Alpaslan, Tuba Ersen Dudu, Nahit Aktas
0179	Reliability of Numerical SOFC Tools for Computing Spatial Current and Temperature Variations Özgür Aydın, Hironori Nakajima, Tatsumi Kitahara

KEYNOTE SPEAKERS

KEYNOTE SPEAKERS

Development of Rare Earth Free Metal Hydrides for Electrochemical Hydrogen Storage

Tayfur Öztürk

Middle East Technical University

Renewable energy, namely solar and wind, has now a considerable share in the total energy generation and it is expected to rise in coming years. This creates a considerable demand for batteries both for grid scale and for off-grid energy storage. Lead –acid and Li-ion batteries are well established, but efforts do continue to produce more efficient, lower cost batteries with extended cycle life and ease of recyclability. NiMH batteries which had a considerable share in 90's for home electronics and portable devices has lost its share to a Li-ion batteries with higher energy density. One of the reasons for this switchover was indeed the higher energy density of Li-ion batteries, the other was related to marketing strategy of rare earth elements, which are used quite extensively as AB5 compounds in NiMH batteries. Whether for grid or off-grid energy storage, the weight is of secondary importance and there is a considerable room for application for NiMH batteries with its mature and reliable technology.

In fact, considerable progress has been made both in anode and cathode of NiMH batteries where the energy density is now approaches that of Li-ion batteries. Together with improved flexible design, the recyclability has improved quite considerably. Our effort to produce cost-effective metal hydride batteries center on two groups of materials. One is the so-called AB2 alloy which makes use of multi-component chemistry with discharge capacity is comparable to that of AB5. Here efforts are concentrated on means of easy activation, as normally AB2 alloys require a number of cycles before they could display their full capacity. The other is magnesium alloys which potentially has discharge capacity 4-5 times that of AB5, but suffers from corrosion in alkaline environment. Studies here explores the possibility of means of isolating the active material from the alkaline environment while making hydrogen permeation possible.

Keywords: Electrochemical Hydrogen Storage, Metal Hydrides, Li-ion batteries

KEYNOTE SPEAKERS

Development of Renewable Hydrogen Energy Systems

Inci Eroglu

Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Hydrogen energy system is bio-analog strategy for the sustainable future. Photosynthesis is one of the most efficient way to store solar energy. Plants, algae and photosynthetic microorganisms have developed their energy transduction centers and they know how to do this energy transformation and storage. Man exploits photobiological and photobiomimetic production of hydrogen. Biological hydrogen production processes, namely biophotolysis, dark fermentation and photofermentation, offer the prospect of producing hydrogen from renewable sources. Rhodobacter species are photosynthetic purple non sulfur bacteria that can produce hydrogen from small-chain organic acids derived from biomass at the expense of light energy. Laboratory scale biohydrogen studies have mostly been carried out with synthetic culture media. High production costs associated with these media are prohibitive for large scale processing, and as a result, the utilization of waste materials as renewable microbial substrate sources is increasingly being considered to address the economic restrictions of biological hydrogen production. Therefore, recent studies are based on the utilization of food and agricultural side products and waste materials with high levels of organic compounds as feedstock. This approach can potentially connect the benefits of energy production with waste management.

Scientific and market strategy is essential in developing biological hydrogen production processes. Here the focus is on the applied issues of photofermentative H2 production using purple non sulfur bacteria (PNSB), and in particular, the optimization of the process on real feedstock such as olive mill wastewater, dark fermenter effluents of thick juice and molasses.

A long-term stable operation is limited by environmental factors, as photobiological hydrogen production has to be carried out in outdoor conditions relying on natural sunlight for an energy-efficient process. Based on the current state of the knowledge in the field, the future applicability and prospects of these systems are evaluated. Strategies to overcome the problems are outlined.

Keywords: Biological hydrogen production, renewable hydrogen, photofermentation

KEYNOTE SPEAKERS

Hydrogen Gas Production by Electrohydrolysis of Organic Wastes

Fikret Kargi

Dokuz Eylul University, Buca, İzmir

Hydrogen gas is a clean energy source with high energy content (122 KJ/g) and also an effective electron carrier. Hydrogen is used for electricity generation in fuel cells and also as a fuel in hybrid automobiles. Present production technologies for H2 gas require high energy input and are expensive. In search of less energy intensive and inexpensive technologies for H2 gas production we have developed a new approach which is electrohydrolysis of organic wastes yielding 99% pure H2 gas.

Partially digested and volatile fatty acids (VFA) containing organic wastes were used for H2 gas production by applying electrical current obtained from photo-voltaic cells (PVC). Different wastes and electrodes were used for this purpose. Among the wastes used for this purpose are: Bakers yeast industry wastewater, anaerobic/aerobic sludge, olive processing wastewater, landfill leachate and cheese whey. Stainless steel, aluminum,and graphite electrodes were used at different voltages varying between 0.5 and 5 V. The most suitable electrode was aluminum and the optimum applied voltage was 2-3 V yieding the highest energy conversion efficiency and H2 gas production. Landfill leachate was found to be the most suitable organic waste among the others tested yielding the highest cumulative H2 production (5000 ml) within 96 h, the highest hydrogen formation rate (HFR, 1277ml/d), and hydrogen yield (HY, 2400 ml/g COD). The gas phase was 99% hydrogen. COD removal and energy conversion efficiencies were 77% and 80%, respectively.

Hydrogen gas production by electrohydrolysis of organic wastes is an energy efficient, and inexpensive method as compared to other alternatives yielding nearly pure H2 gas.

Keywords: electrohydrolysis, hydrogen gas, organic wastes

KEYNOTE SPEAKERS

Hydrogen: Sources and Production

Sema Z. Baykara

Yıldız Technical University

Growth in population and economy in the present world are directly proportional to fossil fuel utilisation, environment deterioration and anthropogenic climate change [1,2]. At current consumption rates, world's proven coal, oil and natural gas reserves are expected to last for approximately 200, 40 and 60 years. The overall fossil energy resources are expected to be in decline following peak production rates of liquid fuels and natural gas finally in 2013 [3]. A "sustainable energy source" would be one that is not substantially depleted by continued use, does not involve significant pollutant emissions or other environmental problems, health hazards or social injustices [4-8]. Renewable energy forms, especially hydrogen produced from water using solar energy comes very close to this definition. However, there are other considerations such as process efficiencies and production costs in addition to environmental impact generally evaluated through life-cycle analyses. More than 90% of commercial hydrogen is obtained from hydrocarbons with established infrastructures such as natural gas, which is mostly methane. Coal is another source for hydrogen. Chemical grade hydrogen is produced from water by electrolysis. Abundantly available biomass and hydrogen sulphide are emerging as new possible sources for hydrogen [9, 10]. Terms of availability of hydrogen, its properties and possible sources and its production methods, and finally, its relationship with renewable energy utilisation, environment and climate are considered.

References

1. Meadows DH et al, Limits to Growth, Universe Books, New York, 1972.
2. Houghton JT et al, Climate Change: The IPCC Scientific Assessment, Cambridge University Press, Cambridge, 1990.
3. BP Statistical Review of World Energy, (www.bp.corn)
4. Boyle G, editor. Renewable energy, power for a sustainable future. Oxford: Oxford University Press, 2004.
5. Veziroglu TN. Ecohealth problems and climate change II: Permanent solution to environmental problems: hydrogen energy system. IFSSH World Congress Health Challenges of the Third Millenium. Book of Invited Background Papers, pp.315-335, Istanbul, August 21-26, 2005.
6. Barbir F, Veziroglu TN, Plass HJ Jr. Environmental damage due to fossil fuel use. Int J Hydrogen Energy 1990; 15(10): 739-750.
7. Veziroglu TN, Barbir F. Hydrogen energy technologies. Vienna: UNIDO, 1998.
8. Baykara SZ. Hydrogen as fuel: a critical technology? Int J Hydrogen Energy 2005; 30(5): 545-553.
9. P. Basu, Combustion and gasification in fluidized beds, Taylor and Francis, 2006.
10. J. Zaman, A. Chakma, Production of hydrogen and sulfur from hydrogen sulphide, Fuel Process Technol, 41 (1995), pp. 159-198.

Keywords: Hydrogen, Sources, Production

INVITED SPEAKERS

Energy Storage - Key Technology For Sustainable Future

Halime Omur Paksoy

Cukurova University

Fossil fuel share in global total final consumption (TFC) was 66.4% in 2014. Moreover, 66.7% of electricity generation, which has 18.1% share in TFC, is also throughfossil fuels (IEA, 2016 a). This fossil fuel dominant energy consumption increases CO2 emissions that lead to climate change threatening our future. Annual CO2 emissions have increased by more than 50% since 1973. In 2015, the average concentration of CO2 in the atmosphere reached to 399 ppm, 40% higher than the pre-industrial level with an average increase of 2 ppm/ year in the past decade (IEA, 2016 b). The resulting climate change imposes immediate actions to be taken. Among the technologies reducing CO2 emissions, renewables with 32% and end-use energy efficiency by 38% are highest contributors according to International Energy Agency's 2-Degree Scenario, which aims no more than 2°C warming above pre-industrial levels by 2050. Meeting these ambitious targets can make the new energy system too complex. We need an optimal transition to a low-carbon energy system for sustainable future. Energy storage with various alternatives has a key role for a smoothtransition. Energy can be stored based on energy transformations between different energy forms, such as thermal, mechanical, chemical and magnetic according to laws of thermodynamics. Energy transformations and possible energy storage technologies can be grouped as: Magnetic (superconducting magnetic energy storage), Mechanical (flywheels, pumped hydro, compressed air energy storage), chemical (electrochemical, hydrogen, CO2, other fuels), thermal (sensible, latent, thermochemical). The roles energy storage can play through these technologiesare:(1) Optimizing renewable integration, (2) Increasing energy efficiency, (3) Stabilizing energy grid stability, (4) Flexibility in energy form. The potential use of energy storage in the value chain of sustainable will be given with examples from around the world in this paper.

Keywords: Energy Storage, Key technology, Sustainable Future

INVITED SPEAKERS

Future of Hydrogen Usage in Automotive Industry

Kadir Aydın

Çukurova University, Department of Automotive Engineering

About 88% of hydrogen is made from fossil fuels like natural gas, liquid hydrocarbons and coal. Electrolysis is the most common method used to split H2 from water and currently, about 12% of hydrogen production globally source is presented by electrolyses. Steam electrolysis uses heat, instead of electricity, to provide some of the energy needed to split water and can make the process more energy efficient. Electricity and hydrogen are convertible one to the other as energy carriers. In the short term, hydrogen can be produced economically by electrolysis of water in off-peak periods, enabling much greater utilisation of base-load generating plants, including nuclear ones. In future, a major possibility is decomposition of water by direct use of heat from nuclear energy, using a chemical process enabled by high-temperature reactors. The rapidly-growing demand for hydrogen favours technologies with low fuel costs, and the scale of hydrogen demand is appropriate to its production by nuclear reactors. Burning hydrogen produces only water vapour, with no carbon dioxide or carbon monoxide. However, it is far from being an energy-dense fuel, and this limits its potential use for motor vehicles. For transport, hydrogen's main use will be in fuel cells. A fuel cell is conceptually a refuelable battery, making electricity as a direct product of a chemical reaction. But where the normal battery has all the active ingredients built in at the factory, fuel cells are supplied with fuel from an external source and oxygen from the air. They catalyse the oxidation of hydrogen directly to electricity at relatively low temperatures and the claimed theoretical efficiency of converting chemical to electrical energy to drive the wheels is about 60% (or more). However, in practice about half that has been achieved, except for the higher-temperature solid oxide fuel cells – 46%. Fuel cells are currently being used in electric forklift trucks, automobiles and buses and this use is expected to increase steadily. They apparently cost about three times as much as batteries but last twice as long (10,000 hours) and have less downtime. Japan had a goal of 5 million fuel cell vehicles on the road by 2020.

Hydrogen and fuel cell technologies promise considerable benefits in terms of energy security and CO2 emission, but they require significant technical breakthroughs, cost reduction and appropriate policies to enter the energy market. Fuel cell and hydrogen energy is highly fragmented. The initial use of hydrogen for transport is likely to be municipal bus and truck fleets, and prototypes have already been on the road in many parts of the world. These are centrally-fuelled, so avoid the need for a retail network, and on-board storage of hydrogen is less of a problem than in cars.

Keywords: Hydrogen, fuel cell, hydrogen refuelling stations, hydrogen storage, hydrogen mobility

ORAL ABSTRACTS

ORAL ABSTRACTS

[**Abstract:0002**]

Performance Investigation of Zirconium Hydrogen Phosphate / Sulphonated Polysulfone Composite Membrane Based DMFCs

***Mustafa Ercelik*[1], *Yagmur Ozdemir*[2], *Adnan Ozden*[3], *Yilser Devrim*[4], *Can Ozgur Colpan*[5], *Feridun Hamdullahpur*[3]**

[1]Dokuz Eylul University, The Graduate School of Natural and Applied Sciences, Mechanical Engineering Department, Tinaztepe Campus, 35397, Buca, Izmir, Turkey
[2]Middle East Technical University, The Graduate School of Natural and Applied Sciences, Department of Polymer Science and Technology, 06800, Ankara, Turkey
[3]University of Waterloo, Mechanical and Mechatronics Engineering Department, 200 University Avenue West, Waterloo, Ontario, N2L 3G1, Canada
[4]Atılım University, Department of Energy System Engineering, 06836 Incek, Ankara, Turkey
[5]Dokuz Eylul University, Faculty of Engineering, Mechanical Engineering Department, Tinaztepe, Buca, Izmir, 35397, Turkey

The performance of direct methanol fuel cells (DMFCs) largely depends on which kind of membrane is used. The reason is that, the cell performance is affected by the membranes' properties such as methanol permeability and proton conductivity. In this study, zirconium hydrogen phosphate / sulfonated polysulfone (ZrP / sPS) composite membranes, which could be alternatives to Nafion® membranes, were prepared. ZrP / sPS composite membranes and commercial Nafion®115 membrane were used in order to prepare membrane electrode assemblies (MEAs). Then, the experimental investigations of the MEAs were conducted. In this context, ZrP / sPS composite membranes were prepared by casting method using different sulphonation degree of sPS polymers while maintaining 2.5 wt.% ZrP. ZrP / sPS composite membranes were extensively characterized by Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA), and water uptake measurement. Single cell performance tests were performed with different cell temperatures and methanol concentrations for DMFCs based on sPS / ZrP composite membranes which were manufactured with different sulphonation degrees and Nafion® 115 membrane. In addition to these tests, short-term life characteristics of all the MEAs were investigated. When the results obtained from this study were evaluated, the potential use of ZrP / sPS based membranes in DMFCs was demonstrated.

Keywords: Direct methanol fuel cells, zirconium hydrogen phosphate / sulfonated polysulfone based composite membranes, characterization, experimental.

ORAL ABSTRACTS

[**Abstract:0003**]

Investigation of Working Temperature Effect on Micro-Cogeneration Application of Proton Exchange Membrane Fuel Cell

***Yağmur Budak*[1], *Yağmur Özdemir*[2], *Yılser Devrim*[1]**

[1]Atılım University Energy System Engineering Department, Incek Ankara Turkey
[2]Middle East Technical University, Polymer Science and Engineering Department, Cankaya Ankara Turkey

Among all fuel cells, proton exchange membrane fuel cells (PEMFC) gain the highest interest and are the topics of research because of their high power densities, modular structures and negligible emission rates. Lately, besides the portable and stationary applications of fuel cells, co-generation applications have become popular. Co-generation is utilization of both power and heat simultaneously. Besides the primary electrical output of the system, hot water can also be utilized for heating applications. For high power capacity co-generation application, usually solid oxide fuel cells (SOFC) are being used. But lately, for low power household applications, high temperature proton exchange membrane fuel cells (HT-PEMFC) are found to be useful. PEMFCs however have some advantages for co-generation due to their small size, high power production capabilities, and high efficiencies.

In this study, it was aimed to increase the productivity of PEMFC by micro-cogeneration application and to compare the fuel cells which have different operation temperature. The 1 kW PEM fuel cell operating at a temperature range of 60-80oC was compared with the 1 kW PEMFC operating at temperature range of 160-200oC. First of all, 1 kW PEMFC micro-cogeneration systems which have two different working temperature were designed by using experimentally determined current density values. Different cooling systems have been used in the designed systems due to the difference of the released heat values from the PEMFC according to the working temperatures. As a result of the design calculations, micro-cogeneration systems cost was determined. The results obtained in the study show that the use of the heat generated from PEMFC improves the system efficiency and more efficient micro-cogeneration system can be achieved by using high working temperature of PEMFC.

This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK) 1001 (Grant number: 214M301) Project.

Keywords: Proton Exchange Membrane, Fuel cell, Micro- cogeneration

ORAL ABSTRACTS

[**Abstract:0004**]

Fabrication of Cross-Linked Polybenzimidazole Membranes for High Temperature PEM Fuel Cells and Investigation of The Amount of Cross-Linker Used on Membrane Performance

***Yağmur Özdemir*[1], *Necati Özkan*[2], *Yılser Devrim*[3]**

[1]Middle East Technical University, Graduate School of Natural and Applied Sciences, Polymer Science and Technology, 06800 Ankara
[2]Central Laboratory, Middle East Technical University, 06800 Ankara
[3]Atılım University, Faculty of Engineering, Energy Systems Engineering, 06836 Ankara

Today, a lot of research on development of alternative low cost, high temperature membranes for proton exchange membrane (PEM) fuel cells is being conducted due to the limitations of industry standard perfluoro-sulfonic acid (PFSA) membranes. These limitations, such as the decrease in performance at temperatures above 80˚C and high cost, restrains the commercialization of PEM fuel cells. Polybenzimidazole (PBI) based membranes are being investigated as an alternative to Nafion® membranes. Fuel cells with PBI/H3PO4 were found to be successful due to their high thermochemical stability between 120˚C–180˚C with high conductivities. However, acid leaching is a major concern in the presence of liquid water which leads to a drop of conductivity of many orders of magnitude during fuel cell operation. Cross-linking the membranes is an alternative way to prevent acid being leached from the membranes. In this study, Bisphenol A diglycidyl ether (BADGE) was used as cross-linker for PBI membranes. Aim of this study was to prepare cross-linked PBI membranes for HT-PEMFCs and to investigate the effect of cross-linker amount on the performance of the membranes. Cross-linked membranes prepared with 2.5 wt%, 5wt% and 7.5 wt% of BADGE, were characterized and compared with pristine PBI membrane. TGA, FTIR and DMA analysis, proton conductivity measurements, acid leaching and chemical stability tests were conducted within the scope of this study. Membrane Electrode Assemblies (MEAs) with 5cm2 active area were prepared for HT-PEMFC tests. Then, MEAs were tested at 160oC, using hydrogen and air as reactants. Results showed that cross-linked membranes performed better in HT-PEMFC tests compared to pristine PBI membrane.

This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK) under project TUBITAK 1001-214M301.

Keywords: Cross-linked PBI membrane, High Temperature PEM Fuel Cell, Hydrogen Energy

ORAL ABSTRACTS

[**Abstract:0005**]

A Comparative Study on the Modelling of Flow Plates with Different Channel Design in PEM Fuel Cell

Elif Eker Kahveci, İmdat Taymaz

Engineering Faculty,Department of Mechanical Engineering,Sakarya University,Sakarya,Turkey

The proton exchange membrane fuel cell (PEMFC) is an advantageous power source of electrical vehicle especially for its characteristics as its high efficiency, low operating temperature, high power density, low emission and low noise. In this study, a three-dimensional, single-phase, single and double serpentine channel of PEM fuel cell models have been developed to investigate performance of fuel cell by determining the current density with different humidity conditions. The numerical simulation was carried out with a PEM fuel cell add-on module based on the computational fluid dynamics software ANSYS Fluent® 16.2. The simulation results were illustrated polarization curves including I–V and I–P curves. The simulations were compared the performance of PEM fuel cells with flow fields which have 70x70 mm2 active layer. Oxygen, hydrogen and water molar concentration of fuel cell at the interface of between cathode catalyst and gas diffusion layer were examined and compared at different gas flow channel and humidification. It was found from simulation results that the current density of fuel cell obtained from the double serpentine flow channel were higher than current density obtained in single serpentine channels.

Keywords: Proton Exchange Membrane Fuel Cell, Polarization curve, Humidification

ORAL ABSTRACTS

[**Abstract:0007**]

Performance Evaluation of a Photoelectrochemical Hydrogen Production Reactor under Concentrated and Non-Concentrated Light

Yusuf Biçer, İbrahim Dinçer

Clean Energy Research Laboratory, Faculty of Engineering and Applied Science, University of Ontario Institute of Technology

This work presents performance analyses of a newly developed photoelectrochemical (PEC) reactor for the production of hydrogen under light and concentrated solar radiation including electrochemical impedance spectroscopy (EIS). With a newly developed device, the solar-light is condensed about 10 times and the voltage-current graph of the photoelectrochemical reactor is examined and the hydrogen production quantities are measured. The application of the electrochemical impedance spectroscopy analysis allows the determination of the fundamental losses limiting the performance of the reactor containing copper oxide as photo-cathode. Copper oxide, which is used as a light-sensitive material, is electrochemically coated on the cathode metal plate to increase the rate of hydrogen evolution. An experimental setup was conducted to investigate the variation of reactor performance with intensified light conditions and the results obtained were compared to the dark conditions. Equivalent electric circuit is modeled for the developed photoelectrochemical cell and fitted to the experimental data. Since electrochemical impedance spectroscopy is an important approach for determining the charge transfer events that take place in photoelectrochemical cells, the present results reveal the distribution of the losses occurring in the cell. Under higher applied voltages and intensified light, the loss of activation is reduced. Under concentrated light conditions, Warburg diffusion element increases the effect of mass transfer by decreasing element values.

Keywords: Hydrogen; photoelectrochemical; concentrated light; performance; electrochemical impedance spectroscopy.

[**Abstract:0008**]

Biohydrogen Production with C. intestinale in Lignocellulosic Substrates

Serpil Özmıhçı, Gülsün Gizem Taylan, Merve Özlem Vurmaz

Environmental Engineering Department, Dokuz Eylül University, Tınaztepe Campus, Buca, İzmir

The most important facts of the day by day growing energy needs depend on the population growth and the associated industrialization and the rise of uncontrolled urbanization. Fossil fuels do not meet needs and bring along as well as the climate change, global warming, environmental issues, such as the deterioration of air quality. The framework of 2011-2023 Development Plan and the National Action Plan on Climate Change, pointed out reduction of fossil fuel energy density, production and increasing the share of use of clean energy as policies of our country. In particular, the EU target 2020 is to provide 20% energy from renewable energy sources of the total within the use of 10% renewable energy sources in transport rather than the use of petrol and diesel. Among these resources it counts wastes, residues, non-food cellulosic materials and lignocellulosic materials.

In achieving the goals of our country and Europe; bio-hydrogen production from waste sources, has gained importance in recent years. It stands out as one of the potential responses that could form the backbone of green technology as well as provides to achieve sustainable development, renewable energy use, mitigation of the effects greenhouse gases, high energy value (122kJ g-1), and from environmental point of view waste reduction and recycling. Biohydrogen gas production was tested with many different configurations and organisms. However it's clearly been understood that there is still a necessity to investigate substrate sources, pre-treatment methods, operation mode and conditions, the type of culture and the process flow sheet to reach economical solutions to achieve required bio-hydrogen gas production yields and rates.

The aim of this project is to evaluate the bio-hydrogen yield and rate with rice husk as a lignocellulosic substrate using C.intestinale dark fermentation. Dark fermentation was carried out at 37oC in mezophilic and static conditions to achieve an economic system. C. intestinale was grown in Medium 1191 and then was transferred to the experimental fermentation media. The max. cumulative hydrogen concentration was achieved with 20 g L-1 rice husk at 48 hours (23 mL). pH was around 6 till the end of the fermentation period. At the end of the fermentation time acetic acid was the dominat volatile fatty acid (0.6 g L-1). Furthermore cellobiose and glucose concentrations at the end of the fermentation period were 2.5 and 1.7 g L-1, respectively.

Keywords: Bio-hydrogen, rice husk, C.intestinale, batch fermentation

ORAL ABSTRACTS

[**Abstract:0010**]

Cost and Productivity Analysis of Storage and Distribution Processes of a Solar Driven Hydrogen Production Plant

***Murat Emre Demir*[1], *İbrahim Dinçer*[2]**

[1]Clean Energy Research Laboratory, Faculty of Engineering and Applied Science, University of Ontario Institute of Technology, Oshawa, Canada
[2]Faculty of Mechanical Engineering, Yildiz Technical University, Besiktas, Istanbul, Turkey

In this study, performance and cost analysis including the stages of hydrogen production, storage and distribution of a solar-based hydrogen production plant. First, the solar energy driven Rankine cycle generates the electricity for the system needs. The generated electricity is converted into the direct current at the AC-DC converter and runs the electrolyzer with proton exchange membranes for electrolysis of water. The produced hydrogen in the electrolyzer is stored and transported to the nearby cities for distribution. Three different scenarios are examined for the process of transportation of the produced hydrogen to the distribution centers. Transportation for hydrogen by the pressurized tanks, cryogenic liquid hydrogen tanker and the gas pipelines are selected as scenarios. Moreover, the transmission options from the distribution center to the target consumer are also examined for three different conditions. As a result, the hydrogen production capacity, the levelized cost of energy distribution (in ₺ / kg), the infrastructure costs (truck, tanker number, gas line costs, etc.) for the selected transmission scenario are obtained. Moreover, the environmental impact (greenhouse gas emissions) and the design parameters of the proposed system (e.g number of hydrogen fuel stations and the distance between these stations, the length of the distribution lines, etc.) are determined as an output of this study. The thermodynamic analysis is also conducted for the production process of hydrogen.

Keywords: Solar energy, hydrogen production, hydrogen storage systems, hydrogen distribution systems, cost analysis

ORAL ABSTRACTS

[**Abstract:0011**]

Preparation of Nickel and Bismuth Deposited Titanium Dioxide Nano-Tubes And Investigation of Electrochemical Hydrogen Production Performance

Başak Doğru Mert, Mehmet Erman Mert, Birgül Yazıcı Devrim

Çukurova University, Science and Letters Faculty, Chemistry Department, 01330 Balcalı, Adana, Turkey

In this study, titanium dioxide nano-tubes were produced and doped with Ni and Bi particles with the help of electrochemical process, to put forth the catalytic efficiency of electrodes on hydrogen evolution reaction (HER) in 1 M KOH, electrochemical impedance spectroscopy and polarization measurements were obtained. The characterization was achieved by cyclic voltammetry, scanning electron microscopy and energy dispersive X-ray analysis. The water wettability characteristics of electrode surfaces were investigated by measurement of contact angle. Due to produce nano-tubes, 17.5 V anodizing potential applied to Ti anode and Pt cathode during 30 min. in 0.1 M HF solution. The electrodeposition of nickel and bismuth was performed by galvanostatically in 30,00% NiSO4.7H2O, 1,00% NiCl2.6H2O, 1,25% H3BO3 (pH: 3.5) and 1 M HNO3 + 0,1 M Bi(NO3)3.5H2O + 0,1 M C4H6O6 (pH: 1.7-2.0). The [Ni2+]:[Bi3+] ratio was 99.5:0.5 in deposition bath. Titanium dioxide nano-tubes were used as working electrode, nickel as counter electrode and Ag/AgCl (3 M KCl) electrode was used as the reference electrode. Results showed that, Ni and Bi deposited titanium dioxide nano-tubes decrease the hydrogen over potential and increase HER efficiency.

Acknowledgements: The authors are greatly thankful to Çukurova University Research Fund for financial support

Keywords: Electrocatalysis, Hydrogen, TiO2 nano-tube

ORAL ABSTRACTS

[**Abstract:0012**]

Boron Based Hydrogen Storage Technologies and Synthesis of some Metal Borohydrides

***Gözde Bayazit*[1], Şadan Özcan[2], Mükerrem Şahin[1]**

[1]Energy Systems Engineering, Ankara Yıldırım Beyazıt Universty, Turkey
[2]Physics Engineering,Hacettepe Uniiversity, Turkey

Energy is the crucial problem in the world and renewable energies are alternative solutions. But these systems have energy storage problem. Hydrogen storage systems can be used to store energy which are produced with renewable systems. Because hydrogen is a good energy carrier and the energy of 1kg hydrogen gas is equivalent to the energy of 2.1 kg natural gas or 2.8 kg oil. Also, it can be used for fuel batteries. The hydrogen storage process classified in three different ways as solid, liquid and gas form. Among these methods, the best way to store that it is solid hydrogen storage. Solid state hydrogen storage is categorize two main group which are physical and chemical storage methods. In physical methods, hydrogen is stored in a structure that will hold the Van Der Waals forces. In chemical methods, hydrogen diffused of the structure and bind chemically. Borohydrides are promising materials for chemical hydrogen storage due to the high gravitational storage properties. For example, $LiBH_4$ 18.3% wt, $MgBH_4$ 14.8% wt, $NaBH_4$ 10.7% wt, $ZnBH_4$ 8.5% wt, have theoretical hydrogen storage capacity.

In this study, $Mg(BH_4)_2$ and $ZnBH_4$ are synthesized by ball milling tecnique. Centrifugal type grinder used for this process. $MgBH_4$ is synthesized by the reaction of elemental boron and magnesium with Ni catalyst. $Zn(BH)_4$ is synthesized with $NaBH_4$ and $ZnCl_2$ metathesis reaction. Structural analyzes of the materials was performed by using X-Ray Diffractometer. Fourier transform infrared spectroscopy used for analyzing the bond between hydrogen, boron and metals. For example, B-H and Zn-H bonds found between 2220-2375 cm^{1-} and 1540-1415 cm^{1-} respectively. After the Thermo-gravimetric analyze, their decomposition temperature was determined. $Mg(BH_4)_2$ and $Zn(BH)_4$ decomposed between 333-370 °C and 130-165 °C respectively. Their hydrogen storage kinetics are examined with Sievert type hydrogen storage capacity measurement apparatus.

Keywords: Hydrogen storage, Borohydrides, Ball millig tecnique

[**Abstract:0017**]

Performance Assesment of Calciumm Bromine Thermochemical Cycle for Hydrogen Production

***Fatih Yilmaz*[1], *Reşat Selbaş*[2]**

[1]Department of Electrical and Energy, Vocational School of Technical Sciences, Aksaray University
[2]Department of Energy System Engineering, Faculty of Technology, Suleyman Demirel University

In this study, performance assessment of Calcium Bromin (Ca-Br) thermochemical/ hybrid cycle for hydrogen production. The performance of each steps of the cycle is evaluated according to energy and exergy methods at different reference ambient temperatures. The overall energy and exergy efficiency of the cycle are calculated as % 46.64, %59.04, respectively, at 25 oC reference ambient temperature. As a result of, this cycle exhibits a good potential because of its high efficiency.

Keywords: Energy, exergy, hydrogen, Ca-Br2

ORAL ABSTRACTS

[**Abstract:0018**]

Biohydrogen Production by Extracted Fermentation from Sugar Beet

Serkan Eker, Burcu Erkul

Department of Environmental Engineering, Dokuz Eylul University, Izmir, Turkey

Energy demand is expected to increase considerably depending on the results of population growth and developments in the industry. Different types of fossil fuels are widely used to provide energy. But hydrogen gas is one of promising energy source, which can be easily used in future fuel cells. High cost of production and storage are important factor that caused delaying in considering hydrogen as an alternative energy source. In this study, biohydrogen gas production, which obtained from sugar beet, was increased by using the Extracted Fermentation method. It is possible to increase the production efficiency for biohydrogen gas production by Ex-Ferm. While microorganisms consume the soluble sugar in the liquid, they also consume sugar in the sugar beet, which is insoluble in the liquid medium. Therefore, surface area of substrate, substrate and biomass concentrations are of important parameters that affecting hydrogen gas production. For this purpose, sugar beet is established according to surface area and prepared as cubes. The surface area was changed 0.06 cm2, 0.54 cm2, 1.5 cm2, 2,94 cm2, and 6 cm2. Microorganism concentration (1 g/L) and sugar beet concentration (60 g/L) were kept constant in all the bottles according to previous study results. Cumulative biohydrogen gas volume increased depending on time and terminated at the end of 168 hours. The highest biohydrogen gas production efficiency was obtained from 0.06 cm2 sugar beets (146.25 ml). The lowest cumulative biohydrogen gas production was obtained from 6 cm2 sugar beet containing bottle (73.75 ml). There is not any production in the control bottle. Gompertz constants were calculated by STATISTICA program for different surface area of sugar beet. Cumulative hydrogen production data were correlated and the highest biohydrogen gas production potential values were calculated at 0.06 cm2 (143.61 mL/h) and 0.54 cm2 (94.46 mL/h) of surface area.

Keywords: biohydrogen, extracted fermentation, sugar beet

ORAL ABSTRACTS

[**Abstract:0021**]

Hydrogen Gas Production from Food Wastes by Electrohydrolysis Using a Statical Design Approach

Ebru Çokay

DEÜ University Environmental Engineering Department Kaynaklar Campus Buca İzmir,TURKEY

Hydrogen gas is identified as one of the major clean energy sources of the future due to its high energy content and reduced green house gas emissions as compared to fossil fuels. Hydrogen gas is not readily available in nature and is produced by some processes such as steam reforming of natural gas or electrolysis of water requiring high energy inputs. Despite the possibility of hydrogen production from water by electrohydrolysis, hydrogen production by electrohydrolysis from waste is an innovative approach and very effective. Electrohydrolysis of organic compounds present in waste materials is realized in anaerobic conditions. At this condition, the electricity obtained from the DC current source is supplied to the wastewater or system by means of the electrodes, hydrogen gas production close to 100% is possible in a very short time. The production of hydrogen gas from the wastes can cause the removal of organic matter and the waste could be assessed and reused.

In this study, food waste was subjected to different DC voltages for hydrogen gas production by using aluminum electrodes and a DC power supply. Effects of the applied DC voltage, reaction time and initial water content (%) on percent hydrogen gas production, cumulative hydrogen production and percent TOC removals from food wastes by electrohydrolysis were investigated.

Box-Behnken statistical experiment design was used for optimizing these reaction conditions. The optimum DC voltage/reaction time/water content ratio resulting in the maximum hydrogen gas production (100%), the highest cumulative hydrogen production (7000 mL), and TOC removal (33%) was found to be 5/75/80. Electrohydrolysis of food waste was proven to be an effective method for hydrogen gas production.

Keywords: Hydrogen gas, TOC removal, DC voltage, Electrolysis,; Food wastes, Box-Behnken

ORAL ABSTRACTS

[**Abstract:0022**]

Hydrogen Production by Aluminum, Copper Doped Zinc Oxide Semiconductor

***Bulut Hüner*[1], *Esra Telli*[1], *Murat Farsak*[2]**

[1]Energy Systems Engineering Department, Osmaniye Korkut Ata University, Osmaniye, Turkey
[2]Chemistry Department, Osmaniye Korkut Ata University, Osmaniye, Turkey

Photovoltaic cells (solar cells) are made of semiconductor materials that convert directly into electricity sunlight coming to the surface. The efficiency of photovoltaic cells is directly related to the semiconductor. Solar cells are silicon-based static systems produced by semiconductor technology using thin film materials. Transparent conductive oxides are used for the electrical conductivity and optical transparency in thin film technology. The most preferred is ZnO. Aluminum, gallium, and indium have widely used the substance to increase the conductivity of ZnO. In this study, we have prepared the dip-coating of ZnO on aluminum and/or copper doped with n-type semiconductor electrodes. Doublet new doping is procured as an alternative due to the low efficiency of produced ZnO up to this time. Hydrogen was produced by using new doped ZnO.

Keywords: Hydrogen, Dopping, Thin Film, ZnO

ORAL ABSTRACTS

[**Abstract:0024**]

Optimization of Particle Number, Substrate Concentration and Temperature of Batch Immobilized Reactor System for Biohydrogen Production by Dark Fermentation

***Pelin Gökfiliz Yıldız*[1], *İlgi Karapınar*[2]**

[1]Dokuz Eylul University, The Graduate School of Natural and Applied Sciences, Biotechnology Department, Izmir
[2]Dokuz Eylul University, Department of Environmental Engineering, Izmir

Using immobilized growth cultures for biohydrogen production by dark fermentation is superior to suspended cultures since higher hydrogen production yields, volumes and rates can be obtained by immobilized cultures. One of the important factor in immobilized bioprocesses is the type of support material used for immobilization of microorganisms. Hydrogen productivity of the bioprocess can be enhanced by using porous support materials which provide high biomass holding capacity and help better gas retrieve in the process. By considering these facts, biohydrogen production by dark fermentation in an immobilized batch process was studied and fermentation conditions which maximize hydrogen yield and production rate was optimized by using Box-Wilson statistical experimental design method in this study. Support particle used for immobilization purpose was polyester fiber with bead diameter Dp= 0.5 cm. Acid hydrolyzed wheat starch syrup which was obtained by hydrolysis of waste wheat powder by sulfuric acid at pH=2 and T= 90 ^{0}C for 15 min was used as substrate. Heat and acid pretreated anaerobic sludge was used as inoculum. The independent variables were X1; particle number (PN=120-240), X2; initial total sugar concentration (TS0=10-30 g/l) and X3; fermentation temperature (T=35-55^{0}C). Quadratic response equations for both independent variables were developed, coefficients of response equations were determined. The optimum conditions for the maximum hydrogen yield (YH2 = 3.21 mol H2/mol glucose) and production rate (HPR= 73.3 ml H2/h) were predicted as PN= 240, TS0 = 10 g/l and T= 44.9 ^{o}C.

Keywords: Biohydrogen, dark fermentation, immobilization, Box–Wilson design, optimization

[**Abstract:0030**]

Oxygen Production on Asymmetric Terminal Alkynyl Zinc Phthalocyanines and Modified Electrodes Using Click Electrochemical Technique

Duygu Akyüz, Atıf Koca

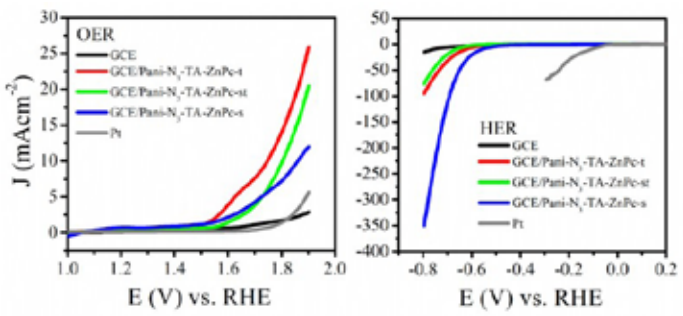
Department of Chemical Engineering, Faculty of Engineering, Marmara University, 34722 Göztepe, İstanbul-Türkiye

It is well known that overpotential limits the power density of fuel cells and the efficiency of electrolysis of water. Catalysts have been developed to reduce excessive stress of hydrogen and oxygen formation reactions to increase water electrolysis efficiency. In this study, newly modified electrodes were developed to reduce the extreme stresses in the electrolysis of water. The electrode modification was carried out by coating the MPc complexes containing the end alkynyl group with Pani-N_3 onto the electrode with the click electrochemical technique. Then, the electrocatalytic activities of the modified electrodes against the oxygen production reaction (OER) were investigated.GCE/Pani-N_3-TA-ZnPc-t, GCE/Pani-N_3-TA-ZnPc-st and GCE/ Pani-N_3-TA-ZnPc-s electrodes, were created by coupling of functional azide groups of Pani-N_3 and TA-ZnPc terminal alkynyl group with a new electrode modification technique called "click electrochemistry (CEC)" Modified electrodes were tested for direct-on-line voltammetry (LSV) and electrochemical impedance spectrometry (EIS). These electrodes were tested as a heterogeneous electrocatalyst for the Hydrogen Production Reaction (HER) and OER. As a result of these tests, it was observed that these electrodes did not exhibit any significant electrocatalytic activity against HER reaction when lowering the over-tension of OER when compared to the platinum (Pt) electrode. The GCE / Pani-N_3-TA-ZnPc-t electrode decreased the overvoltage in the OER reaction by about 250 mV and increased the current density by about 6 times compared to Pt electrode. This study demonstrates the utility of the modified electrodes obtained by the click electrochemical technique as an electrocatalyst in oxygen production.

Acknowledgment : This study was supported by TUBITAK project (Project No: 214Z092).

Keywords: Oxygen evolution, Metallophthalocyanines, Click electrochemisty, Hydrogen evolution reaction

Graphical abstract



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ORAL ABSTRACTS

[**Abstract:0032**]

Methods of Hydrogen Storage in Energy Conversion Systems

Muhittin Bilgili

Gazi University, Faculty of Engineering, Mechanical Engineering Department, Maltepe, Ankara

Alternative systems that meet today's energy needs are an important research topic. The required energy can be provided in different ways instead of the usual systems. Fuel cells operating by hydrogen can be used to provide this energy conversion. An effective and safe storage method is required for fuel cells to provide the necessary hydrogen during operation. In this study, the current hydrogen storage methods and new developments in these methods will be investigated. For example, in a fuel cell application where the power source is portable, a storage tank that carries hydrogen is needed. During the design of this reservoir, both volume and weight must be considered. In fixed applications, storage may not be so critical, as solutions can be found by connecting fuel cells to a hydrogen-to-natural gas pipeline. However, when a portable application is considered, a tank that stores high-density hydrogen is needed, even if the stack of fuel cells is optimally placed at a very small location. This can cause the total system to be too large to be accepted. Similarly, in automobile applications, a tank that stores hydrogen is needed. The hydrogen tank feeding the system must be at the capacity to pass the total distance covered by the fuel tanks in vehicles using fossil fuels. It is also expected that the energy densities in terms of volume and weight will be at least comparable to those of fossil fuel tanks. In this respect, it can be seen that it is difficult to store hydrogen in volumetric and weight as high energy density. This work will focus on the comparison of hydrogen storage methods developed today and the emerging innovations.

Keywords: Hydrogen, hydrogen storage, compressed hydrogen, liquid hydrogen, metal hydrides

ORAL ABSTRACTS

[**Abstract:0041**]

Comperative Analysis of Two Mobile Cooling Systems with Solar Source and Energy Storage in Off-grid Areas

***Ümit Deniz Akyavuz*[1], *Hasan Özcan*[2]**

[1]Department of Electricity and Energy, Kilis 7 Aralık University, Kilis, Turkey
[2]Department of Mechanical Engineering, Karabuk University, Karabuk, Turkey

In this study, the energy requirement in the off-grid areas of the cold storage container with a cooling load of 11 kW was considered to be met by the PV panel. Two systems with energy storage are emphasized, they can work all day. The first system is stored with hydrogen and the necessary energy is provided by the fuel cell during the night.. The other system is hydro-pumped storage and the necessary energy is obtained with the turbine-generator during the night.

Analysis results showed that the PV area required of the first system operation for the off-grid is 104 m^2, the cost 58738 $ and the energetic and exergetic COP values are 0.21 and 0.018 respectively. The required PV area of the second system is 44 m2, the cost approximately $ 220,000, and the energetic and exergetic COP values are 1.34 and 0.112, respectively.

Keywords: energy and exergy analysis, hydrogen storage, hydro-pumped storage, solar energy

[**Abstract:0042**]

Production of CVD Graphene Electrocatalyst for Oxygen Reduction Reaction

***Mehmet Akif Azder*[1], Ömer Salihoğlu[2], M. Suha Yazıcı[2]**

[1]Department of Physics, Recep Tayyip Erdogan University, Rize, Turkey
[2]TUBITAK-MAM Energy Institute P.K.21, Gebze-Kocaeli 41470

CVD based production of graphene-based electrocatalyst which will be used on Polymer Electrolyte Membrane (PEM) Fuel Cell instead of high-cost platinum will be presented.

In this study, starting with different substrates (Cu, Co, Pt), first graphene and then nitrogen and boron doped graphene are tried to be produced. Transfer processes to usable surfaces will be discussed. End products were analyzed with Raman spectroscopy and SEM techniques. Electrochemical measurements were made and oxygen reduction reaction potential of the products have been determined.

The study will be shared in detail.

Keywords: CVD Graphene, PEM Fuel Cell, Oxygen Reduction Reaction

[**Abstract:0043**]

CVD Graphene Doping for Fuel Cell Electro-catalyst Development: Literature Survey

Mehmet Suha Yazici

TUBITAK-Marmara Research Center, Energy Institute

Graphene based electro-catalysts have been developed to replace high cost platinum used in polymer electrolyte fuel cells (PEMFC) Most common method to produce these catalyst are wet-chemistry based approaches. Graphene produced by CVD process requires alternative approaches to obtain functional materials. Literature on graphene doping will be analyzed and discussed.

Keywords: Graphene, electrocatalyst, doping, fuel cell, CVD

ORAL ABSTRACTS

[**Abstract:0044**]

Preparation of MoPd Deposited Carbon Felt Electrodes and Investigation of their Electrochemical Activity for Hydrogen Production

Derya Dilek Demir, Abdullah Salcı, Ramazan Solmaz

Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

Surface of carbon felt (C) electrode was activated by electrochemical deposition of Mo (C/Mo). Then, a small amount of Pd was electrochemically deposited over this modified surface (C/Mo-Pd). The prepared electrodes were characterized using scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX). The electrodes were tested as cathode in 1 M KOH solution and their hydrogen evolution activity was evaluated. Fort his aim, cathodic current-potential curves and electrochemical impedance spectroscopy techniques were used. SEM studies showed that Mo-Pd modified electrodes have large surface area. Enhancement of surface area increases the rate of hydrogen evolution reaction. EDX analysis indicated that Pd and Mo metals almost homogenously distribute over the surface. This is a very important advantage since the hydrogen evolution reaction takes place homogenously over the catalyst surface. Electrochemical data showed that the modification of C surface with a thin Mo film increase its electrochemical activity. However, the deposition of Pd over the surface of C/Mo enhances the rate of this reaction more and more. The enhanced activity of the PdMo-modified electrocatalyst was related to a possible synergistic effect between the metals and enhanced real surface area of the electrode.

Acknowledgement: This study was supported by Bingöl University Scientific Research Projects Coordination Unit (BÜBAP) (Project Number: BAP-52-277-2015). The authors are greatly thankful to BÜBAP for financial supporting and Bingöl University Central Laboratory for characterization measurements.

Keywords: Carbon felt, palladium, molybdenum, electrolysis, hydrogen production

ORAL ABSTRACTS

[**Abstract:0045**]

Electrochemical Preparation and Characterization of NiPd Deposited Ni-modified Carbon Felt Electrodes and Their Application for Hydrogen Evolution Reaction in Alkaline Solution

Ramazan Solmaz

Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

Electrocatalysis is a surface process. Therefore, the supporting materials with high surface area are essential to prepare modified electrocatalysts. Because carbon felt (C) has low cost, good electrical conductivity and high surface area, it could be used as supporting material for preparation of catalytic electrodes. The use of such electrodes provides important advantages. However, pure C has low electrochemical activity. To overcome this disadvantage, surface of the C electrode was electrochemically modified with a thin Ni film (1 g Ni/1 g C). It is well-known that Ni has relatively high activity for the hydrogen evolution reaction. But, literature survey showed that pure Ni losses its activity with time during the electrolysis. In order to overcome this disadvantage, low amounts of Ni and Pd metals with various metal rations were co-deposited over the previously thin Ni film-modified C surface (C/Ni-NiPd). High price and low abundance of Pd limit its wider usage for industrial applications. Co-deposition of these two metals at various metal ratios provides great advantages and enhances electrochemical activity of the C/Ni-NiPd electrodes. The surface structure of the electrodes was investigated by scanning electron microscopy (SEM). Their surface composition and the distribution of the elements over the catalyst surface were analyzed using energy dispersive X-ray spectroscopy (EDX). The prepared electrodes were tested as cathode in 1 M KOH solution and their electrochemical activities for hydrogen evolution reaction was investigated with the help of various electrochemical techniques. SEM and EDX analysis showed that Ni and Pd metals almost homogenously distributed over the surface and the surface has large surface area. Electrochemical data indicated that co-deposition of Ni and Pd over the Ni-modified C surface enhances hydrogen evolution reaction. The rate of this reaction depends on metallic ratios of deposited Ni and Pd.

Acknowledgement: The author is greatly thankful to Bingöl University Scientific Research Projects Coordination Unit (BÜBAP) for financial supporting and Bingöl University Central Laboratory for characterization measurements.

Keywords: Electrochemical metal deposition, electrolysis, electrochemical hydrogen production NiPd-modified electrode.

ORAL ABSTRACTS

[**Abstract:0052**]

Energetic and Exergetic Investigations of an Innovative Light-based Hydrogen Production Reactor

***Canan Acar*[1], *Ibrahim Dincer*[2]**

[1]Bahçeşehir Üniversitesi
[2]University of Ontario Institute of Technology

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 used in fuel cells, H_2 is converted to water and it gives little or zero exhaust of greenhouse gases. For 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 thermodynamically analyze and experimentally investigate a continuous type hybrid photoelectrochemical H_2 generation reactor. This system enhances solar spectrum use by employing photocatalysis and PV/T. Additionally, by replacing electron donors with electrodes to drive the photocatalysis, the potential of pollutant emissions are minimized. In this study, the present reactor is tested under electrolysis operation during which the present reactor is investigated under three different inlet mass flow rates (0.25, 0.50, and 0.75 g/s). The results are compared to the thermodynamic model outputs. Parametric studies are run by varying the inlet mass flow rate between 0–1 g/s. The present experimental results show that the highest hydrogen production rate is observed at 0.75 g/s, which is 2.43 mg/h. The highest energy and exergy efficiencies are calculated at 0.25 g/s, which are 36% and 32%, respectively. In addition, thermodynamic model results are confirmed to have a good agreement with the experimental results.

Keywords: Energy, exergy, efficiency, hydrogen, photoelectrochemical, solar

[**Abstract:0053**]

Daily Performance Assessment of an Integrated Thermal System on Hydrogen Production

***Ayhan Atiz*[1], *Mustafa Erden*[2], *Müzeyyen Cilogullari*[2], *Mehmet Karakilcik*[2]**

[1]Alanya Alaatin Keykubat University
[2]Çukurova University

In this study, hydrogen production performance of an integrated thermal system is investigated. The system is consisting of solar pond, evacuated tube solar collectors, Organic Rankine Cycle (ORC) and water electrolysis system. In the integrated system, the output water at higher temperature can be obtained from the evacuated tube solar collector supported by the solar pond in a short time for a day. The higher temperature of input water plays a key role on the power efficiency of the ORC and also on the rate of the hydrogen production by the electrolysis of water. For this purpose, thermodynamic analysis is carried out to better understand the effects of the performance of the system components on the rate of the hydrogen generation by using the Engineering Equation Solver (EES) program. As a result, significant amounts of hydrogen can be produced in a short time.

Keywords: Solar pond, evacuated tube solar collector, hydrogen production, exergy

ORAL ABSTRACTS

[**Abstract:0054**]

Effects of Process, Operational and Environmental Variables on Biohydrogen Production Using Palm Oil Mill Effluent (POME)

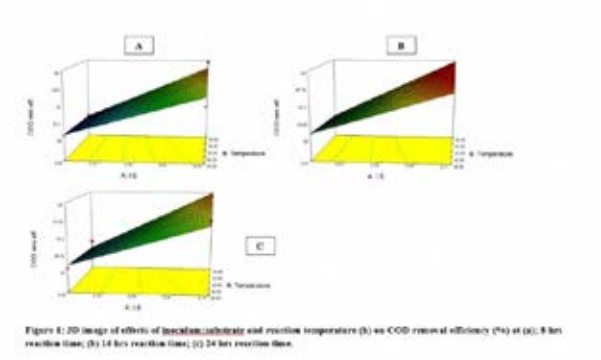
***Bidattul Syirat Zainal*[1], *Shaliza Ibrahim*[1], *Ali Akhbar Zinatizadeh*[2], *Nuruol Syuhadaa Mohd*[1]**

[1]University of Malaya, Kuala Lumpur, Malaysia
[2]Razi University, Kermanshah, IRAN

One of the plausible resources for the biohydrogen production in Malaysia is from the treatment of palm oil-based industry's wastewater. Malaysian palm oil industry is a highly-regulated industry and is one of the world's largest palm oil exporter. In this study, raw palm oil mill effluent (POME) and POME sludge collected from Jugra Palm Oil Mill, Banting, Selangor were used as a substrate and inoculum, respectively for biohydrogen production. This study aims to produce biohydrogen with the highest hydrogen yield and COD removal efficiency (%) with optimum process, operation and environmental variables. Prior to its use, POME sludge was heat-treated at 100°C for 1 hour to promote Hydrogen Producing Bacteria (HPB). Experiments were conducted in 156ml serum bottles with different reaction temperature (30°C, 40°C and 50°C) and different inoculum size to substrate ratio (I:S) with lowest range: 10:90, middle range: 20:80 and highest range: 40:60 of inoculum:substrate (v/v). Experiments were designed using Response Surface Methodology (RSM) and were conducted for 8 hr, 16 hr and 24 hr of reaction time. Optimum condition of biohydrogen production was achieved with COD removal efficiency of 31.38% with hydrogen yield of 17.76 ml H2 g-1 COD removed. The inoculum substrate ratio was 0.66, with- 40:60 (I:S) (i.e <20 g L-1 CODin) with reaction temperature of 49.16°C and reaction time of 16 hours. Based on the optimization process using RSM, it can be concluded that lower substrate concentration (not more than 20 g/L) for biohydrogen production using pre-settled POME as a substrate was achieved, with optimum reaction time of 16 hours under thermophilic condition (40-50 °C).

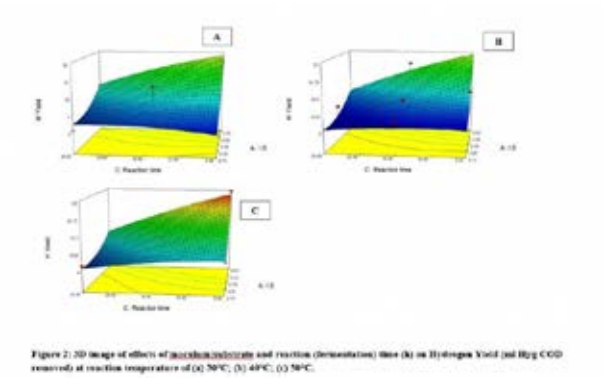
Keywords: Palm Oil Mill Effluent (POME), biohydrogen, COD removal, response surface methodology (RSM).

Figure 1



3D image of effects of inoculum:substrate and reaction temperature (h) on COD removal efficiency (%) at (a); 8 hrs reaction time; (b) 16 hrs reaction time; (c) 24 hrs reaction time.

Figure 2



3D image of effects of inoculum:substrate and reaction (fermentation) time (h) on Hydrogen Yield (ml H2/g COD removed) at reaction temperature of (a) 30°C; (b) 40°C; (c) 50°C.

ORAL ABSTRACTS

[**Abstract:0056**]

Estimation of Required Hydrogen Flow Rate for PEMFC by Using Artificial Neural Network

***Mehmet Seyhan*[1], *Yahya Erkan Akansu*[2], *Mustafa Sarioglu*[1]**

[1]Karadeniz Technical University, Mechanical Engineering Department, Trabzon
[2]Omer Halisdemir University, Mechanical Engineering Department, Niğde

Prediction of required hydrogen flow rate of a proton exchange membrane fuel cell (PEMFC) with the help of artificial neural network (ANN) is investigated to adjust the output power. PEMFC consist of the serpentine flow channel made up of graphite, Nafion 115 membrane, gold coated copper plates, gaskets and stainless steel end plates. Operating temperature of the cell is 60 oC. PEMFC having 25 cm^2 active area is used for both oxygen flow rate of 0.5, 0.75, 1.25 and 2.25 SLPM and constant oxygen flow rate of 3.5 SLPM at hydrogen flow rate of 0.1, 0.3, 0.5 and 0.9 SLPM, respectively. Oxygen flow rate, output voltage and output current utilized as input parameters in train, validation and test. Activation function is sigmoid. ANN model using Levenberg-Marquardt backpropagation as training algorithm was trained with 150 data in order to predict hydrogen flow rate and these data are randomly divided as 70% training, 15% validation and 15% test. Mean absolute percentage error (MAPE) of training, validation and test is determined as 5.12%, 2.84% and 1.36%, respectively for ANN model having 8 hidden neurones. According to these results, developed ANN model shows good performance for prediction of hydrogen flow rate. Results of ANN model indicated that developed ANN model can be predicted required hydrogen flow rate of the PEMFC and used to decrease the number of required experiments.

Keywords: PEM Fuel Cell, Artificial Neural Network, Hydrogen

ORAL ABSTRACTS

[**Abstract:0057**]

Investigation of Effect of Spark-Plug Plasma Synthetic Jet Actuator on PEM Fuel Cell Performance

Yahya Erkan Akansu[1], Mehmet Seyhan[2], Cihan Yesildag[1], Vuralcan Hammutoglu[1]

[1]Omer Halisdemir University, Mechanical Engineering Department, Nigde
[2]Karadeniz Technical University, Mechanical Engineering Department, Trabzon

An experimental study is carried out to investigate the effects of spark-plug plasma synthetic jet actuator (SPSJ) actuator on the performance of Polymer Electrolyte Membrane Fuel Cell (PEMFC). SPSJ actuator consist of two main components which are spark plug and cap creating cavity volume and also having orifice. One actuator directly integrated into the cathode side of the fuel cell. On the cathode side of PEMFC, SPSJ actuator generates a periodic pulsating flow with the aim of increasing the diffusion rate, eliminating the flooding and improve fuel cell performance. PEMFC having single cell with the active area of 25 cm2 (5 layer Nafion 115) is used. In order to determine optimum the air and hydrogen flow rate, five different flow rates are used in the experiments. The results compared with actuator on/off stations. When SPSJ actuator applied to cathode side of PEMFC, current and power density slightly increased for low voltage level of PEMFC.

Keywords: Plasma synthetic set, Actuator, PEMFC,

[**Abstract:0060**]

Dark Fermentative Hydrogen Gas Production from Waste Peach Pulp in a Pilot Scale Reactor

Hidayet Argun*, *Siaka Dao

Pamukkale University Engineering Faculty Department of Environmental Engineering, Denizli-Turkey

Hydrogen gas production from waste peach pulp using dark fermentation was studied in a pilot scale reactor. In this context the reactor was operated with and without inoculation at 45 g TS/L initial waste peach pulp concentration. Hydrogen gas production was faster when no inoculum was used. The hydrogen production rates and yields with and without inoculum addition were 6.05 L H2/h, 735.66 mL H2/g TOC and 12.62 L H2/h, 855.66 mL H2/g TOC, respectively. The hydrogen percentage in the biogas was about 50% in both set of experiments. Glucose in the waste was completely consumed and the TOC percentage was about 25% at the end of experiments. Experimental results were correlated with the Gompertz equation to compare the hydrogen production performance of the experiments. It was concluded that hydrogen could be more effective produced from waste peach pulp without any microbial inoculation.

Keywords: Waste peach pulp, pilot scale reactor, dark fermentation, hydrogen

ORAL ABSTRACTS

[**Abstract:0061**]

Investigation the Effect of Annealing Atmosphere and Time on Photoelectrochemical (PEC) Properties of α-Fe2O3 Photoanode

Selim Demirci, Cevat Sarıoğlu

Department of Metallurgical and Materials Engineering, Marmara University, Istanbul, Turkey

Photoelectrochemical (PEC) cells offer the ability to convert electromagnetic energy from our largest renewable source, the Sun, to stored chemical energy through the splitting of water. The aim of this study is the fabrication of α-Fe_2O_3 (hematite) photoanodes and application them for hydrogen production. In this study, α-Fe_2O_3 photoanodes were successfully fabricated by thermal oxidation of the commercial cold-rolled steel at 500 °C in pure water vapor and air atmosphere for various time. PEC performance of the as-produced α-Fe_2O_3 photoanodes were investigated. The crystal phase structure, surface morphology, and optical properties of the α-Fe_2O_3 photoanodes were characterized using an X-ray diffractometer (XRD), field emission scanning electron microscopy (FESEM) and UV–VIS spectrophotometer, respectively. PEC studies of the α-Fe_2O_3 photoanodes were assessed in the 0.1 M NaOH electrolyte solution. The results showed that α-Fe_2O_3 photoanodes had high crystalline phase and the annealing atmosphere influenced the morphology of the α-Fe_2O_3 photoanodes. The optical band gap values of the α-Fe_2O_3 photoanodes varied between 2.38 and 2.70 eV. The PEC findings exhibited that the α-Fe_2O_3 photoanode annealed 15-min in water vapor had best PEC performance achieving photocurrent density 0.228 mA/cm^2 at 1.57 V vs. VRHE and highest carrier density value (ND=1.15×10^{21} cm^{3-}). Furthermore, the photoanodes annealed in water vapor atmosphere revealed at least three times higher PEC performance than that of photoanodes annealed in air. Thermal oxidation method in water vapor is an efficient methods for enhancement of PEC performance of α-Fe_2O_3 photoanodes.

Keywords: Hematite, Thermal annealing, Water vapor, Photoelectrochemical Properties (PEC), Optical Properties

ORAL ABSTRACTS

[**Abstract:0062**]

Biohydrogen Production from Acid Hydrolyzed Waste Wheat in a Continuously Operated Packed Bed Reactor

***Betul Kirli*[1], *Ilgi Karapinar*[2]**

[1]Dokuz Eylul University, Graduate School of Natural and Applied Sciences, Department of Biotechnology, Tinaztepe Campus, Buca, Izmir, Turkey

[2]Dokuz Eylul University, Department of Environmental Engineering, Tinaztepe Campus, Buca, Izmir, Turkey

Biohydrogen production from carbon rich organic wastes by dark fermentation is considered one of the renewable energy production technology. Continuously operated immobilized system have been received considerable attention recently to obtain high yield and rate of production. Selection of support particle and determination of operation conditions as hydraulic retention time (HRT) and organic loading rate (OLR) are the main research subjects. The effect of HRT is under investigation, since, high yields were obtained at low HRTs in some studies and relatively longer HRTs in other ones. The relationship between support particle characteristic and HRT is one of the reasons of this variation. Therefore, the conditions in continuously operated immobilized systems should be determined specific to the support particle type. Our previous study resulted in that metal mesh covered plastic scouring sponge pad was the best support particle with 2.1 mol/ mol glucose production yield among the other porous support particles used in repeated batch operation. As a second part of this study, the effect of HRT on biohydrogen production in continuously operated up-flow packed bed reactor with this particle was investigated. It was aimed to determine the best HRT which results in the highest yield and rate with this particle. The substrate was waste wheat which was hydrolyzed at pH=2 and T=90 °C in an autoclave for 15 min. The reactor was operated at HRTs between 2 h and 13 h at constant initial total sugar concentration of TSo=5 g/L and T=37 °C. The highest volumetric hydrogen production rate and yield were obtained as VHP= 1.75 L H_2/L d and YH_2=1.6 mol/mol TS, respectively, at HRT= 2 h. The results indicated that the metal mesh covered scouring sponge pad particles can be used as microorganism immobilization material for efficient biohydrogen production by dark fermentation at short HRTs.

Keywords: Biohydrogen, dark fermentation, hydraulic retention time, packed bed, waste wheat.

ORAL ABSTRACTS

[**Abstract:0064**]

Investigation on Part-load Performance of a Hydrogen-blended Gasoline Rotary Engine at Two Speeds

Teng Su, Changwei Ji, Shuofeng Wang, Lei Shi, Jinxin Yang, Xiaoyu Cong

College of Environmental and Energy Engineering, Beijing University of Technology

In this paper, a gasoline rotary engine equipped with a gasoline and hydrogen port-injection system was developed to investigate the combustion and emissions characteristics of a hydrogen-blended gasoline rotary engine at two engine speeds. A self-developed hybrid electronic control unit was adopted to adjust the injection durations of gasoline and hydrogen. The rotary engine was run at 3000 and 4500 rpm, respectively. A manifold absolute pressure of 35 kPa with a fixed spark timing of 25 °CA BTDC. Hydrogen volume fraction in the total intake were kept at 0%, 2% and 4%, respectively. Excess air ratio was kept at 1.00. The test results showed that peak combustion temperature and brake thermal efficiency were elevated with the hydrogen addition. Brake mean effective pressure at 3000 rpm is increased whereas decreased at 4500 rpm because of hydrogen addition. Moreover, hydrogen enrichment effectively shortened flame development and propagation periods, and cyclic variation. HC emissions were reduced with the hydrogen addition. NOx emissions were increased when hydrogen addition or operation speed was elevated, due to the raised combustion temperature.

Keywords: Hydrogen addition, Gasoline, Rotary engine, Performance, Speed

[**Abstract:0066**]

Synthesis of La-Mg-Ni-Co Hydrogen Storage Alloys by Electro-deoxidation

Alanur Binal Aybar, Mustafa Anik

Department of Metallurgical and Materials Engineering, Eskisehir Osmangazi University, Eskisehir, Turkey

(La1-xMgx)2(Ni0.8Co0.2)7 (x = 0.125, 0.25, 0.5) alloys were synthesized from sintered mixture of La2O3 + NiO + CoO + MgO in the molten CaCl2 salt at 750°C and the electrochemical hydrogen storage characteristics of the synthesized alloys were observed. Non-hygroscopic LaNiO3 phase formed during sintering (at 1200°C for 2 h) as a result of the reaction of hygroscopic La2O3 with NiO. Another sinter product was Mg0.4Ni0.6O phase. Both mixed oxide sinter products facilitated the La-Ni and Mg-Ni phase formations. X-ray diffraction peaks indicated that the first stable phase appeared in the alloy structure was LaNi5 which formed upon reduction of La2NiO4 phase. Increase in Mg content caused formation of La1.5Mg0.5Ni7 phase in the alloy structure that its presence improved the hydrogen storage performance of the electrodes. The porous alloy structure was beneficial for higher hydrogen storage capacity and it was observed that (La1-xMgx)2(Ni0.8Co0.2)7 (x = 0.125, 0.25, 0.5) alloys had promising discharge capacities changed between 319 mA h g-1 and 379 mA h g-1 depending on the alloy Mg content.

Keywords: Hydrogen storage, Electro-deoxidation, A2B7 type alloys

[**Abstract:0070**]

Thermodynamic Modeling and Optimization of a Hydrogen Liquefaction System Using Geothermal Energy

Ceyhun Yılmaz

Mechanical Engineering, Afyon Kocatepe University, Afyonkarahisar, Turkey

In this study, a liquid geothermal source available at 200°C at a rate of 100 kg/s is used to precool the hydrogen gas before to liquefaction in absorption refrigeration cycle. High temperature geothermal water leaving the absorption cooling cycle is used to produce electricity in the binary cycle. Geothermal electricity is used to liquefy precooled hydrogen gas in the Claude liquefaction cycle. The exergetic cost ratio of geothermal water at the wellhead is calculated to be 80.08 $/h. As a fuel input, the average exergetic cost of geothermal water is calculated to be 1.373$/GJ. The exergetic unit cost of electricity is calculated to be 4.12 $/GJ (0.0148 $/kWh) in the binary power unit. The exergetic cost of hydrogen liquefaction is 8.011 $/GJ (0.963 $/kg H2). In this system, the exergetic cost of hydrogen supplied from the outside is selected to be 24.5 $/GJ (2.94 $/kg H2). Based on optimization calculations, hydrogen gas can be cooled to -30°C in the cooling cycle. This allows the exergetic cost of hydrogen gas to be reduced to be 20.16 $/GJ (2.42 $/kg H2).

Keywords: Geothermal energy, hydrogen liquefaction, thermoeconomic optimization, genetic algorithm

ORAL ABSTRACTS

[**Abstract:0075**]

Reduced Graphene Oxide Assembled Bimetallic PdM (M = Fe, Ag, Au) Alloy Nanoparticles as High-performance Electrocatalysts for Direct Borohydride Fuel Cells

***Önder Metin*[1], *Melike Sevim*[1], *Marta Martins*[2], *Biljana Šljukić*[2], *Diogo M.f. Santos*[2]**

[1]Department of Chemistry, Faculty of Science, Atatürk University, 25240 Erzurum, Turkey.
[2]CeFEMA, Instituto Superior Técnico, Universidade de Lisboa, 1049–001 Lisbon, Portugal.

In alkaline fuel cells, and specifically in their subclass of direct borohydride fuel cells (DBFCs), platinum (Pt)-based materials are widely used as electrocatalysts for both the cathode (oxygen reduction, ORR) and the anode (borohydride oxidation, BOR) reactions. However, Pt presents some limitations such as poor stability, scarceness and high price which hampers the commercialisation of fuel cells. In this context, recent efforts have been made in the search for new electrocatalysts with lower cost and higher electrocatalytic activity for these reactions. Palladium (Pd) is one of the leading candidates in this respect. On the other hand, the performance of an electrocatalyst is greatly affected by the support material. In recent studies, reduced graphene oxide (rGO) has been demonstrated as a support material that enhances the activity and stability of metal electrocatalyst owing to its advantageous properties such as high surface area, high conductivity and potentially low-cost manufacturing. In this work, a series of bimetallic palladium alloy nanoparticles assembled on reduced graphene oxide, namely PdFe/rGO, PdAg/rGO and PdAu/rGO were prepared and tested for oxygen reduction reaction (ORR) and borohydride oxidation reaction (BOR) in alkaline media. The morphology and structure of the as-prepared PdM alloy NPs and PdM/rGO electrocatalysts were characterised by XRD, TEM, XPS and ICP-MS. Their electrochemical activity towards the ORR and BOR was investigated by cyclic voltammetry, linear scan voltammetry and chronoamperometry using rotating disc electrode. Among the tested electrocatalysts, PdAu/rGO demonstrated the best performance by providing high current densities for both ORR and BOR and high number of exchanged electrons. The order of reaction for BOR was evaluated to be in the range from 0.4 for PdAg/rGO to 1 for PdAu/rGO. Furthermore, effect of temperature was studied and BOR activation energy determined to be 23 kJ mol−1.

Keywords: palladium alloys, reduced graphene oxide, oxygen reduction reaction, borohydride oxidation reaction, direct borohydride fuel cell.

ORAL ABSTRACTS

[**Abstract:0079**]

Thermodynamic Analysis of OTEC Based Hydrogen Production System

Murat Öztürk[1], Fatih Yilmaz[2], Reşat Selbaş[3]

[1]Department of Mechatronic Engineering, Faculty of Technology, Suleyman Demirel University
[2]Department of Electrical and Energy, Vocational School of Technical Sciences, Aksaray University
[3]Department of Energy System Engineering, Faculty of Technology, Suleyman Demirel University

In this study, the thermodynamic assessment of an ocean thermal energy conversion (OTEC) based hydrogen production plant is performed using the energy and exergy analysis. This integrated system is consisted of the heat exchangers, turbine, condenser, pumps, solar collector system, hot storage tank, cold storage tank and proton exchange membrane (PEM) electrolyzer. The exergy destruction rate, exergy destruction ratio and exergy efficiency of OTEC based hydrogen production system components and whole system are analyzed by using the balance equations, such as mass, energy, entropy and exergy, and also energy and exergy efficiency equations. In addition to that, the impacts of different design indicators and reference ambient parameters on the exergy destruction rate and exergy efficiency of OTEC based hydrogen production system are analyzed.

Keywords: OTEC, integrated system, hydrogen energy.

ORAL ABSTRACTS

[**Abstract:0080**]

Numerical Modelling of Hydrogen-Natural Gas Mixtures Flows in Looped Networks

Zahreddine Hafsi[1], Sami Elaoud[1], Lamjed Hadj Taieb[2]

[1]Laboratory of Applied Fluids Mechanics Process and Environment Engineering, ENIS P.O. Box, W, Sfax, 3038, Tunisia
[2]College of engineering, Salman Bin Abdul-Aziz University, Kingdom of Saudi Arabia

This paper presents a numerical analysis of high pressure hydrogen-natural gas mixtures flows in pipeline networks during steady and transient states. The considered fluid is an homogeneous mixture of hydrogen and natural gas. An adiabatic process is admitted for the two components and under such assumption the density of the binary gas mixture is defined. The steady state was studied by the use of Hardy Cross method. The numerical simulation of the transient regime was performed by solving the conservation equations, for one-dimensional adiabatic compressible flow, using the characteristics method of specified time intervals. The obtained results have proved the efficiency of the characteristics method compared to other numerical techniques. The numerical obtained results have shown that, during transients, pressure oscillations for hydrogen and hydrogen-natural gas mixtures are higher compared to those for natural gas.

Keywords: hydrogen, natural gas, transient flow, looped network, Hardy Cross method, method of characteristics

ORAL ABSTRACTS

[**Abstract:0081**]

Future of the Hydrogen Energy at the light of Transatlantic Trade and Investment Partnership – ''TTIP '' between the USA and EU

***Sudi Apak*[1], *Erhan Atay*[2], *Duygu Erdoğan*[2], *Güngör Tuncer*[3]**

[1]Department of Industrial Engineering, Esenyurt University, Istanbul, Turkey
[2]Department of Economics, Trakya University, Edirne, Turkey
[3]Department of Business Adm., Kavram University, Istanbul, Turkey

Energy is the very lifeblood of today's society and economy. Our work, leisure, and our economic, social and physical welfare all depend on the sufficient, uninterrupted supply of energy As one of a kind of renewable energy sources hydrogen is considered to be an ideal energy carrier in the foreseeable future. Hydrogen can be used in any application in which fossil fuels are being used nowadays. Accordingly hydrogen economics should be taken into account for the future enery policy by both governmental and private sector bodies for improving the hydrogen energy based sustainability.. Advocates of the Transatlantic Trade and Investment Partnership –TTIP on both sides of the Atlantic,the USA and EU are quick to paint the agreement as a massive contibution to economic one;'growth and jobs'.

This study focuses on some policy parameters for strategic use of hydrogen energy in order to combat the negative effects of convantionale fuel consumption such as petroleum and coal in accordance with TTIP opportunity between the USA and EU.

Keywords: TTIP, Hydogen Energy, USA, Environment, EU

ORAL ABSTRACTS

[**Abstract:0085**]

A Rewiew on Novel Flow Field Designs for PEM Fuel Cells and Systematic Comparison of Designs

***Erman Çelik*[1], *Irfan Karagöz*[2]**

[1]Mechanical Engineering Department, Faculty of Technology, Fırat University, Elazığ
[2]Mechanical Engineering Department, Engineering and Architecture Faculty, Uludağ University, Bursa

PEM Fuel Cell (PEMFC) technology is the most promising technic which is convenient to be used as carbon free energy conversion to electricity from hydrogen and oxygen. Especially its high energy density, lightweight structure and lower operating temperature makes it useful for mobile applications including automotive industry. However, pressure drop, water and heat management are important issues to increase PEMFC performance which should be studied in detail. Flow field design is one of the most dominant factors effecting pressure drop, uniform reactant distribution and water-heat management thus PEMFC performance. In this study, most prominent PEMFC flow field designs and local improvements on fundamental gas distribution models have been investigated from patent databases and scientific studies. Selected designs have been compared with each other and their effects on performance have been studied with regards to origin, objective and innovation strategy of design and local betterment beside their strength and weakness. As result, latest enhancements on PEMFC flow field design are summarized systematically to guide prospective studies.

Keywords: PEM, Fuel Cell, Flow Field Design, Channel Improvement

ORAL ABSTRACTS

[**Abstract:0086**]

Determining the Effect of Trace Elements on Biohydrogen Production From Fruit and Vegetable Wastes

***Tugba Keskin Gündoğdu*[1], *Kübra Arslan*[3], *Haris Nalakath Abubackar*[4], *Gozde Duman*[2], *Koray Akarsu*[2], *Jale Yanık*[2], *Nuri Azbar*[1]**

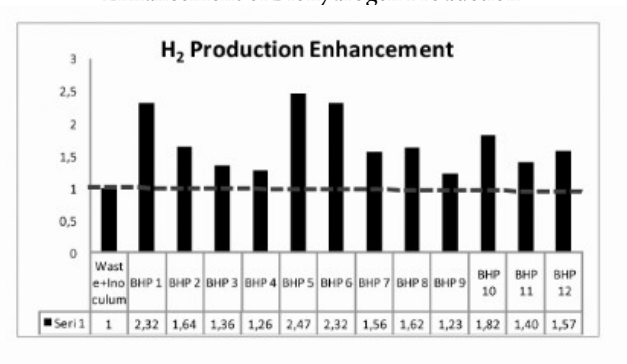
[1]Bioengineering Department, Ege University, Izmir, Turkey
[2]Chemistry Department, Ege University, Izmir, Turkey
[3]Center for Environmental Studies, Ege University, Izmir, Turkey
[4]Faculty of Sciences and Center for Advanced Scientific Research (CICA), University of La Coruña, La Coruña, Spain

Dark fermentative hydrogen production from fruit and vegetable wastes (FVW) is a very effective, energy efficient and environmentally friendly method.However many factors can influence the hydrogen production yields from the process such as organic loading rate, hydraulic retention time, pH and temperature etc.Trace elements are one of the important parameters for dark fermentative hydrogen production because they work as cofactors in hydrogen formation biochemistry. Lack or excess of trace element concentrations in basal medium might be an important reason for the low yield of hydrogen production. In this study the effect of 11 different trace elements(Fe, Ni, Zn, Co, Cu, Mn, Al, B, Se, Mo and W) were tested at two different concentration levels using plackett-burman factorial design to understand its effects on hydrogen yield. Each of the experimental set-up was conducted in duplicates in 100-ml serum bottles at pH 5.5 under thermophilic conditions (55 ± 1°C), thus a total of 24 experimental run were performed. Flocculated biomass obtained from an industrial scale anaerobic thermophilic bioreactor was used as inoculum. The (FV) wastes were collected from main hall of Izmir (Turkey) Municipality. The trace elements were added to each reactors according to the statistical design. The cumulative biohydrogen values were changed between 30-75 mL and the hydrogen content at the head space of the bottles was changed between 15-30 % (Figure 1). The positive effect of trace element addition was observed clearly in comparison to BHP reactors without its addition and an enhancement of 1.2 to 2.5 times of biohydrogen production was obtained (Figure 2). The trace elements Zn and Ni were found to be the most influential trace elements on biohydrogen production in this study.(Figure 3). The digestate of the experiments were sent for further treatment by supercritical water gasification.

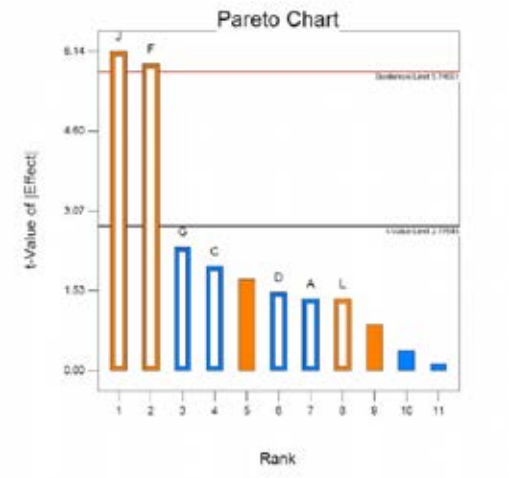
Acknowledgement: The authors wish to thank TUBITAK-MAG-215 M 314 for the financial support of this study. We also thank to IZSU for their kind supports. HNA thanks the Xunta de Galicia (Spain) for his postdoctoral fellowship (ED481B-2016/195-0)

Keywords: Biohydrogen, Dark Fermentation, Statistical Design, Trace Elements

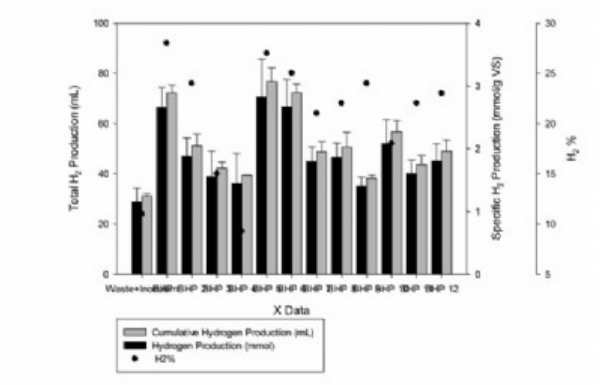
Enhancement of Biohydrogen Production



Pareto Chart of Statistical Design for Trace Elements



Specific Hydrogen Production



[**Abstract:0087**]

Co-gasification of Çan Lignite with Kenaf Hydrolysate: Effects of Temperature and Flow rate

Açelya Seçer, Nilgün Küçet, Arif Hasanoğlu

Department of Chemistry, Cukurova University, Adana, Tukey

Co-gasification of hyrdolised biomass may lead to higher gasification yields in order to the increase in gasifiable contents of biomass by hydolysis and stil having the inorganic salts acting like catalyst at the sime time in the hyrolysis solution. Steam is used as gasification agent in traditional methods of production of hydrogen from coal and a steam generator is used to produce steam, and carrier gases are used in these traditional methods. In this study, a modified method, which will be called as atmospheric pressure vapor phase reforming (AVPR), in which water is directly vaporized in the gasification reactor instead of producing steam with steam generator, was used to produce hydrogen from coal. Çan lignite, a Turkish lignite with a % 4,6 S content, is co-gasificated with Kenaf biomass (Hibiscus cannabinus L.) without using catalyts, with AVPR method at different flow rates and temperatures below 1000 °C Effects of hydrolysis, flow rate and temperature on hydrogen production and gasification yields were investigated. Coal samples were first co- gasificated with Kenaf biomass at 700°C at different flow rates from 0,5 mL/min to 2,0 mL/min for two hours and maximum gasification yield was achieved at 0,5 mL/min with a total gas volume of 1695,8±18,5 mL and % 74,3±1,1 hydrogen yield. It was seen that an increase in flow rate effected gasification yield negatively. In the second part of the study, coal samples were gasificated at 600, 700, 800 and 900 °C respectively to investigate the effect of temperature on gasification. In this part, gasification experiments were performed at 0,5 mL/min. The maximum amount of total gas was achieved at 900 °C 3060±56,6 mL with 67,0±1,0 % of hydrogen.

Acknowledgement: This study was funded by Çukurova University Research grant. (Project number: FDK-2016-5653)

Keywords: hydrogen, coal, gasification

ORAL ABSTRACTS

[**Abstract:0088**]

Comparison of Silica and Alumina Based Catalysts in Hydrogen Production From Biomass

***Birce Pekmezci Karaman*[1], *Nurbanu Çakıryılmaz*[1], *Hüseyin Arbağ*[1], *Nuray Oktar*[1], *Gülşen Doğu*[1], *Timur Doğu*[2]**

[1]Department of Chemical Engineering, Gazi University, Ankara, Turkey
[2]Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Steam reforming of acetic acid is one of the most promising processes for hydrogen production from biomass. Operating conditions and the performances of catalysts play crucial roles in hydrogen production through acetic steam reforming. Silica and alumina based catalysts are commonly used as support materials while nickel and copper are generally used as active metals for steam reforming processes. In this study, activities of MCM-41 supported catalysts and a copper based commercial catalyst HifuelR-120 (Alfa Aesar) were compared in acetic acid steam reforming. MCM-41 was synthesized using a hydrothermal route and nickel and/or copper were incorporated into the structure of catalysts by impregnation method. In order to define physical and structural properties of the catalysts, XRD, N2 adsorption-desorption and TG-DTA analysis were performed. BET analysis results showed that surface areas of the synthesized MCM-41 supported catalysts (0%Ni, 5%Ni, 5%Cu, 2.5%Ni-2.5%Cu by wt.) were in the range of 390-900 m2/g. Moreover, surface area of HifuelR-120 and 5% nickel impregnated HifuelR-120 were 77.3 m2/g and 7.5 m2/g, respectively. The activity test results showed that, among the catalysts used, MCM-41 had the lowest activity in steam reforming of acetic acid. Impregnation of 5% Cu into the structure of MCM-41 increased hydrogen selectivity slightly at 750oC. HifuelR-120 and 5% Cu impregnated HifuelR-120 showed almost similar hydrogen selectivity values at 750oC. Ni incorporation into HifuelR-120 and MCM-41 gave highly promising results to achieve high conversion and high hydrogen selectivity. Bimetallic 2.5Ni-2.5Cu@MCM-41 catalyst showed good performance for hydrocarbon production via Fischer-Tropsch synthesis. Activity test results indicated that nickel has higher capability to break the C-C than copper. Co-impregnation Cu and Ni into the structure of catalyst formed Ni&Cu alloy and enhanced the resistance of catalyst to carbon formation.

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

Keywords: Hydrogen, Steam Reforming, Acetic Acid, MCM-41, Copper, Nickel

ORAL ABSTRACTS

[**Abstract:0089**]

Various Amine Compounds Stabilized Pd(0) Nanoparticles: Synthesis, Identification and Catalytic Use in the Dehydrogenation of Dimethylamine-Borane

Ebru Köktepe, Sibel Duman

Department of Chemistry, Bingol University, Bingol, Turkey

Recently, dimethylamine-borane (DMAB) has been appealed as one of the most promising hydrogen storage materials owing to its high gravimetric capacity of hydrogen (3,5 wt%) that is higher than the material-based gravimetric target set by the US Department of Energy (DOE) for 2025 [ ]. Up to now, DMAB and related boron-nitrogen compounds have also attracted much research interest as a candidate for hydrogen storage [ ]. In the scope of this study, it has been investigated; (i) compare to effect of initial dodecylamine (DodAm), hexylamine and oleylamine on the catalytic activity of Pd(0) NPs, (ii) decision to selected of DodAm because of its higher activity on stabilization of Pd(0) NPs, (iii) effect of extensive kinetic data to define the rate law of DodAm stabilized Pd(0) NPs catalyzed dehydrogenation of DMAB at 25.0+0.1°C, (iv) determination of activation parameters for DodAm stabilized Pd(0) NPs catalyzed dehydrogenation of DMAB; (v) demonstration of the catalytic lifetime of DodAm stabilized Pd(0) NPs in the dehydrogenation of DMAB at 25.0+0.1°C, (vi) identification of DodAm stabilized Pd(0) NPs was characterized by various spectroscopic techniques (vii) quantitative carbon disulfide poisoning experiments to find a corrected TTO and TOF values on a per-active-palladium-atom basis, (viii) testing the isolability and reusability of DodAm stabilized Pd(0) NPs in dehydrogenation of DMAB.

Keywords: Dodecylamine, hexylamine, oleylamine, palladium, dimethylamine-borane

ORAL ABSTRACTS

[**Abstract:0090**]

Investigation of Hydrogen Production Performance of a Reactor Assisted by a Solar Pond by Photoelectrochemical Method

Mehmet Karakilcik[1], Mustafa Erden[1], Muzeyyen Cilogullari[1], Ibrahim Dincer[2]

[1]Department of Physics, Faculty of Sciences and Letters, University of Cukurova, Adana 01330, Turkey
[2]Faculty of Engineering and Applied Science, University of Ontario Institute of Technology (UOIT), 2000 Simcoe Street, North Oshawa, Ontario, L1H 7K4, Canada

In this study, hydrogen production performance of a reactor assisted by a solar pond by photoelectrochemical method is examined conceptually. The main components of the new integrated system are a solar pond, a photovoltaic panel (PV) and a hybrid chlor-alkali reactor that consists of a semiconductor anot, photocathode and cation exchange membrane. The proposed system produces hydrogen via water splitting reaction and also yields the by products namely chlorine and sodium hydroxide while consumes saturated NaCl and pure water. In order to increase the effciency of the reactor, the saturated hot NaCl solution at the heat storage zone (HSZ) of the solar pond is transfered to the anot section and the heated pure water by heat exchanger in the HSZ is transfered to cathode section. The electrodes are used as electron donors for photochemical hydrogen production with diminishing the power requirement from the PV panel that is used to provide the necessary electrical energy for the electrolysis. As a result, the thermal performance of the solar pond plays a key role on the hydrogen production efficiency of the reactor.

Keywords: Hydrogen production, Photoelectrochemical process, Solar energy, Solar pond, Exergy, Efficiency

ORAL ABSTRACTS

[**Abstract:0096**]

Synthesis and Characterization of IrxRu1-xO2 Catalysts for the Oxygen Evolution Reactions

***Mehmet Fatih Kaya*[1], *Nesrin Demir*[1], *Ayşe Bayrakçeken Yurtcan*[2]**

[1]Department of Energy Systems Engineering, Erciyes University, Kayseri, Turkey
[2]Department of Chemical Engineering, Atatürk University, Erzurum, Turkey

Electrochemical water electrolysis method has a great potential as an alternative technology to produce hydrogen efficiently. During the operation, the oxygen electrode has a significant impact on the performance and long-term stability of the electrochemical cell. Under acidic operating environments, it has poor durability and slow kinetics drawbacks. To improve durability and kinetic parameter, more active and stable electrodes are investigated. Rather than transition metals, noble metals are commonly used as catalysts for the oxygen evolution reactions (OER) in acidic media. For Proton Exchange Membrane Water Electrolyzers (PEMWE) RuO_2 and IrO_2 are widely used. RuO_2 is a very active metal oxide, but in long term operating conditions, it has stability problems. IrO_2 is more stable during long time working condition and its kinetic activity is similar to RuO_2. Therefore, a mixture of Iridium-Ruthenium oxides is studied extensively to increase the durability of metal oxides. These oxide films can be produced by hydrolysis, sputtering, and Adam's fusion method. Adam's Fusion method is a simple and effective method to obtain metal oxides compared with other methods. It has especially selected by the researchers in order to increase the active surface area.

In this study, IrxRu1-xO2 with different molar ratios (x) varying in between 0.2 to 1 were synthesized using Adam's Fusion method. The crystallinity of the metal oxide materials are characterized by X-Ray Diffraction (XRD) instrument. Oxidation states are analyzed by using X-Ray Photoelectron Spectroscopy (XPS). Surface morphology of the materials are investigated by using Scanning Electron Microscope (SEM). Atomic ratios in the metal oxide materials are determined by using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) method. Electrochemical measurements are conducted by using Cyclic Voltammetry (CV) and Chronoamperometry (CA) measurements in a standard three electrochemical cell configuration. The best molar ratio is determined according to the kinetic parameters of the corresponding electro-catalyst.

Keywords: Electro-catalyst, Oxygen Evolution, PEM Water Electrolyzers

[**Abstract:0099**]

High-Yield Hydrogen Production Through Aqueous-Phase Reforming of Biomass Hydrolysate Over Carbon Nanotube Supported Pt Catalysts

Burçak Kaya Özsel[1], Bahar Meryemoğlu[2], Berna Niş[1], Arif Hasanoğlu[3]

[1]Department of Chemistry, Bursa Technical University, Bursa, Turkey
[2]Central Research Laboratory, University of Cukurova, Adana, Turkey
[3]Department of Chemistry, University of Cukurova, Adana, Turkey

In recent years, depletion of fossil fuel reserves has led to an increased interest in clean energy technologies and renewable energy sources. Hydrogen, as a clean enegry carrier, is often considered as one of the most promising alternatives to fossil fuels. Biomass-based hydrogen production technologies as a carbon-neutral and a renewable energy resource, could overcome both the problems of fossil fuel depletion, greenhouse gas emissions and global warming.

In the present work, Pt-SWCNT and Pt-MWCNT catalysts were prepared by deposition of platinum on single-walled and multi-walled carbon nanotubes using nanotechnological approaches in supercritical carbon dioxide media [1] to evaluate gasification performance of cellulosic/lignocellulosic biomass hydrolysate and glucose as basic model compound for hydrogen-rich gas production via aqueous-phase reforming (APR). A very important point for the economic use of supported precious metal catalysts is the recovery, refining and recycling of the metal. The size of Pt particles on carbon nanotubes were 2.3–2.6 nm, and they had a uniform dispersion on CNT surfaces. Cotton linter, an important by product of the textile industry, was used as cellulosic biomass while wheat straw and sorghum were used as lignocellulosic biomass feed stock in reforming process. Single-walled carbon nanotube supported Pt catalyst showed better activity on gasification of real biomass hydrolysate while the multi-walled carbon nanotube catalyst was better for the glucose feed. It was also observed Pt-MWCNT catalyst also effective for water-gas shift reaction that led to reduction of CO in gas mixture in addition to the decomposition reactions of the biomass hydrolysates.

Reference:

[1] Zhang, Y, Erkey, C, Journal of Supercritical Fluids, 38, 252-267, 2006.

Keywords: catalysts, aqueous-phase reforming, hydrogen, biomass.

ORAL ABSTRACTS

[**Abstract:0100**]

Effect of SiC Formation on Sustainability of H2 Production in the Presence of Ni Core-shell Microsphere Catalysts

Gamze Gunduz Meric, Levent Değirmenci

Department of Chemical and Process Engineering, Bilecik, Turkey

Dry reforming of methane reaction (DRM) directly converts CH4 and CO2 known as greenhouse gases to synthesis gases [1]. The efficiency of the process is determined by the proximity of H2/CO ratio to 1. Among many catalysts used in reaction, noble metals showed better activity, stability and resistivity to coking at DRM, as compared to their reasonably-priced alternatives such as Nickel (Ni) [2]. Nevertheless, Ni based catalysts are still being preferred due to their high cost and limited availability. The major problem is deactivation via coking and sintering with this metal and support materials such as SiO2 (silica) is used to provide a high dispersion and hence minimize coke formation during DRM [3]. Ni particles in a core-shell structure have strong chemical and physical interaction with the support and in our opinion, coating of Ni with SiO2 shell enable the microsphere catalyst to be more resistant to coke formation than other synthesized Ni catalysts.

Mesoporous Ni based core-shell microsphere catalysts (10-5-2.5-1.25 % wt.) were prepared with modified sol-gel method. Ni based microspheres showed high activity and stability in DRM with negligible coke formation. It was observed from TGA and FTIR analysis that SiC, along with a negligible amount of coke had been formed during reaction. Formation of SiC was thought to occur as a result of the applied synthesis procedure which had differences from the ones applied in literature [4, 5]. To the best of our knowledge, this is the first report on formation of SiC on catalyst surface during CO2 reforming of methane.

Keywords: Dry reforming, methane, microsphere, hydrogen

ORAL ABSTRACTS

[**Abstract:0101**]

Affective Factors Improving Catalyst Layers of PEM Fuel Cell

***Gokce S Avcioglu*[1], *Berker Ficicilar*[2], *Inci Eroglu*[1]**

[1]Department of Chemical Engineering, Middle East Technical University, 06800 Ankara, Turkey
[2]Department of Chemical Engineering, Ondokuz Mayıs University, 55139 Samsun, Turkey

Water management is one of the major challenges of low temperature hydrogen/oxygen and hydrogen/air proton exchange membrane (PEM) fuel cells. Water produced on the active sites of the cathode catalyst layer (cCL) condenses while it moves along the pores of the electrode. Accumulation of liquid water in the pores prevents oxidant gas from reaching active sites. Mass transport limitation occurring in the porous structure causes lower performance. The effect of Pt percentage in catalyst on performance has been investigated by comparing the performances of membrane electrode assemblies prepared with 20% and 70% Pt/C catalysts using ultrasonic coating technique. The power density increased from 0.25 to 0.7 W/cm2 at 0.5 V with the increase in the Pt weight percentage on Pt/C catalyst for H2/air atmosphere. The power density decreased from 1.3 to 1.1 W/cm2 at 0.5 V by increasing Pt loading on electrodes from 0.4 to 1.2 mgPt/cm2 for H2/O2 reactant gasses. SEM images prove that the thickness of the catalyst layer increases by increasing Pt load. Thinner electrodes have lower charge transfer resistance according to electrochemical Impedance spectroscopy (EIS) results.

The inclusion of 30 wt. % PTFE nanoparticles in catalyst ink enhanced the cell performance at higher current densities by increasing hydrophobicity for those electrodes manufactured with 20 % Pt/C. However increasing hydrophobicity did not significantly affect the performance of the fuel cell using the commercial catalyst having 70% Pt/C. Electrochemical active surface area (ESA) of these electrodes were by calculated from cyclic voltammograms. The addition of PTFE nanoparticles, increased the ESA of the electrodes prepared with 20 % Pt/C, however, reverse effect was observed for the 70% Pt/C.

Keywords: Proton exchange membrane fuel cell performance, electrocatalyst, catalyst layer, hydrophobic nanoparticle, water management

ORAL ABSTRACTS

[**Abstract:0102**]

Three-Dimensional Nonisothermal Model Development of High Temprature PEM Fuel Cells

***Berna Sezgin*[1], *Dilara Gülçin Çağlayan*[1], *Yılser Devrim*[2], *Inci Eroğlu*[1]**

[1]Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey
[2]Department of Energy Systems Engineering, Atilim University, Ankara, Turkey

In this study three-dimensional two mathematical models of High Temperature PEM Fuel Cell are developed by using Comsol Multiphysics with isothermal and non-isothermal operation conditions. The active area of the cell having phosphoric acid doped PBI membrane as an electrolyte is 25 cm2. The flow channels have triple mixed serpentine geometry. Inlet temperatures of anode and cathode reactants are taken as 438 K. The model results include concentration, pressure, velocity profiles of anode and cathode compartments as well as the temperature profile within the fuel cell. Conservation of mass, momentum and charge are used with the appropriate assumptions and boundary conditions. For the non-isothermal model energy balance is included in order to take into account the temperature variation within the system. The non-isothermal model is simulated for two different operation voltages, which are 0.45 V and 0.60 V. According to the non-isothermal model results, the temperature gradients are determined as 0.31 K and 0.18 K for operation voltages of 0.45 V and 0.60 V, respectively. Based on Faraday's law, consumed amount of hydrogen and oxygen are dependent on the current density, which is inversely proportional to the operation voltage in the activation and ohmic regions. The current density is directly related to the source term in the conservation of energy. As the current density increases, the heat evolving due to the reaction increases. Since the temperature variation within the cell is not significant, it is concluded that isothermal operation assumption is valid.

Keywords: Nonisothermal, High Temprerature PEM Fuel Cells, Modelin, Comsol Multiphysics

ORAL ABSTRACTS

[**Abstract:0103**]

Palladium Based Electrocatalysts for Ethylene Glycol Fuel Cells

***Özlem Gökdoğan Şahin*[1], *Hilal Demir Kıvrak*[2]**

[1]Selcuk University
[2]Yüzüncü Yıl University

Metallic nanomaterials, owing to their interesting physical and chemical properties, have found wide applications in many areas. Direct alcohol fuel cells (DAFCs) are one of the most promising renewable and clean energy technologies. These fuel cell systems use variety of alcohols such as methanol, ethanol, and ethylene glycol (EG). Among these alcohols, EG is noticeable due to its many advantages such as lower toxicity, higher energy density and reaction activity. Pt-based materials have been considered to be efficient electrocatalysts for alcohol oxidation. However, easy poisoning by intermediate products and high cost of Pt would restrict its application in DAFCs. Palladium is considered as electrocatalyst to overcome these problems with remarkable electrocatalytic activity. They are less expensive and have better electrocatalytic activities than Pt-based catalysts for alcohol oxidation. Many studies have been devoted to Pd-based catalysts for the electro-oxidation of alcohols. These studies have shown that bimetallic catalysts could be preferred with enhanced electrocatalytic activies than monometallic ones. Another way to improve the activity of catalysts catalytic activity is the core-shell structures with bimetallic particles. Moreover, core-shell nanoparticles with thin noble metal shells are of great importance in chemical catalysis due to their enhancing properties to substrate oxidation. In this study, the electrocatalytic activity of the both core –shell and alloy palladium-based catalysts toward the EG oxidation reaction has been examined by electrochemical techniques such as cyclic voltammetry, chronoamperometry, electrochemical impedance spectroscopy. The results show that Mn-Pd/CNTs (core-shell) showed better electrocatalytic activity towards EG electro-oxidation. Moreover, the oxidation of EG on Mn-Pd/ CNTs was observed at lower onset and peak potentials, higher current and faster kinetics (lower impedance) than at the other three catalysts. Moreover, Mn-Pd/CNTs (core-shell) increases the electrocatalytic activity and stability of the electrode.

Keywords: Palladium based electrocatalysts, ethylene glycol electrooxidation, fuel cells

ORAL ABSTRACTS

[**Abstract:0109**]

Hydrogen production from municipal solid wastes by hydrothermal gasification

***Jale Yanik*[1], *Gözde Duman*[1], *Koray Akarsu*[2], *Tugba Keskin Gündoğdu*[3], *Kübra Arslan*[2], *Nuri Azbar*[2], *Haris Nalakth Abubackar*[4]**

[1]Chemistry Department, Ege University
[2]Bioengineering Department, Ege University
[3]Center for Environmental Studies, Ege University
[4]Faculty of Sciences and Center for Advanced Scientific Research (CICA), La Coruña University

Hydrogen is an important energy carrier that will have an important place today and in the future. The importance of hydrogen production increases when it is produced by the processes with low energy requirements or from renewable energy sources, such as biomass. Hydrogen production from biomass is carried out by thermo-chemical and biochemical routes. One of the thermo-chemical methods is the gasification of biomass in supercritical water. For wet biomass containing large amounts of water up to 90%, supercritical water gasification (SCWG) appears as a useful technology, besides anaerobic digestion. SCWG produces the H2 and CO2 at temperatures of 400 ◦C or higher. Because of the high water excess, up to half of the H2 formed originates from water, the conversion of CO with water into H2 and CO2. In this study, SCWG of fruit and vegetable wastes and digestate from dry anaerobic digestion of fruit and vegetable wastes, was carried out at different temperatures. The food wastes (containing 11.4 % dry matter) were collected from main hall of Izmir Municipality. The catalyst used (trona) was supplied by Eti Soda Inc., Turkey. The effect of temperature and catalyst on efficiency of hydrogen production was determined. Hydrogen yields were increased extremely by increasing of temperature and using catalyst. The H2 yields from food wastes were 6.25 mmol/100 g waste and 14.69 mmol/100 g waste for 400 and 450 ◦C, respectively. On the other hand, the temperature led to increase in CH4 production besides H2 production. The use of catalyst significantly increased H2 production. For digestate, the H2 yields were 2.5 mmol/100 g digestate and 3.85 mmol/100 g digestate in absence and presence of catalyst, respectively. For food waste, H2 yield from catalytic run was almost two times more than that from thermal run. The results showed that HTC is a promising process for production of hydrogen from biomass in a biorefinery concept.

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Keywords: hydrothermal gasification, hydrogen production, biomass

ORAL ABSTRACTS

[**Abstract:0110**]

Hydrogen Productionfrom the Methanolysis Ofammonia Borane by Pd-Co/Al2O3 Coated Monolithic Catalyst

***Hatice Begüm Murathan*[1], Gülay Özkan[2], Meryem Sena Akkuş[1], Derya Öncel Özgür[1], Göksel Özkan[1]**

[1]Department of Chemical Engineering, Gazi University, 06570 Maltepe, Ankara, Turkey
[2]Department of Chemical Engineering, Ankara University, 06100 Tandoğan, Ankara, Turkey

Amine borane, which has excellent properties used as the chemical hydrogen storage materials, has begun to attract interest in recent years. Among the amine-borane, ammonia borane (NH3BH3, AB) with 19.6 wt % H2, which has a stable structure in both solids and liquid solutions, is being investigated intensively to enable high H2 production yield at low temperatures.The main advantage of catalytic methanolysis instead of hydrolysis of AB arises from the by-products that are easier to recycle and thus is able to produce hydrogen with high purity for fuel cell applications.

The aim of this study is to investigate thereleasing hydrogen by catalytic methanolysis of AB in the presence of a cordierite type ceramic monolithic.Monolithic channel surfaces were coated with Al2O3 by wash-coating method and then this layer was impregnated with 1wt%Pd-2wt%Co bimetallic catalyst. The characterization of the catalyst was carried out by SEM-EDS and multi-point BET analysis.Experimental studies were conducted at 40°C, and with various AB feed concentrations (0.1%, 0.2% and 0.4wt%) and flow rates (1-1.3 ml/min, 3.2-3.3 ml/min)in the continuous flow type reactor.It was found that the highest hydrogen production yield (89%)was obtained at 40°C,flow rate of 3.3 ml/min, and AB feed concentration of 0.1 wt %.

Keywords: Ammonia borane, monolithic catalyst, methanolysis

ORAL ABSTRACTS

[**Abstract:0111**]

Hydrogen Generation From the Dehydrogenation of Ammonia Borane by Using Amberlyst-15 Supported Catalysts

***Derya Öncel Özgür*[1], *Tayyibe Şimşek*[1], *Göksel Özkan*[1], *Meryem Sena Akkuş*[1], *Gülay Özkan*[2]**

[1]Department of Chemical Engineering, Gazi University, Ankara, Turkey
[2]Department of Chemical Engineering, Ankara University, Ankara, Turkey

The ammonia borane (denoted AB, NH3BH3) complex having remarkably high hydrogen content as high as 19.6 %wt has been considered as promising hydrogen storage materials for on-board hydrogen storage application. AB is highly soluble in water and its solution is stable at room temperature. Considerable research efforts were put forth to improve catalysts for the AB decomposition reaction. In the past decade, a number of noble metals, including Ir, Rh, Ru, Pd, and Pt were applied and showed higher catalytic activity than non-noble metal catalysts in decomposing AB. To improve the catalytic activity as well as prepare a low-cost, and efficient system for practical use, ruthenium metal catalyst was incorporated on Amberlyst-15 resin (a sulfonic acid type based upon a styrene-divinylbenzene copolymer). Resin catalysts have the advantage of the various properties and long lifetime due to regenerated facilely and thus makes them the attractive supports. In this study, a comparative study was conducted to optimize the dehydrogenation reaction condition with using two different types of support materials: Al2O3; alumina, and Amberlyst-15. It has been considered for the first time using ruthenium (Ru) catalysts based on Amberlyst-15 support material and compare the results with Al2O3, the common supporting material. The similar study was carried out for non-noble tin (Sn) catalyst to better comprehend the role of amberlyst-15 support effects. The effect of temperature (20-50), the initial AB concentration (0.05- 0.5 %wt), and catalyst amount (0.2-0.5 g) on product yield were also investigated. It was found that Ru or Sn supported on Ambelyst-15 showed the good activity, which means the Amberlyst-15 supporting effect on ruthenium or tin metal led to increase in the hydrogen production rate.

Keywords: Catalytic hydrolysis, Ammonia Borane, Al2O3 support, Amberlyst-15 support, Kinetics

ORAL ABSTRACTS

[**Abstract:0113**]

Two New Bio-inspired Distributed and One Side Inlet Honeycomb Flow Field Designs for PEM Fuel Cells and Performance Investigation of Models via CFD Tools

***Erman Çelik*[1], *Irfan Karagöz*[2]**

[1]Department of Mechanical Engineering, Faculty of Technology, Fırat University, Elazığ, Turkey
[2]Department of Mechanical Engineering, Faculty of Engineering and Architecture, Uludağ University, Bursa, Turkey

Proton Exchange Membrane Fuel Cell (PEMFC) technology is one of the most prominent carbon free energy conversion method which is highly suitable for mobile applications especially as vehicle powertrain with its quick start up, relatively low operating temperature and high power output characteristics. PEMFC is a device which generates electricity as result of electrochemical reactions whose inputs are Hydrogen and Oxygen gases as reactant and outputs are electric current, heat and water. Despite its advantageous properties, it is needed to be improved in aspects of better reactant distribution, quick excess water discharge while keeping membrane humid enough to achieve higher power output and durability. In this study a new bio-inspired Distributed Inlet and One Side Inlet honeycomb flow field design have been developed for PEMFC to achieve a better reactant and pressure distribution in addition to active water disposal. Performance of new designs are predicted by three dimensional CFD analysis using Ansys Fluent PEM Fuel Cell module in which the models have been verified by using experimental data of a single serpentine PEMFC. Simulations belonging to new designs have been done on 50 cm2 active surface area single cell models. Performances of new designs have been investigated comparing with performance of a 50 cm2 single serpentine PEMFC. Promising character of bio structures on new PEMFC flow field designs have been revealed.

Keywords: PEM Fuel Cell, CFD Modeling, Bio-Inspired, Flow Field Design

[**Abstract:0115**]

Copper-covered AA6013-T6 Al Anode(Al/Cu) for Al-Air Battery

Rasiha Nefise Mutlu, Birgül Yazıcı

Chemistry Department, Science and Letters Faculty, Çukurova University Adana/TURKEY

The rapid economic development and the huge energy consumption have laid rapid decrease of fossil fuels. The excessive yield of recent investigations on new energy is reached and will quicken the conversion of fossil fuel based energy to clean energy. Alternatively, hydrogen energy, metal-air batteries etc., Al-air battery because of high energy density (400 Whkg-1) have been investigated more than 50 years. However, aluminium suffers substantial corrosion in alkaline solution with the production of large amount of hydrogen gas covered on the surface of aluminium anode, induction of columbic loss on discharge and stand-by [1]. Copper thin film widely acknowledged because of their good magnetic, mechanical, electrocatalytic properties, wear resistance as well as their good corrosion resistance can be considered to overcome such problems [1-3]. In this study, aluminium alloy (AA6013-T6 Al) electrode cooperated with aluminium electrode chemically coated with copper (AA 6013-T6 Al /Cu) in (wt%) 2.85% CuSO4•5H2O and 11.10% H2SO4. electrolyte during 12h. The open circuit potential and current were recorded during 3600 sec. The corrosion performance of electrodes has been investigated in 4 M NaOH by using EIS, polarization techniques for 1800 sec. For self-corrosion evaluation, the cylindrical aluminium sheets (surface area 6.28 cm2) and immersed in 4 M NaOH for 30 min. The weight loss measured and corrosion rate calculated. The sheets were immersed in the 4 M NaOH electrolyte at 25 ± 1 oC for 30 min, the gas volumes were measured. The hydrogen gas evolution rate is calculated. Galvanostatic discharge test is carried out at the current density of 10 - 50 mA cm-2. The weight of the anodes was measured both before and after discharge. The anode utilization (Ua%) and capacity density were calculated and SEM images were taken. As a result, when AA6013-T6 Al /Cu electrode compared with AA 6013-T6 Al as Al-air battery anode for Al-air alkaline battery, the composition of AA6013-T6 Al /Cu had been more successful at low corrosion rate and low hydrogen gas evolution respect. The copper and aluminium worked together to produce an enhanced result and copper showed surprisingly synergistic effect with aluminium. The copper also increased the catalytic activity. This increased battery performance.

Keywords: Copper thin film, air battery, aluminium, hydrogen, energy

Self –Corrosion and Hydrogen evolution rates

Anode	Self -Corrosion Rate (mm yr-1)	GH2 mL cm-2min-1
AA 6013-T6 Al	270.58	0.16
AA6013-T6 Al /Cu	251.99	0.1377

ORAL ABSTRACTS

[**Abstract:0119**]

Grain Boundaries Contribution on Ionic Conductivity of Oxide Semiconductors

***Musa Mutlu Can*[1], *Shalima Shawuti*[2], *Mehmet Ali Gülgün*[2], *Ayşe Zehra Aroğuz*[3], *Harun Cerit*[4]**

[1]Physics Department, Faculty of Science, Istanbul University, Istanbul, Turkey
[2]Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul, Turkey
[3]Chemistry Department, Faculty of Engineering, Istanbul University, Istanbul, Turkey
[4]Department of Animal Science and Animal Nutrition, Faculty of Veterinary, Istanbul University, Istanbul, Turkey

Variety of different additive atoms may open a new research area for metal oxides to use for low temperature solid oxide fuel cells (SOFCs). SOFCs are foreseen as a new way to generate electricity [1]. However, the disadvantages of SOFCs are the high operating temperatures (~1000 oC) and high costs. The demands on alternative materials in SOFCs were urgent, thus the studies are now focused on lowering both operating temperature and the cost by using metal oxides [2,3]. Among many researches, ZnO is a good candidate due to tuneable conductivity with doping elements that mainly affected both internal grain and grain boundary. Furthermore, ac impedance spectroscopy is a useful way to distinguish the electrical and ionic conductivity originating from grain or grain boundary. Co amount in ZnO lattice can tune the ionic conductivity at the internal grain or through the grain boundary. The resistivity changes in grain and grain boundaries were analysed via AC electrochemical impedance spectroscopy. The resistivity values were correlated with the change in crystal quality by Co amount in the lattice. The AC impedance measurements were performed in temperature ranges from room temperature to 400 °C, at which ac conductivity response disappeared. Influence of substituted Co amount on the resistivity of grain or grain boundary was related with enhanced activation energies of ionic conductivity through the grain boundaries. The change in the activation energy implies that the mechanism of ionic conduction through the boundaries modified with Co-doping. Three conductance mechanisms, which were represented by the three fits at each Cole-Cole plot, were used to determine the relaxation mechanism and activation energies of ionic transportation. The ionic conductivity of ZnO at 350 °C was on the order of magnitute of 1.25 x 10-6 S cm-1. Increased temperature cause an increase in conductivity, therefore the calculated activation energies of ZnO was 171 meV [4]. Meanwhile, the doping with Co atoms increased the activation energy of ionic conductivity through the grain boundaries. Furthermore, 10 mol% Co doping into ZnO lattice attributed new activation energy, 395 meV, related with ionic conductivity through the grain boundary. Increased activation energy implies that stability of ionic conductivity was enhanced at high temperatures due to decrease in electronic conductivity compared to undoped ZnO. Implication of Co doping on possible defect formation mechanisms was discussed.

References:

[1] L. Fan, et.al., Journal of Power Sources 203 (2012) 65– 71
[2] J. M. Ralph, et. Al., Journal of Materials Science 36 (2001) 1161 – 1172
[3] B. Zhu, et.al., Energy Environ. Sci., 2011, 4, 2986
[4] S. Shawuti, M. M. Can, M. A. Gülgün, T. Fırat, Electrochimica Acta, 145 (2014) 1, 132–138.

Keywords: Solid Oxide Fuel Cells, Oxide semiconductors, ionic transport

ORAL ABSTRACTS

[**Abstract:0122**]

Thermodynamic Assessment of Combined Geothermal Energy Based Hydrogen Production and Liquefaction System

Yunus Emre Yuksel[1], Murat Ozturk[2], Ibrahim Dincer[3]

[1]Department of Elementary Science Education, Education Faculty, Afyon Kocatepe University,
[2]Department of Mechatronics Engineering, Faculty of Technology, Suleyman Demirel University
[3]Faculty of Engineering and Applied Science, University of Ontario Institute of Technology (UOIT),

In this study, the thermodynamic analysis of combined geothermal energy based hydrogen production and liquefaction process is detailed investigated. This hydrogen production and liquefaction process is consisted of the combined geothermal power system (direct steam system and binary cycle), the PEM electrolyzer, the hydrogen liquefaction and the storage sub-system. The exergy destruction rate, exergy destruction ratio and exergy efficiency of integrated system components and whole system are calculated by using balance equations, such as mass, energy, entropy, energy and exergy, and also energy and exergy efficiency equations. Finally, the effect of some design parameters and other indicators on the hydrogen production and liquefaction system exergy destruction rate and exergy efficiency are investigated.

Keywords: Geothermal energy, integrated system, hydrogen, liquefaction, energy and exergy analysis.

ORAL ABSTRACTS

[**Abstract:0123**]

High Yield Hydrogen Production from Sodium Borohydride by Non-Catalytic Steam Reforming: A Parametric Study

***Meryem Sena Akkuş*[1], *Hatice Begüm Murathan*[1], *Derya Öncel Özgür*[1], *Gülay Özkan*[2], *Göksel Özkan*[1]**

[1]Department of Chemical Engineering, Gazi University, 06570 Maltepe, Ankara, Turkey
[2]Department of Chemical Engineering, Ankara University, 06100 Tandoğan, Ankara, Turkey

A number of research studies have been focused on sodium borohydride ($NaBH_4$, 10,8% H_2 wt) in chemical hydrogen storage materials due to its outstanding properties. In the past decade, there are so many studies about hydrolysis of $NaBH_4$ in the presence of catalysts under mild condition. However, those catalysts were easily deactivated due to the by-product of $NaBO_2$ that deposed on those catalysts surface. In this study, it is aimed to produce H_2 from $NaBH_4$ solution and its hydrolysis was carried out at higher temperature in the absence of any catalyst. In the experimental system, the fixed bed reactor system was used. The $NaBH_4$ solution was fed to system at low flow rate (0,66 ml/min) to control the H_2 releasing rate. The effect of $NaBH_4$ feed concentration and temperature (110°C-150°C) on H_2 generation rate was investigated. Experimental results from non-catalytic steam reforming of $NaBH_4$ indicated that the hydrogen generation yield was maximized under the reaction temperature of 150°C, and the $NaBH_4$ concentration of 5% wt. To prevent the decomposition of unstable $NaBH_4$ in the aqueous solution at even room temperature, NaOH was added to the feeding $NaBH_4$ solution. In this case, HCl solution (1-3 M) was also fed to system to neutralize or study in acidic medium. When the reaction was carried out at temperature 150 °C, the feed concentration; $NaBH_4$ 5% wt and NaOH 7% wt, and 2M HCl acid, hydrogen production yield was increased up to 99%. The by-products were characterized by XRD and FTIR to figure out the reaction pathway. It was concluded that steam reforming of $NaBH_4$ in acidic medium led to the rise of H_2 production yield as well as shifting toward the by-product as boric acid.

Keywords: NaBH4, Non-catalytic steam reforming, Hydrogen production

[**Abstract:0126**]

Optimal Design of a Hydrogen Refueling Station Powered by Wind-PV Hybrid Power System

***Murat Gökçek*[1], *Cihangir Kale*[2]**

[1]Department of Mechanical Engineering, Ömer Halisdemir University, Niğde, Turkey
[2]Department of Energy Systems Engineering, Fırat University, Elazığ, Turkey

Hydrogen fuelling station is an infrastructure for the commercialization of hydrogen energy utilizing fuel cells, particularly, in an automotive sector. Hydrogen fuel produced by renewable sources such as wind and solar energy may be used as possible alternative fuel to reduce use of fuels based fossil sources in the road transport sector of the countries. By replacing the gasoline fuel with hydrogen fuel produced using renewable sources in road transport sector, environmental benefits can be achieved. In this study, techno-economic analysis of hydrogen refuelling station powered by hybrid wind-pv power system to be installed in İzmir-Çeşme, Turkey is performed. This analysis is carried out around the year to successfully refuel 25 vehicles on daily basis using HOMER. According to optimization results obtained for the proposed system, the levelized cost of hydrogen production was calculated to be US $5-10/kg in different renewable fractions. These results show that hydrogen refuelling station powered by renewable energy may be appropriate for considered site.

Keywords: Hydrogen refueling station, Levelized cost of hydrogen, HOMER

[**Abstract:0129**]

Energetic and Economic Analysis of On-board Hydrogen Production System in SI Engine Vehicle

Habib Gürbüz, Hüsameddin Akçay, Ismail Hakkı Akçay, Selim Demirtürk

Süleyman Demirel University, Faculty of Engineering, Department of Mechanical Engineering, Automotive Engineering Undergraduate Program

In this paper, energetic and economic analysis was performed to SI engine vehicle which is used addition hydrogen produced by on-board PEM electrolysis system. PEM electrolyser was supplied by vehicle charging system and its enter water was heated by using exhaust waste heat for saving energy. Studies is composed of two parts as experimental and theoretical. Firstly, effect on performance parameters (i.e thermal efficiency, specific fuel consumption, engine power and torque) of addition hydrogen was determined by measurement of in-cylinder pressure and fuel consumption of a single cylinder SI gasoline engine. Secondly, experimental results was adapted to a typical SI engine vehicle for energy analysis. As a result, energetic (performance improvement and conversion efficiency) and economic analysis (economic life and setup cost) was performed of on-board PEM electrolyser system having heated water entering for a typical SI engine vehicle which is added hydrogen to gasoline fuel. In addition, the conversion efficiency of each part of the system and the total conversion efficiency of the system are calculated by using obtained results.

Keywords: SI engine vehicle, On-board hydrogen production, Heated water, Energetic and economic analysis.

[**Abstract:0131**]

Parametric Investigation of 3D Geometrical Design of PEM Fuel Cells

Muhammed Mücahit Toprak, Mehmet Utku Badak, Suha Orçun Mert

Department of Chemical Engineering, Yuzuncu Yıl University, Van, Turkey

Day after day, along with the renewal of the technology, the need for energy is also increasing. In this sense, energy production and conservation gets an increasing importance in scientific researches. Interest in renewable energy sources is increasing at national and international scale due to the gradual decline of non-renewable energy sources in the world, In this sense, Fuel cell systems come to the fore. In this study, 3D modeling and parametric investigation of the flow channels of the Proton Exchange Membrane fuel cell (PEM) systems were carried out To contribute to the need for renewable energy. The effect on the efficiency of the flow channels providing the distribution of the substances entering the reaction was examined parametrically on the efficiency. Hydrogen and oxygen flow rates and flow density were evaluated as parameters. In order to increase energy efficiency, it is aimed to determine the most suitable flow rates. As a result of the study, the anode cathode material (hydrogen, oxygen, water) concentrations, voltage and efficiency were examined on whole surface of the fuel cell.

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

[**Abstract:0132**]

Hydrogen Production Potential From Solar Energy in Kayseri

Gamze Genc, Seyfettin Gurel

Department of Energy Sytems Engineering, Erciyes University, Kayseri, Turkey

Demand on the clean renewable energy sources has gradually increased because of the negative effects of fossil fuels on environmental pollution. And the combination of hydrogen production with solar power is a popular solution as an environmentally friendly and safe energy source. In this paper, the hydrogen production potential was analyzed using solar-electrolysis system for Kayseri. For this purpose, firstly daily and annually solar energy potential of Kayseri was calculated from the global radiation. Depending on the obtained energy from solar energy, hydrogen production potential was investigated by considering three different electrolyze cases such as i) 10x10kW ii) 5x20kW and iii) 1x100kW. The results brought out that the most hydrogen was produced in the case of 10x10kW electrolyze case.

Keywords: solar energy, hydrogen production, electrolysis

ORAL ABSTRACTS

[**Abstract:0133**]

Electrochemical Property of Nano-Composite Electrolyte for Fuel Cells

Shalima Shawuti, Ahmet Deniz Benli, Mehmet Ali Gulgun

Sabanci University, Istanbul, Turkey

Abstract— Importance of the composite electrolyte comes mainly from investigation of defects generated intentionally in/at oxide phase which ultimately affects surface charges. Surface charges ultimately determine the ionic conductivity depending on the ion exchange throughout the fuel cell. This study is focused on evaluating the effect of engineered surface charges on the positive ions as conductive agent. The surface charges were manipulated by reducing solid oxide phase in nano-composite fuel cells con-sisting of Na2CO3 matrix.

The use of hybrid fuel cells with solid oxide phase as scaffold and molten carbonate phase as matrix are the main concerns for this study due to their promising applications as electrolytes [1]. Ionic transport in amorphous structures may be easier than their crystalline counterpart. Some evidence has already emerged that the ionic conduction through amor-phous structures are almost 104 times higher than the value for crystalline structures. [2] The study of observing net negative ionic current change with carbonate ions and hydrogen ions had already been per-formed while attaching sodium ions to the surface of samari-um doped ceria (SDC) phase.

Hence, converting this system to the other way around i.e. attaching negative ions to the surface of solid oxides while measuring ionic conductivity with positive ions are desir-able to see if the system gives practically proper and effective outcome. In this project varied solid oxides: SiO2, TiO2 and Fe2O3 in-teractions with the Na2CO3 matrix phase have been chosen to construct a composite like structure as they are both electronic insulators. However, they conduct ionic currents in the amor-phous nature of structure. So, it has been considered to use different oxide materials under reducing atmosphere to see the change in ionic conductivity. Those materials which are used to bind or repel ions on their surfaces are entitled as soggy sands.

References:

[1] Shawuti, S., & Gulgun, M. A. Int. Journal of hydrogen energy 41 (44), 20343-20349 (2016).
[2] A. J. Bhattacharyya, Jürgen Fleig, Yu-Guo Guo, Joachim Maier, Adv. Mater. 17, 2630 (2005).
[3] Shawuti, S., & Gulgun, M. A. Journal of Power Sources 267, 128-135 (2014).

Keywords: Fuel cell, Electrolyte, Composite

ORAL ABSTRACTS

[**Abstract:0134**]

Experimental Investigation of Ni-doped Multi-walled Carbon Nanotubes for Hydrogen Storage at Different Temperatures

***Songül Kaskun*[1], *Muhammet Kayfeci*[2]**

[1]Songül Kaskun
[2]Muhammet Kayfeci

One of the least harmful energy sources to people and the environment, among all the alternative energy sources, is hydrogen energy. The most important factor of hydrogen energy, which is separated from other energy source, is to be widely produced, it's storage ability and its low weight. The most important aspect of hydrogen energy is its storage ability which can be used to reduce the dependence on energy. One of the hydrogen storage methods used recently is that provided by carbon nanotubes. They have high hydrogen storage ability compared to other methods due to the large surface area of the carbon nanotubes. The hydrogen storage capacity can be increased by added functional groups and doping with transition metals. The reason is to use transition metals on multi-walled carbon nanotubes that to enhance porosity and dipole interaction which are responsible for high hydrogen adsorption. For this reason, Nickel doping is generally used multi-walled carbon nanotubes to enhance Hydrogen adsorption in parallel to increase Hydrogen storage capacity. There are many reasons can effect Hydrogen storage capacity especially temperature, pressure, pH etc. On the basis of this study, the Ni decorated multi-walled carbon nanotubes were used in order to investigate Hydrogen storage capacities under at different temperature conditions.

Keywords: Ni-doped, carbon nanotubes, hydrogen storage

ORAL ABSTRACTS

[**Abstract:0137**]

Parametric investigation of direct catalytic conversion of synthesis gas to dimethyl ether

Hatice Merve Can, Zeynep Ilsen Önsan, Ahmet Kerim Avci

Department of Chemical Engineering, Bogazici University, Bebek 34342, Istanbul, Turkey

The objective of this study is to examine the catalytic performance of bi-functional catalyst systems in direct production of dimethyl ether (DME) from synthesis gas, a mixture of H2 and CO. Direct production method involves two consecutive steps, namely methanol synthesis followed by methanol dehydration. Hence, a commercial methanol synthesis catalyst (Cu-ZnO based HiFuel-R120) was coupled with ceria promoted methanol dehydration catalysts in a dual-bed micro-reactor. Methanol dehydration catalysts were prepared by incipient-to-wetness impregnation by varying CeO2 loading on Al2O3. Syngas-to-DME performance of the bi-functional catalyst system was studied in an Autoclave Engineers' BTRS-Jr-PC high-pressure, high-temperature reaction test system with a down-flow fixed-bed reactor. Temperature, pressure, feed composition and CeO2 loading were tested for their effects on catalyst performance expressed in terms of CO conversion; DME, methane, carbon dioxide and methanol yields, and DME selectivity. Temperatures of 250, 275 and 300°C and pressures of 25 and 34 bar were tested with CeO2 loadings of 5%, 10% and 20% for methanol dehydration. Results on 5% and 10% CeO2/Al2O3 catalysts indicate that increasing the temperature enhances CO conversion and increases both DME selectivity and DME yield, while CO conversion on 20% CeO2/Al2O3 is not altered, which may be due to metal sintering. Increasing the pressure leads to higher catalytic activity on 5% and 10% CeO2/Al2O3, due to Le Chatelier's principle operative in methanol synthesis. Effect of H2/CO molar feed ratio on CO conversion and DME selectivity is studied at ratios of 1 and 2, and results show that a H2-rich medium increases DME selectivity. Effect of decreasing CeO2 loading is to enhance CO conversion and DME selectivity. Highest CO conversion (36.6%) and DME selectivity (74.4%) are obtained when HiFuel-R120 is coupled with 5% CeO2/Al2O3 at 300°C and 34 bar using a H2/CO molar feed ratio of 2.

Keywords: Hydrogen, Synthesis Gas, Dimethyl Ether, Catalyst

[**Abstract:0138**]

Role of Hydrogen in 100 % Renewable Energy Systems of the Future

Tanay Sıdkı Uyar

Department of Mechanical Engineering, Marmara University, Istanbul, Turkey

Transition from fossil age to solar age is not a dream anymore since renewable energy resources are available free of charge whereever they are needed. Renewable energy technologies to convert renewable energy resources to process heat, electricity and transport fuels are available commercially today.

There are steps to be taken for effective deployment of renewable energy and to speed up the transition to 100 % renewable energy societies.

Priority is always energy end use efficiency with best available technologies in order to minimize the total energy consumption without sacrificing the comfort and quality of the services provided.

Due to the high entropy nature of renewable energy resources, local community power solutions can be designed with the ownership of citizens, municipalities and non profit cooperatives to produce electricity and district heating with integrated utilization of renewable energy resources. Smart grids for electricity; hydrogen using the existing natural gas Networks with power to gas options will be the reality of future energy systems. Planning the future energy systems with the information of the future requires local energy planning integrated to national energy planning by using the existing and the future technologies as candidates.

Cheapest electricity produced from wind and solar power plants, net zore energy building designs and energy end use efficiency substitute fossil fuel consumption with solar energy utilisation in heating and cooling sector.

Intermittent character of renewable energy resources requires storage of renewable energy to make the energy solution independent from the problem, that is renewable energy independent from the fossil fuels.

Transportation fuels such as hydrogen and biogas are emerging technologies to end up the fossil fuel utilisation in transportation. Cheap electricity supplied from wind and solar contribute to production and commercialisation of hydrogen energy with competitive prices.

This paper will discuss the role of hydrogen as an energy carrier in future 100 % renewable energy systems for energy storage, as a transportation fuel in Fuel Cells, as a supplier of the gas distribution networks and as one of the main synthetic fuels from electrolysers.

Keywords: hydrogen as a carrier, 100 % renewable energy, fuel cells

ORAL ABSTRACTS

[**Abstract:0139**]

Catalytic Reforming of Glycerol to Hydrogen in Wall Coated Microchannels

Amin Delparish, Ahmet Kerim Avci

Department of Chemical Engineering, Bogazici University, Bebek 34342, Istanbul, Turkey

Glycerol, a by-product of biodiesel synthesis, is known as a potential source for renewable production of H2. The predictions indicate a huge surplus of glycerol, 3 megatons by 2020; therefore, glycerol valorization via reforming processes has been of great interest [1,2]. However, microchannel enabled reforming of glycerol have been barely investigated in the literature. Microchannels offer surface area-to volume ratios that are up to two orders of magnitude higher than those of conventional units, provide much lower resistance against heat flow and significantly reduce pressure drop [2]. In this work, glycerol steam reforming (GSR) and oxidative steam reforming (OGSR) is studied over a Rh/Al_2O_3 wall-coated microchannel reactor at GHSV of 10^5 h^{1-} and steam-to-carbon molar ratio of 5. Temperature and carbon-to-oxygen molar ratios (C/O) were studied in the range of 500-600 °C and 0.75 to 2.25, respectively. Under GSR conditions, maximum conversion is found to be 24.2% that is obtained at 600 °C. However, in the case of OGSR at C/O of 1.125 and 600 °C, glycerol conversation is as high as 73.1%. This remarkable improvement in conversion can be due to the oxidation of coke into carbon oxides which improved CO and CO_2 yields. The significantly suppressed coke formation also provides more available active sites accelerating water-gas shift reaction, and consequently, H_2 formation. The effect of C/O on OGSR is also investigated at 550 °C. It is found that at lower C/O, total oxidation of glycerol becomes the dominant reaction and leads to high CO_2 and diminished H_2 yields. Moreover, compared to packed-bed reactors, microchannels are found to be capable of delivering up to ~10^2 higher H_2 yield per unit mass of catalyst.

References:

[1] Gerpen, J.V. Fuel Process. Technol. 86 (86) 1097.
[2] Koc, S., and Avci, A.K. Appl. Fuel Process. Technol. 156 (2017) 357.

Keywords: Glycerol, hydrogen, steam reforming, oxidative steam reforming, catalyst, microchannel

ORAL ABSTRACTS

[**Abstract:0143**]

Investigation of Hydrogen Production by using Silver Covered Platinum Electrode in Base Media

Guray Kilincceker[1], Mehmet Karakilcik[1], Refik Cetin[1], Mustafa Kemal Sangun[2]

[1]Çukurova University
[2]Mustafa Kemal University

In this study, electrolytic hydrogen production performance of electrodes electrochemically coated with silver (Ag) element platinum (Pt) surface was determined. For this, the surface morphology of the electrodes has been examined. Some characteristics of the surface structure to determine the effect of the chemical structure of the composition forming the morphology of the silver alloy surface to increase the hydrogen yield were analysed by scanning electron microscopy (SEM), atomic force microscopy (AFM), energy dispersive X-ray spectroscopy (EDX), and X-ray fluorescence spectrometry XRF).

Keywords: Hydrogen production, Silver, Covered Platinum, Electrolyse

ORAL ABSTRACTS

[**Abstract:0144**]

The Effect of Bacteriologically Generated Carbohydrates on Electrocatalytic Oxidation and Hydrogen Efficiency

Güray Kılınççeker[1], Mehmet Karakilcik[1], Eren Caglar[1], Mustafa Kemal Sangun[2]

[1]Cukurova University
[2]Mustafa Kemal University

In this study, the hydrogen efficiency performance and electrocatalytic oxidation was examined by the bacteriologically produced carbohydrate using electrochemically coated electrodes with silver (Ag) element on the surface of platinum (Pt). In addition, hydrogen production rates will be determined by electrolysis. Some characteristics of the surface structure to determine the effect of the chemical structure of the composition and the morphology of the surface were analysed by scanning electron microscopy (SEM), atomic force microscopy (AFM), energy dispersive X-ray spectroscopy (EDX), and X-ray fluorescence spectrometry XRF). As a result, electrocatalytic effect in the hydrogen gas production by using these coated electrodes was found.

Keywords: Hydrogen gas, Silver, Covered Platinum, Bacteria, Electrolyse

ORAL ABSTRACTS

[**Abstract:0146**]

A Parametric Study on A Run-of-the River Mini Hydropower Plant Integrated Hydrogen Production

Adnan Midilli, Mert Özsaban

Mechanical Engineering Department, Faculty of Engineering, Recep Tayyip Erdoğan University, Rize, Turkey

The main objective of this study is to perform a parametric investigation of hydrogen production by using a run-of-river mini hydropower plant integrated PEM electrolysers. In this study, hydrogen production system includes a run-of-river mini hydropower plant and three PEM electrolysers. In this system, hydrogen production capacity has been determined by depending on the hydropower quantity, and therefore three PEM electrolysers have been integrated in the system. At the end of the calculations, it is determined that mini hydropower plant generates maximum 455 kW power, and PEM electrolyzer produces 2.661 kg/h (30 Nm3/h) hydrogen gas at 30 bar and 70 °C under the following operating conditions: i) mini hydropower gross head ranging from 50 m to 200 m with 30 intervals, ii) discharges ranging from 0.2 m3/s and 0.3 m3/s with 0.025 intervals. Accordingly, minimum hydrogen production rate are calculated to be 1.324 kg/h at 50 m gross head and 0.2 m3/s of discharge by utilizing 75.462 kW electricity from mini hydropower plant. Maximum hydrogen production rate are estimated to be 7.941 kg/h at 200 m gross head and 0.3 m3/s of discharge by using 453 kW electricity from the plant.

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

[**Abstract:0147**]

Investigation of the Underground Hydrogen Storage Structures

Hatice Karakilcik

Cukurova University

In this study, underground hydrogen storage structures were investigated. These structures have very large energy storage capacities. With this regard, hydrogen energy can also be stored in these structures in very large quantities and more economically. As well as the hydrogen production, large storage area has a key role. For this reason, the gas-tight underground geological areas can be determined and the hydrogen gas can be stored at a considerably large amount at a lower cost. Underground energy storage areas are only possible in some gas-tight geological layers or structures, and can be determined by geophysical methods. For this purpose, underground hydrogen storage structures have been investigated and the most suitable geological structures have been tried to be determined. As a result, these structures have been found to be underground salt caverns or salt domes, porous geological formations, depleted oil and gas reservoirs in the subsurface. In addition to very large-scale hydrogen energy storage capacity of the storage areas, it have also been shown to be able to meet peak load demands in the event of an increase or decrease in energy demand using the highly power hydrogen fuel cells.

Keywords: Hydrogen storage, Underground structures, Geophysics methods, Salt caverns

ORAL ABSTRACTS

[**Abstract:0148**]

Assessment of a Geothermal Based Integrated System For Power and Hydrogen Production

Hatice Karakilcik, Mustafa Erden, Mehmet Karakilcik

Cukurova University

In this study, power and hydrogen production performance of an integrated system based on geothermal energy is studied. The integrated system consists of a steam power turbine, an organic Rankine cycle (ORC), a chlor-alkali reactor, a water purification system and a saturated NaCl solution reservoir tank. The steam power turbine is driven by high temperature water steam from geothermal reservoir. The generated power is delivered to city grid and waste heat from the steam power turbine is used for running of the ORC. The generated electricity from the ORC is used for the electrolysis takes place in the chlor-alkali reactor. To enhance the performance of the reactor, the saturated NaCl solution and pure water is heated by the waste heat from the ORC. So, this integrated system produces electricity and hydrogen, and also yields the by products namely chlorine and sodium hydroxide while consumes saturated NaCl solution and pure water. As a result, the geothermal energy potential plays an important role on the integrated system performance and rate of hydrogen production.

Keywords: Hydrogen production, Geothermal energy, Integrated system, Exergy, Efficiency

[**Abstract:0149**]

Transport Limitations of Oxygen Exchange in Solar Thermochemical Hydrogen Production: An Experimental Study on Co3O4

Atalay Çalışan, Serkan Kıncal, Deniz Üner

Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Solar hydrogen production is becoming increasingly popular for sustainable and green fuel production [1]. Reducible metal oxides as oxygen storage materials are recently integrated these processes via chemical looping technologies. The hybrid technology called as two step solar thermochemical cycles eliminates the high temperature gas separation of hydrogen and oxygen since hydrogen and oxygen is produced in separate steps. The bottleneck of these technologies is the activation of metal oxide by thermal decomposition reaction such that oxygen removal is the rate determining step requiring very high temperatures. In addition, the significance of heat and mass transfer limitations at reaction environment is still not clear. In this study, thermodynamic, kinetic, heat and mass transfer related problems were investigated separately during the oxygen transport from a model compound Co_3O_4. Equilibrium analysis revealed that Co_3O_4 can be thermally decomposed around 800 °C in an inert atmosphere. Temperature programmed reduction, oxidation and thermal decomposition experiments were performed to determine the magnitude of kinetic, heat and mass transfer limitations. Oxides of Co supported on Al_2O_3 exhibit higher oxygen evolution rates on the basis of per gr Co. The enhancement was alluded to higher surface areas provided by Al_2O_3 support. The addition of Pt on Co_3O_4 enhances the rate of reduction in hydrogen atmosphere and shifts oxidation temperatures to lower values. Finally, transport limitations were minimized by doping Pt/Co_3O_4 samples on monolith.

Refenrece:

[1] Chueh, W., Falter, C., Abbott, M., Scipio, D., Furler, P., Haile, S., & Steinfeld, A. High-flux solar-driven thermochemical dissociation of CO2 and H2O using nonstoichiometric ceria. Science, (2010) 330, 1797-1801.

Keywords: Solar thermochemical, transport limitations, oxygen exchange, hydrogen

ORAL ABSTRACTS

[**Abstract:0151**]

Parametric Analysis of Hydrogen Storage Taking into Account of Three Different Metal Hydride Materials

***Ümran Elmas*[1], *Fevzi Bedir*[2], *Muhammet Kayfeci*[3]**

[1]TÜBİTAK Türkiye Bilimsel ve Teknolojik Araştirma Kurumu - Ankara/TÜRKİYE
[2]Gebze Teknik Üniversitesi, Mühendislik Fakultesi, Gebze-Kocaeli/TÜRKİYE
[3]Karabuk Üniversitesi Teknoloji Fakultesi, Karabuk/TÜRKİYE

In this study, firstly the results of experimental and of finite element-based modeling are evaluated as being confirmed each other. Then many of parameter combinations which are directly affect the hydriding and metal hydride-based hydrogen storage process are defined. The combinations are particule size of hydride material, the tank design with or without fins, varying hydrogen inlet pressure, changing the temperature of the cooling fluid around the the tank, the variation in the inner radius, the general convective heat coefficient as well as changing the wall thickness. The system and the other related parameters mentioned above are modelled by COMSOL. These variables are analyzed together with taking into account of the thermo-physical properties of three different types of metal hydride materials of MmNi4,6Al0,4, LaNi4.75Al0.25 and LaNi5 in terms of having the results in the temperature distribution inside the tank, in the amount of hydrogen mass to be stored in the tank and in variation of the equilibrium pressure of the system. The final conclusions are also remarked.

Keywords: Metal Hydride Alloys, Hydrogen Storage Tank, Absorption, Desorption, COMSOL Modelling

ORAL ABSTRACTS

[**Abstract:0153**]

Evaluation of Waste Paper Towel for Hydrogen Gas Production by Dark Fermentation

Hidayet Argun*, *Gülizar Onaran

Pamukkale University Engineering Faculty Department of Environmental Engineering, Denizli-Turkey

Effects of substrate concentration on dark fermentative hydrogen production from waste paper towel hydrolysate was investigated in batch experiments. Glucose concentration was varied between 5-40 g/L while the biomass concentration was kept constant at 0.1 g/L. The hydrolysate was subjected to lime and resin treatment before inoculation to remove excess 5-Hydroxymethylfurfural and sulfate. Optimum hydrogen production was obtained at 20 g/L glucose concentration. Glucose concentration less than 20 g/L led to substrate limitation while higher concentrations than 20 g/L resulted in substrate inhibition. Hydrogen and TVFA yields for the experiment with 20 g/L initial glucose concentration were 1.34 molH2/mol glucose and 0.515 gTVFA/g glucose, respectively. Gompertz equation coefficients on the other hand were determined as P: 242.5 mLH2, Rm: 3.64 mLH2/mL and λ: 56.75 h. It was seen that waste paper towel could be evaluated for hydrogen gas production after a proper removal of inhibitory compounds that are produced during the acid hydrolysis step.

Keywords: Waste paper towel, acid hydrolysis, anaerobic sludge, dark fermentation, hydrogen

ORAL ABSTRACTS

[**Abstract:0156**]

Synthesis of Polymer Supported Ni (II) - Schiff Base Complex and Its Usage as a Catalyst in Hydrogen Generation From NaBH4 Hydrolysis

***Dilek Kilinç*[1], *Omer Sahin*[2]**

[1]Faculty of Science and Letters, Department of Chemistry, Siirt University
[2]Faculty of Engineering and Architecture, Department of Chemical Engineering, Siirt University

Hydrogen promises to be a new energy source for the future because it is more advantageous than other energy sources. One of its advantages is that the product obtained from hydrogen combustion is a harmless substance such as water. Sodium borohydride is safe and has practical use in hydrogen storage. When the aqueous basic NaBH4 solution is contacted with selected catalysts, it is hydrolyzed according to the following reaction to give H2 gas and water-soluble sodium metaborate. [1]

In this research, we synthezed the new Schiff base ligand which named 5-Amino-2, 4-dichlorophenol-3,5-di-tert-butylsalisylaldimine and its Ni complex. Than this complex supported on amberzyme oxirane resin polymer and it was used as a catalyst for H2 production from NaBH4 hydrolysis. Polymer-Ni catalyzed NaBH4 hydrolysis reaction was investigated depending on concentration of NaBH4, concentration of NaOH, temperature, percentage of Ni complex and amount of catalyst. In addition the catalyst and products were characterized with some analysis technique like FT-IR, SEM, BAT, XPS.

When polymer supported Ni (II) complex used as catalyst; the maximum reaction rate was 13000 mL H2. g-1 cat..min-1 and 24242 mL H2/ gcat.min at 30 °C and 50 °C, respectively. The activation energy of complex catalyzed NaBH4 hydrolysis reaction was found as 25370 kj.mol-1. As seen in Table 1 amberzyme oxirane resin polymer supported Ni (II) complex catalyst has a high activity in NaBH4 hydrolysis reaction for H2 production.

References:

[1] Kilinc, Dilek, Saka, Cafer, Sahin, Omer Journal of Power Sources 217 (2012) 256-261
[2] Walter, J. C., A. Zurawski, D. Montgomery, M. Thornburg, and S. Revankar. J. Power Sources 179 (2008) 335–339
[3] Amendola, S. C., S. L. Sharp-Goldman, M. S. Janjua, M. T. Kelly, P. J. Petillo, and M. Binder. J. Power Sources 85 (2000) 186–189
[4] Larichev, Y. V., O. V. Netskina, O. V. Komova, and V. I. Simagina. Int. J. Hydrogen Energy 35 (2010) 6501–6507
[5] Xu, D., H. Zhang, and W. Ye. Catal. Commun. 8 (2007) 1767–1771

Keywords: Complex, Hydrolysis, Catalyst, NaBH4,Hydrogen Production

Table 1. Comparison metal catalysts for sodium borohydride hydrolysis

Catalyst	Activity (mL H2 min-1(g catalyst-1)	Temperature (0C)
Ni-B	3400	30[2]
Ru	18600	60[3]
Rh/TiO2	215	23[4]
Pt/C Powder	170	30[5]
Ni/A.O.R. Polymer (in this work)	13000 24242	30 50

ORAL ABSTRACTS

[**Abstract:0158**]

Analysis of Control Strategies for Fuel Saving in the Hydrogen Fuel Cell Vehicles

Yakup Hameş[1], Kemal Kaya[1], Ertuğrul Baltacıoğlu[2], Arzu Türksoy[1]

[1]Department of Electrical and Electronics Engineering, Iskenderun Technical University, Iskenderun-Hatay/Turkey
[2]Department of Mechanical Engineering, Iskenderun Technical University, Iskenderun-Hatay/Turkey

Thanks to sustainable fuel nature of hydrogen, hydrogen fuel cell vehicles are inevitably more advantageous than other conventional vehicles. Since the energy efficiency of the hydrogen fuel cell is high, replacing the internal combustion engines with hydrogen fuel cell vehicles will contribute to the developing technology. A hydrogen fuel cell vehicle requires fuel cells, batteries, controllers and smart control units with their control strategies. The controller is responsible for the energy transfer between the battery and the fuel cell and for controlling the motor output power via commands from the auxiliary power units. The smart control unit compares the nominal output power of the fuel cell with the requested power, calculates the parameters and continuously adjusts the variables. The control strategies that can be developed for these units will enable us to overcome the technological challenges for hydrogen fuel cell vehicles in the near future. This study presents the best hydrogen fuel cell vehicle configurations and control strategies for safe, low cost and high efficiency by comparing control strategies in the literature for fuel saving.

Keywords: Hydrogen, Fuel cell, Control strategy, Fuel saving.

ORAL ABSTRACTS

[**Abstract:0159**]

Nuclear-based Hydrogen Production Cost Evaluation for Two Possible Nuclear Power Plants

***Fatih Sorgulu*[1], *Ibrahim Dincer*[2]**

[1]Yıldız Technical University
[2]Kahramanmaraş Sütçü İmam University
[3]University of Institute and Technology

Hydrogen is recognized as one of the most promising alternative fuels to help meet the energy demand for future by providing a carbon-free solution. In regards to hydrogen production, there has been increasing interest to develop, innovate and commercialize efficient, effective and economic methods, systems and applications. Nuclear based hydrogen production options through electrolysis and thermochemical cycles appear to be potentially attractive and sustainable routes for the expanding hydrogen sector. In this study, two nuclear power plants, which will be built soon in Akkuyu and Sinop in Turkey, for hydrogen production scenarios and their cost evaluations. Both power plants are planned to employ the pressurized water reactors with the electricity production capacities of 4800 MW (consisting of 4 units of 1200 MW) for Akkuyu nuclear power plant and 4480 MW (consisting of 4 units of 1120 MW) for Sinop nuclear power plant. Each of these plants are expected to cost about 20 billion US dollars. In the present study, these two plants are considered for hydrogen production and their cost evaluations by employing the special software entitled "Hydrogen Economy Evaluation Program (HEEP)" developed by International Atomic Energy Agency (IAEA) which includes numerous options for hydrogen generation, storage and transportation. Therefore, the costs of hydrogen production, storage and transportation considered for both Akkuyu and Sinop nuclear power plants. The costs of capital, fuel, electricity, decommissioning and consumables are calculated and evaluated in detail for hydrogen generation, storage and transportation in Turkey's conditions.

Keywords: Hydrogen Production, Nuclear Power Plants, Hydrogen Economy Evaluation

ORAL ABSTRACTS

[**Abstract:0161**]

Optimization of Operation Conditions of Solar Thermal Water Splitting Process

Ezgi Yavuzyılmaz, Deniz Üner, Serkan Kıncal

Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Hydrogen production by solar thermal water splitting is an eco-friendly way of storing solar energy in chemical bonds. The most important obstacles for the viability and the commercialization of this technology are lower energy efficiencies and higher production costs compared to conventional hydrogen production ways such as steam reforming, coal gasification, and electrolysis of water. Two-step thermochemical hydrogen production by using solar energy is an alternative method to conventional hydrogen production. In this method, the thermochemical cycle consists of two sequential steps. First step requires high temperature where the decomposition of the redox material is driven by solar energy whereas a relatively moderate temperature step where oxidation of the redox material is achieved by steam fed to the reactor in the second step.

The scope of this study is to introduce a solution approach to the realistic representation of the energy efficiency and yield optimization problem of the solar thermochemical water splitting reaction system. A prototype reactor has been designed and installed with the purpose of hydrogen production via solar thermal water splitting. It was aimed to describe the current situation of the solar thermal water splitting reactor system, identify the energy efficiency problem related to this system and analyse its components. In this framework, significant factors affecting the thermochemical efficiency based on different performance criteria such as hydrogen production amount or total energy loss in a cycle have been determined by adopting a thermodynamic parametric statistical analysis approach. In this approach, a thermodynamic model was generated and simulated by using MATLAB. Statistical analysis was conducted to determine the optimal operation conditions with JMP as the outputs of the model.

Keywords: Solar hydrogen production, thermochemical, optimization

[**Abstract:0164**]

Approach to Design of Control Electronic on Energy Storage Systems of Hydrogen Fuel Cell Vehicles

Yakup Hameş, Kemal Kaya, Ömer Türksoy, Arzu Türksoy

Department of Electrical and Electronics Engineering, Iskenderun Technical University, Iskenderun-Hatay, Turkey

Fuel cell vehicles are a revolution in the transport sector, driven by renewable energy. Hydrogen fuel cell vehicles, which use fuel cells, batteries and supercapacitors as energy storage systems, are very different from traditional vehicles in terms of energy efficiency and fuel economy. In hydrogen fuel cell vehicles, control strategies developed for other elements that work in coordination with the fuel cell and store energy are crucial for vehicle performance. These strategies enable control of energy storage systems while allowing economic methods to be identified.

This study examines the various control strategies in energy storage systems of hydrogen fuel cell vehicles to maximize efficiency and reduce mass and cost of the total system to the greatest extent.

Keywords: Hydrogen fuel cell, Energy storage system, Supercapacitor, Control strategy.

[**Abstract:0165**]

Investigation of Magnetic Field Effect on Hydrogen Production Performance by Aqueous Methanol Electrolysis

Emrumiye Arli, Zeynep Baz, Hatice Karakilcik, Mehmet Karakilcik, Güray Kılınçeker

Cukurova University

In recent years, the limited availability of fossil fuels and the increasing environmental pollution derived from their use as main source of energy has led to the development of new technologies for the production of zero environmental impact energy vectors such as hydrogen [1]. Hydrogen is a storable, clean and environmentally friendly fuel whose combustion results in the solely generation of water, with no emissions of atmospheric pollutants, greenhouse gases or particulates. However, about 95% of hydrogen currently derives from fossil fuels, mainly by steam reforming of natural gas and petroleum, while the remaining 5% comes from the electrolysis of water [2]. Nevertheless, electrolysis is the best option for producing hydrogen very quickly and conveniently. Water electrolysis as a source of hydrogen production has recently gained much attention since it can produce high purity hydrogen and can be compatible with renewable energies. Besides the water electrolysis, under the magnetic field aqueous methanol electrolysis has been reported in several studies [3], [4], [5].

In this study, we are investigating the effect of magnetic field on hydrogen production efficiency in aqueous methanol electrolysis by using electromagnet apparatus. Furthermore, the influences of magneto-hydrodynamics on the electrolysis process varying current and number of turn of coil related to magnetism and water electrolysis are discussed. The influences of working parameters are also discussed as well. Finally, the optimized it indicates that the magnetic field does enhance the efficiency of water electrolysis.

Keywords: Hydrogen production, Water electrolysis, Magnetic field, Efficiency

[**Abstract:0166**]

Enhancement of Efficiency on Hydrogen Network via Pinch and Exergy Analysis

Fatma Alyer, Zehra Özçelik

Ege University

Hydrogen is an important fuel for future and it is the most renewable energy source all over the world. It offers solutions to some of the greatest energy problems and challenges facing future generations. In many industries hydrogen usage is available as a reactant. At the same time, hydrogen is produced as product or by product. It is investigated that to increase the yield through the more efficient use of hydrogen on the plant, to achieve lower cost alternatives, to reduce CO2 emissions, etc. In addition to these, there are main critical problems based on hydrogen utilization in chemical plant. If more hydrogen needs to be produced or purchased, operating cost increases. If hydrogen production capacity needs to be scaled up, capital investment increases. To eliminate the critical problems hydrogen management is necessary for all chemical industries and especially refineries. In this study, the hydrogen pinch analysis is applied to the hydrogen network in the petrochemical industry.

Hydrogen pinch analysis is the optimization process on the network. By this method, hydrogen demand and supply is determined, and surplus hydrogen of the network is obtained by using graphical method. Energy optimization is provided by hydrogen pinch approach. As a result, hydrogen recovery is obtained about 30%. Purification unit is added to the network to purify the recycle waste hydrogen as desired purity. Besides available network hydrogen feed amount is 277,2 mol/s, retrofit network hydrogen feed become 196,8 mol/s.

Operating cost is decreased according to the unit operating costs and annual cost of hydrogen as a raw material. In addition to the integration, in available network and retrofit design exergy analysis is applied. The exergy analysis allows to specify losses and sign the units with more potential for improvement. Combination of the pinch and additionally exergy analysis guarantees efficient configuration of the industrial plants. It is examined that exergy loss of retrofit system is lower than the available system. For exergy calculations, Aspen Plus simulation program is used.

Keywords: Hydrogen, Pinch, Exergy

ORAL ABSTRACTS

[**Abstract:0171**]

An Investigation on Exergetic Performance of Hydrogen Gas Flowing Through the Annular Curved Duct

Adnan Midilli, Haydar Kucuk, Ugur Akbulut

Mechanical Engineering Department, Engineering Faculty, Recep Tayyip Erdogan University

Heat transfer enhancement has become very crucial attempt for energy management in heat transfer equipment. Of the parameters affecting the heat transfer enhancement, curvature is an important for increasing the heat transfer in energy systems such as heat exchangers, nuclear and chemical reactors, gas turbines, drying machinery, solar collector applications, electronic cooling and fuel cells, etc. Under these considerations, the main objective of this study is to parametrically investigate the exergetic performance of hydrogen gas flow through the curved annular duct in terms of the second law of thermodynamics. For this purpose, it is assumed that, i) the flow of hydrogen gas as an ideal gas is steady state and laminar fully developed, ii) the hydrogen gas has constant physical properties, iii) the channel inner and outer walls are exposed to constant wall boundary condition. Moreover, the following important parameters are taken into consideration: i) aspect ratio (four different values which are 5.5, 3.8, 2.9 and 2.36), ii) environment temperature (ranging from -30 to 30 with 10 oC intervals), iii) Dean number (varying between 24 and 208), and iv) Operating pressure (=1 atm). Considering these parameters, total exergy input, exergy destruction and exergy efficiencies are calculated for each aspect ratio. Consequently, because the main target of the curved annular duct is to increase the heat transfer, the increased heat transfer in the channel will naturally rise the entropy generation. This is not a negative situation but a fact indicating the rise of exergetic efficiencies of the curved annular duct due to the enhancement of heat transfer during hydrogen gas flow in the channel with the increase of Dean number because of the curvature. Thus, it can be said that the increased heat transfer creates the rise of entropy, and also exergetic efficiency of the curved annular duct decreases based on the increased reference temperature that creates higher exergy destruction though constant entropy generation arisen from the constant wall temperature boundary condition and constant physical properties of the hydrogen gas in the curved annular duct.

Keywords: Performance analysis, annular curved duct, hydrogen flow, exergy, entropy generation, Dean number

ORAL ABSTRACTS

[**Abstract:0172**]

Bonding Strength and Fuel Sealing Tests For Crofer®22 APU Solid Oxide Fuel Cell Metallic Interconnects

Bülent Öztürk[1], Alparslan Topcu[2], Sultan Öztürk[1], Ömer Necati Cora[3]

[1]Department of Metallurgical and Materials Engineering, Karadeniz Technical University, Trabzon, Turkey
[2]Department of Mechanical Engineering, Adana Science and Technology University, Adana, Turkey
[3]Department of Mechanical Engineering, Karadeniz Technical University, Trabzon, Turkey

In this study, first Crofer metallic interconnect samples were manufactured through powder metallurgy approach from powders as well as commercially available bulk Crofer®22 APU alloy through machining. Performance evaluation of those interconnets was carried out in terms of bonding strength and gas leakage.

To determine the bonding strength of interconnects, tensile test method was employed which is widely used in literature. Test specimens and glass-ceramic sealants were prepared for both the P/M and the machined samples. These samples then, were placed in a temperature controlled furnace and same heat treatment was applied to both. Tensile tests were carried out after the heat treatment and this process were repeated ten times for every samples. Bonding strength results were analyzed with Weibull distribution method, and reliability analysis was performed. Weibull distribution results showed that samples fabricated through P/M approach were more consistent in terms of bonding strength.

To perform the fuel leak tests, a ring-shaped sample fabricated through powder metallurgy method was welded on the leakage test apparatus. Electrolyte, glass-ceramic and leakage test apparatus system were placed in the temperature controlled furnace. Constant hydrogen flow was provided to the furnace through inlet at 35 kPa continuously and flow rate was measured at the outlet after each thermal cycle. Hence, pressure drop was determined per thermal cycle for both samples fabricated with P/M and the one machined from commercial alloy. Results showed that, pressure steadily decreased till 10th cycle for the machined sample while the P/M sample maintained the inlet pressure till 6th cycle. After tenth cycle, the pressure values were recorded as 34,39 and 34,85 kPa for machined and P/M samples, respectively.

From bonding strength of point of view, T/M sample exhibited failure not only at contact interface but also glass-ceramic interface. This was interpreted as tensile strength of the T/M sample is comparable with the strength of glass-ceramic layers. Sample machined from Crofer®22 commercial alloy, on the other hand, showed failure at glass-ceramic interface, only. Reliability analysis yielded that the T/M sample is more reliable at low tensile force while the sample machined from commercial alloy is preferrable at higher tensile forces. As overall conclusion, interconnect sample manufactured through powder metallurgy approach can be a reliable alternative to the one manufactured from commercial Crofer®22 alloy through machining.

Keywords: Solid oxide fuel cell, powder metallurgy, bonding strength, fuel leakage.

ORAL ABSTRACTS

[Abstract:0175]

The Hydrogen Sensing Ability of Oxide Semiconductors

***Musa Mutlu Can*[1], *Shalima Shawuti*[2], *Mehmet Ali Gülgün*[2], *Harun Cerit*[3], *Ayse Zehra Aroğuz*[4]**

[1]Physics Department, Istanbul University, Istanbul, Turkey
[2]Faculty of Engineering and Natural Sciences, Sabanci University, Orhanlı, Istanbul, Turkey
[3]Department of Animal Science and Animal Nutrition, Istanbul University, Istanbul, Turkey
[4]Chemistry Department, Istanbul University, Istanbul, Turkey

The native defects have been defined as cation or anion vacancies, anti-site located host atoms and interstitial atoms. These defects are the origin of shallow energy levels, which lead to the changes in the physical properties. Because of shallow energy levels, many theories such as the shallow donors mediated strong exchange coupling between 2p levels of oxygen and d levels of transition metals or s-d interactions due to hybridization between the impurity bands of defects and 3d bands. Thus, the number of transition metals, carrier type and the shallow energy levels (originating from point defect) are the known reasons for the gas sensing ability of the oxide semiconductors. The work is based on hydrogen sensing ability depending on point defects and hybridization between the impurity bands of defects and 3d bands. In this research, 10 mol% Co and 1 mol% W doped ZnO thin films were used[1-4]. Thin films were fabricated under different post annealing conditions, which were aimed to investigate the magneto electrical improvement in W doped ZnO thin films by adding Co atoms. The origin of the polarized spin currents were investigated; thus, the impacts of W impurities and the intrinsic defects, Zni2+, VZn, Oi2-, VO2-, Oi and OZn, on polarized spin currents were investigated, separately. Photoluminescence (PL) analyses were used to define the point defect type and amount in the structure. The magnetoelectrical analyses were also done for thin films, grown without post–deposition annealed, highly included point defects. The amount of Vo point defects and thus, increasing polarized spin currents depending on enhanced the p – d or s-d hybridizations were correlated with the hydrogen sensing ability of the oxide semiconductors.

References:

[1] Musa M. Can, Shalima Shawuti, T. Fırat, S. I. Shah, Experimentally Tailoring s-d and p-d Interactions in Spin Polarization via Post Deposition Annealing Conditions, Journal of Alloys and Compounds, 660 (2016) 423-432
[2] Musa M. Can, S. I. Shah, T. Fırat, Defect dependent polarized spin current in 1% Co doped ZnO thin films, Journal of Magnetism and Magnetic Materials, 377, (2015) 229–238.
[3] Musa M. Can, S. I. Shah, T. Fırat, Applied Surface Science, 303 (2014) 76-83, "The formation of anomalous Hall effect depending on W atoms in ZnOthin films"
[4] Musa M. Can, S. Ismat Shah, T. Fırat, Chelsea R. Haughn, Matthew F. Doty, Journal of Physics: Applied Physics, 45 (2012) 195104, "Electrical and Optical Properties of Point Defects in ZnO Thin Films

Keywords: Hydrogen storage, Oxide semiconductors, gas sensing

ORAL ABSTRACTS

[**Abstract:0177**]

Study of the Electronic Properties of Titanium Oxide Thin Films for Water Photolysis and Hydrogen Production

Cebrail Gumus, Yuksel Ufuktepe

Cukurova University

Titanium dioxide (TiO2) thin films show many excellent optical and structural properties, so they play an important role in many technological areas including sensors, optics, solar energy and automobile industries. Nano sized titanium oxide surface can play an important role in photocatalytic process for hydrogen production. The aim of the work was preparation of titanium oxide thin films and study of changes of composition and nanostructure with different deposition parameters. To understand the electronic properties of TiO thin films, in photovoltaics we examined its optical absorption, band gap and electronic structure. Titanium oxide (TiOx) films deposited on a glass substrate by spray pyrolysis method were characterized using Ti L_{23} and O K edge X–ray absorption spectra (XAS). The films were deposited at at various substrate temperatures ranging between 400 to 475 °C in steps of 25 °C. The effect of substrate temperature on the structural and optical properties of the films was investigated. The result shows that the structure of the titanium oxide closely depends on the molarity of the solution and also the substrate temperature during the deposition process. It is found that 0,4 M and 450 oC temperature give a layer of TiO2 having anatase crystal structure.

Keywords: Titanium oxide, thin films, water photolysis, hydrogen production

ORAL ABSTRACTS

[**Abstract:0181**]

Modelling of Hydrogen Production From Hydrogen Sulfide in Geothermal Power Plants

***A. Karapekmez*[1], *Ibrahim Dincer*[2]**

[1]Yıldız Technical University
[2]Yıldız Technical University, University of Ontario Institute of Technology

One of the most important enviromental issues related to the use of geothermal fluids to generate electricity is the emission of non-condensable gases to the atmosphere. Vent stacks from geothermal plants emit carbon dioxide (CO2) and methane (CH4) causing human health and wealth concerns because of their major role as greenhouse gases. It is necessary to note that geothermal power plants also emit hydrogen sulfide (H2S) in relatively high amounts, since H2S is one of the main constituents of the geothermal fluids. The presence of H2S in the air, and then in water, soils and vegetation is considered one of the critical environmental concerns for the areas that host geothermal fields. The question is can we make use of this for something useful? As many know, hydrogen is recognized as one of the most promising alternative fuels to help meet the energy demand for future by providing a carbon-free solution. We can consider producing hydrogen from hydrogen sulfide.

This is the main focus of the present study. This can help reduce emissions and at the same time provide energy. In the present study, we aim to examine an integral geothermal system for hydrogen production. This hydrogen production system consists of two main processes, such as mercury abatement by using a chemical absorption and hydrogen production from hydrogen sulfide (H2S) by electrolysis. These are included in the integrated geothermal energy system. A comprehensive thermodynamic analysis through energy and exergy approaches is conducted to analyze the system and its components and evaluate its performance through energy and exergy efficiencies. The exergy results are quite encouraging by having the hydrogen production option versus no hydrogen production case. There is also a great potential to apply such a geothermal based hydrogen production system in Turkey where there are vast amount of geothermal energy potentials.

Keywords: Modelling, Hydrogen Production, Hydrogen Sulfide, Geothermal Power Plants

ORAL ABSTRACTS

[**Abstract:0188**]

A Numerical Analysis of an Ejector for Micro Combined Heat and Power Systems Based on 1 kw Solid Oxide Fuel Cell

Omer Genc[1], Serkan Toros2, Mohammad Ziauddin Chowdhury[2]

[1]Gumushane University
[2]Omer Halisdemir University

In this study, a numerical analysis of an ejector for micro combined heat and power systems based on 1 kW Solid Oxide Fuel Cell (SOFC), using methane as fuel, for small-scale residential applications is presented. A detailed procedure for the ejector designing is provided and its efficiency is researched at different methane pressure to exhaust pressure ratio and methane inlet temperature. Results show that fuel inlet temperature and the pressure ratio of the methane to exhaust largely affect the steam to carbon ratio (STCR) and entrainment ratio. Large pressure ratio and methane temperature allows a high entrainment ratio and STCR but as pressure ratio and methane temperature increasing, STCR and entrainment ratio stay constant after specific values. 1140 different design points are created to determine the optimum operating condition. Simulations show that the optimum methane inlet pressure is 709275 Pa and exhaust pressure is 117422 Pa. Entrainment ratio and STCR are determined respectively as 2,005 and 0,902 at this optimum design point.

Keywords: Numerical Analysis, Micro Combined Heat, Power Systems, Solid Oxide Fuel Cell

ORAL ABSTRACTS

[**Abstract:0189**]

Numerical Investigation of the Effect of Channel Width to Land Ratio on PEM Fuel Cell Performance

***Mohammad Ziauddin Chowdhury*[1], *Omer Genc*[2], *Serkan Toros*[1]**

[1]Omer Halisdemir University
[2]Gumushane University

Proton exchange membrane (PEM) fuel cells become an emerging sector for growing demand of sustainable energy systems. Therefore; a necessity arises for researchers to develop more efficient PEM fuel cell. Numerical analyses provides an understanding the internal phenomena of PEM fuel cell instead of experimental measurements, which are highly expensive and time consuming. Flow field design is one of the major research parameters of the system since the appropriate flow field design can improve the cell performance significantly. Among the different parameters of the bipolar plate flow field design, channel width to land ratio is a critical parameter for PEM fuel cell performance. In this numerical study, different channel width to land ratio's for anode and cathode sides are analyzed with fixed channel depth as well as channel length for a straight channel geometry. Based on the cell performance by analyzing the consequence parameters, the optimization of channel width to land ratio is carried out for anode and cathode channel geometry.

Keywords: Channel Width, Land Ratio, PEM Fuel Cell, Performance

ORAL ABSTRACTS

[**Abstract:0192**]

Effects of Land Use and Microbial Technology to Obtain Biomass from Salty and Marginal Lands in Turkey

***M.A. Khalvati*[1], *N. Javani*[2]**

1Faculty of Bogazici University, Institute of Environmental Sciences, Hisar Campus, Bebek, Istanbul, Turkey
2Faculty of Mechanical Engineering, Yildiz Technical University, 34349 Besiktas, Istanbul, Turkey

Non-agricultural area such as salinity soils are one of the promising hydrogen production. The approaches is to convert energy crops to biomass, which is abundant, clean and renewable source of energy. Sorghum plants are well-known as energy crops which play a very important role in the development of hydrogen economy. At the other hand, salinity and margin lands in Turkey are increasing every year by triggering wrong agricultural activities. Soil microbiological technology are under loops of scientist and agronomical experts to apply with crop plants. The main objectives of the current study are to assess the contribution of soil beneficial microbes in improving salt tolerance, and to evaluate possible hydrogen production from the biomass of sorghum plant. The study was conducted in order to elucidate the effects of colonization of sorghum (*Sorghum bıcolor* L.) roots with two AMF fungi (*Glomus intraradices* and *Glomus hoı*) on biomass production. It has been observed mild effects of the two mycorrhizal fungi on leaf water relation between AMF and non-AMF salinity stressed plants but no specific effects on yield parameters or plant nutrients uptake. However, that salinity conditions surprisingly increased root colonization by AMF. Salinity resistance parameters such as leaf salt potential was slightly higher in plants colonized by *G. hoi* , and leaf osmotic potential was lower in the plants colonized by *G. intraradices* as compared with non-AMF plants. It has been also noted some differences between *G. intraradices* and *G. hoı* in their effect by sorghum under same growth conditions. These plants morphological characters show a higher biomass production during saline conditions up to 2000kg/hectare. In this study some alternative thermochemical (pyrolysis and gasification) and biological (biophotolysis, water–gas shift reaction and fermentation) processes suggested and finally gasification process were chosen as the optimal method which can be practically applied to produce hydrogen from sorghum plant. Sorghum produced 10000kg biomass over three times harvesting thereby could provide almost 3000kgH for bio-hydrogen production. This could be an appropriate resource for obtaining biofuels particularly bio-hydrogen from 3 million hectares of salinity land of Turkey by producing 9 million tons of Hydrogen. The findings data gives an overview of these technologies for hydrogen production from biomass by provide yield of 28.2 gH/100 g biomass or 33.17 to 44.26 (g H2) about 10.7% based on fresh weight plant materials.

Keywords: Saline and margin lands, Biomass, bio-hydrogen and soil microorganisms

POSTERS

[**Abstract:0029**]

Preparation of Electrochemically Mo-deposited Carbon Felt Electrodes for Alkaline Water Electrolysis: Optimization of pH, Current and Metal Amount

Derya Dilek Demir, Abdullah Salcı, Ramazan Solmaz

Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

In the present study, Mo was electrochemically deposited over carbon felt (C) electrode which is very suitable as electrode material and has large surface area in order to improve hydrogen evolution activity of the electrode in alkaline medium. Fort his aim, the effects of pH of deposition bath solution, deposition current and amount of Mo were studied and optimum conditions were determined. Hydrogen evolution activity of the electrodes was evaluated in 1 M KOH solution using various electrochemical techniques. Surface structures of the electrodes were investigated by scanning electron microscopy (SEM). It was found that 1 g Mo/g C deposited electrode at pH 6 and 50 mA current exhibits the highest electrochemical activity. SEM images showed that the electrode prepared at these optimum conditions has large surface area and fine structure. The high hydrogen evolution performance of this electrode was assigned to its large surface area as well as high intrinsic catalytic activity of Mo metal.

Acknowledgement: This study was supported by Bingöl University Scientific Research Projects Coordination Unit (BÜBAP) (Project Number: BAP-52-277-2015). The authors are greatly thankful to BÜBAP for financial supporting and Bingöl University Central Laboratory for characterization measurements.

Keywords: Carbon felt, electrochemical deposition, molybdenum, electrolysis, hydrogen production

[**Abstract:0046**]

Hydrogen Production by Alkaline Water Electrolysis at Activated Cu/NiCuZn Electrodes: Metal Ratio, Deposition Current Density and Thickness Optimizations

***Ramazan Solmaz*[1], *Gülfeza Kardaş*[2]**

[1]Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey
[2]Çukurova University, Science and Letters Faculty, Chemistry Department, 01330 Balcalı, Adana, Turkey

In this study, NiCuZn composite coatings were electrochemically deposited on a copper electrode. The effects of metal ratios, thicknesses of the deposits and deposition current densities were investigated and optimum conditions were determined for hydrogen evolution reaction. The prepared electrodes were exposed to a concentrated alkaline solution (30 % NaOH) and more active Zn metal was chemically dissolved in order to produce a porous and electrocatalytic surface suitable for use in the hydrogen evolution reaction. The electrodes were characterized using cyclic voltammetry (CV), atomic absorption spectroscopy (AAS) and scanning electron microscopy (SEM). The electrodes were used as cathode in 1 M KOH solution and their hydrogen evolution activities were investigated using electrochemical techniques. It was reported that the alkaline leached NiCuZn coatings have great hydrogen evolution activity in the alkaline solution. Their activities depend on the chemical composition and thickness of the coatings as well as the deposition current density.

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

Keywords: NiCuZn electrocatalysts, alkaline water electrolysis, hydrogen energy

[**Abstract:0047**]

The Effect of Diameter of Three-dimensional Silver Nanodomes on Electrochemical Hydrogen Production

***Handan Yüksel*[1], *Ayşe Özbay*[2], *Mehmet Kahraman*[2], *Ramazan Solmaz*[1]**

[1]Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey
[2]Department of Chemistry, Faculty of Arts and Sciences, Gaziantep University, 27310 Şehitkamil, Gaziantep, Turkey

In this study, three-dimentional (3D) Ag nanodomes (AgNDs) at various diameters were fabricated using combination of soft lithography and nanosphere lithography. A Ni film was electrochemically deposited on the nanodomes which were prepared on PDMS templates to increase its mechanical strength. The 3D-AgNDs were connected to a conductive wire and electrodes were prepared for the measurements. The 3D nanostructures were characterized using scanning electron microscopy and atomic force microscopy. The hydrogen evolution activities of the nanodomes were investigated in 6 M KOH solution and the effect of diameter of the domes were determined. For this aim, cathodic current-potential curves and electrochemical impedance spectroscopy measurements were performed. The activities of the 3D-AgNDs were compared with the activity of bulk Ag electrode. It was found that well-structured AgNDs have higher hydrogen evolution activity than Ag bulk. The activities of the domes depend on their diameter.

Acknowledgements: Preparation and characterization of 3D-AgNDs studies were supported by TUBİTAK (Project Number: 114Z414). Hydrogen evolution studies were supported by Bingöl University Scientific Research Projects Coordination Unit (BÜBAP). The authors are greatly thankful to TUBİTAK and BÜBAP for financial supporting and Bingöl University Central Laboratory for characterization measurements.

Keywords: Three-dimentional silver nanodomes, electrochemical metal deposition, electrolysis, hydrogen evolution

[**Abstract:0058**]

Graphene Aerogel Supported Platinum Catalyst for Formic Acid Electrooxidation

***Mehmed Selim Çögenli*[1], *Ayşe Bayrakçeken Yurtcan*[2]**

[1]Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum, Turkey
[2]Department of Chemical Engineering, Ataturk University, Erzurum, Turkey

Fuel cells are electrochemical energy devices that convert continuously supplied fuel to electricity. Direct formic acid fuel cells (DFAFCs) have attracted considerable attention because they are promising power sources for portable devices. Important issues involved in developing efficient fuel cells are related with the catalyst and catalyst support material. The insufficient activity and durability of electrocatalyst used for formic acid oxidation at the anode is still a major concern. Carbon materials have been widely used as catalyst supports for fuel cells. Vulcan XC-72 carbon black is a popular carbon support because of its high surface area and conductivity. Reduced graphene oxide (rGO) and graphene aerogel (GA) are considered promising candidates for new support materials because of their extraordinary electronic and mechanical properties. The combination of graphene aerogel and carbon may lead to hybrid support materials with improved electrocatalytic activities for application in DFAFCs. The graphene oxide used in this work was prepared from natural graphite powder by a modified Hummers method. The prepared stable suspension (5mg/ml in water) with GO was transferred into a Teflon-lined autoclave with a stainless steel shell and graphene aerogel was obtained by hydrothermal synthesis. In this study, GA and carbon have been employed as hybrid supports for the dispersion of Platinum (Pt) nanoparticles to improve their electrocatalytic activities for the oxidation of formic acid. Chemical reduction method using microwave heating have been applied to the synthesis of Pt nanoparticles supported on the defect sites of hybrid support materials. The as-prepared GA catalyst was characterized by a variety of means such as SEM, EDS, XRD, BET. The electrocatalytic activities of the catalyst is evaluated for formic acid oxidation using electrochemical measurements.

Keywords: Direct formic acid fuel cell, Graphene aerogel, Formic acid electrooxidation

[**Abstract:0067**]

Effect of Temperature on Catalytic Gasification of Biomass for Hydrogen Production

Bahar Meryemoğlu[1], Mehtap Kurtuluş[2], Ihsan Demirci[2], Sibel Irmak[3], Arif Hasanoglu[2]

[1]Central Research Laboratory, Çukurova University, Adana, Turkey
[2]Chemistry Deparment, Çukurova University, Adana, Turkey
[3]Biological Systems Engineering, University of Nebraska, Lincoln, USA

Gasification of biomass with atmospheric pressure vapour–phase reforming (AVPR) technique is a promising process to produce hydrogen gas at mild conditions in presence of a reforming catalyst. Hydrogen as a fuel has the highest specific energy content of all conventional fuels. Because of being non-edible for humans and having high carbohydrate content, kenaf biomass is a good condidate for AVPR. In order to prepare feed solution for AVPR, kenaf biomass was hydrolyzed in the pressurized water containing 5% H2O2 at 250 °C. The AVPR of the hydrolysate was performed at various temperatures (150, 200 and 250°C) using raney nickel as a reforming catalyst. It was observed that gas yield increased with increasing temperature. Hydrogen yield was increased from 4.8 mL H2/g catalyst to 9.1 mL H2/g catalyst by increasing the temperature from 150 °C to 250 °C, respectively. The total sugars contents of the hydrolysates were considerably lower at the higher temperatures because of consumption of these compounds for formation of gaseous products. The contents of water soluble phenolic compounds in the hydrolysates were also decreased after AVPR.

Acknowledgement: Financial supports from Scientific and Technical Research Council of Turkey (TUBITAK) and Çukurova University is gratefully acknowledged (The project numbers: MAG 114M146 and FUK-2015-4370, respectively).

Keywords: Hydrogen, Gasification, Catalyst, Biomass

[**Abstract:0068**]

Low Temperature-Steam Phase Catalytic Gasification of Biomass Hydrolysates

Arif Hasanoğlu[1], Bahar Meryemoğlu[2], Ihsan Demirci[1], Sibel Irmak[3]

[1]Deparment of Chemistry, Çukurova University, Adana, Turkey
[2]Central Research Laboratory, Çukurova University, Adana, Turkey
[3]Biological Systems Engineering, University of Nebraska, Lincoln, USA

There has been increasing interest in the production of gaseous compounds such as hydrogen, carbon dioxide, carbon monoxide, methane, etc. from biomass. Some of these gaseous compounds can be directly used as fuel after purification steps or converted to other useful compounds that can be used for synthesis of biofuels, bioproducts or chemicals. Determinations of important parameters for gasification process are very important to produce target compound in a high yield. Present study was designed to determine optimum condition for gasification of biomass (kenaf) for hydrogen gas production by low temperature-steam phase catalytic gasification technique. The temperature (230-290°C), the feed flow rates (0.3-1.0 mL/min) and the biomass feed concentrations (1000-4000 mg/L carbon) were the factors investigated by employing response surface methodology (RSM). The experimental plan was based on Box-Behnken design. The results indicate that temperature was the main factor on hydrogen-rich gas production. The optimal hydrogen that resulted in minimum carbondioxide yield were observed at following conditions: 270.3 °C gasification temperature, 0.37 ml/min feed flow rate and 4000 mg/L carbon as biomass feed concentration. Under these conditions, the hydrogen yield was found to be 1.18 mmol/ g catalyst.

Keywords: Hydrogen, Response Surface Methodology, Optimization

[**Abstract:0074**]

Catalytic activity of PtRu/C, PtPd/C and PtSn/C bimetalic catalysts toward methanol oxidation reaction

***Mehmed Selim Çögenli*[1], *Ayşe Bayrakçeken Yurtcan*[2]**

[1]Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum, Turkey
[2]Department of Chemical Engineering, Ataturk University, Erzurum, Turkey

Direct methanol fuel cells (DMFCs) currently employ Pt-based anode catalysts for oxidation of methanol. Methanol has been proposed as a fuel because of its low pollutant emission, low cost and high theoretical energy density. Bimetallic catalyst systems are known to have better catalytic activities than pure noble metals for the electro-oxidation of small organic molecules such as methanol, ethanol, and formic acid. A number of Pt alloy, intermetallic catalysts on different support materials for methanol oxidation have been introduced in recent years. In this study, carbon-supported Pt-based catalysts, were prepared by co-depositing PtRu, PtPd and PtSn with weight ratios of (2:1) on carbon black (Vulcan XC-72) via microwave heating of ethylene glycol (EG) solutions of 0.05M H2PtCl6.6H2O, RuCl3, PdCl2 and SnCl2.2H2O. These catalysts were systematically evaluated and compared with both commercial Pt black, PtRu black catalysts and with each other. The catalysts were characterized with SEM, EDS and XRD. The electrocatalytic activities of the catalysts are evaluated in sulfuric acid solution containing methanol using electrochemical measurements.

Keywords: Direct methanol fuel cell, Bimetalic catalyst, Methanol electrooxidation

[**Abstract:0084**]

Photoelectrochemical Activity of ZnO Nanorods: Synthesis and Characterization

Fatih Tezcan, Asad Mahmood, Gülfeza Kardaş

Department of Chemistry, Çukurova University, Adana, Turkey.

Water electrolysis utilizing photoelectrochemical cells (PECs) to produce hydrogen provide opportunities to overcome the environmental issues such as global warming and acid rain associated with energy generation from fossil fuel and natural gas. Zinc oxide, characterized as a direct wide band gap (Eg ≈ 3.37 eV @ ToRoom) semiconductor, is a potential material for photonics and optoelectronic applications. The large excitonic energy (60 mV), which renders an effectual excitonic emission in ZnO is exploited as potential photoelectrodes in PECs. In this study, we processed ZnO films using electrodeposition method. The deposition of ZnO was carried using a three electrode cell with varying deposition potential (-0.7, -0.8, -0.9 V). X-ray diffraction (XRD) showed single phase ZnO after annealing at 300 °C for 3 hours. Field emission scanning electron microscope (FESEM) confirmed ZnO nanorods arrays on the tin-doped indium oxide (ITO). The photocatalytic properties of as-synthesized films were measured in 0.5 M Na_2SO4 solution under AM 1.5 G solar simulator. The films deposited at 0.8 V showed the highest photocatalytic properties as an anode for water splitting via solar irritation.

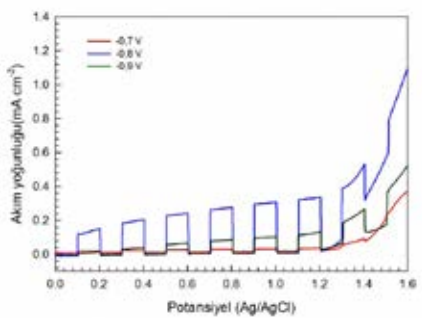
Acknowledgetment: The authors would like to acknowledge the funding received from the Scientific and Technological Research Council of Turkey (TUBITAK Project No: 116C035) under the 2236-Co-Funded Brain Circulation Scheme, TÜBİTAK, within 2211-National Ph.D. Fellowship Programme, Çukurova University BAP Project No: FDK-2014-3488.

References:

[1] F. Urbain, J.-P. Becker, V. Smirnov, J. et al., Materials Science in Semiconductor Processing, 42 (2016) 142-146.
[2] S. Banerjee, S.K. Mohapatra, M. Misra, Journal of Physical Chemistry C, 115 (2011) 12643-12649.
[3] H.H. Li, C. Chen, X.Y. Huang, Y. et al., Journal of Power Sources, 247 (2014) 915-919.
[4] Y. Shi, C. Gimbert-Surinach, T. Han, S. et al., ACS Appl Mater Interfaces, 8 (2016) 696-702.
[5] M.S. Islam, M.F. Hossain, S.M.A. Razzak, Journal of Photochemistry and Photobiology A: Chemistry, 326 (2016) 100-106.

Keywords: ZnO, Water splitting, PEC

Chopped current density vs. potential for the ITO/ZnO films electrodeposited at selected potentials.



[**Abstract:0091**]

Hydrogen Release from Dehydrogenation of Ammonia Borane by Isolable And Reusable In Situ Generated Oleylamine Stabilized Nickel(0) Nanoparticles

Sibel Duman

Department of Chemistry, Bingol University, Bingol, Turkey

Among the boron-nitrogen compounds tested as solid hydrogen storage materials, ammonia-borane has received increasing attention owing to its impressive gravimetric hydrogen content of 19.6% wt (6.5 and 13.1% wt for the first and second equivalents of H_2, respectively), stability in the solid state under ambient conditions, and nontoxicity [,]. In this study, oleylamine stabilized Ni(0) nanoparticles were in situ prepared from the reduction of nickel(II) acetylacetonate by ammonia-borane in THF under inert gas atmosphere at room. Oleylamine stabilized Ni(0) nanoparticles were reproducibly isolated from the reaction solution by filtration and characterized by using various spectroscopic techniques. These nanoparticles were found to be highly active catalyst in the dehydrogenation of ammonia-borane providing a release of 2.0 equivalent H_2 per mole of ammonia-borane and an initial turnover frequency of 251 (mol H_2)(mol Ni)$^{1-}$(h)$^{1-}$ at °0.1 ± 25.0C. They preserve %79 of their initial catalytic activity even after the fifth run of dehydrogenation of ammonia-borane with the complete conversion of cyclopolyborazane to polyborazylene derivatives and plus 2 equivalent of H_2 at room temperature [ ]. Moreover, the work reported here includes a wealthy collection of kinetic data to determine the rate law and apparent activation energy for the catalytic dehydrogenation of ammonia-borane (Eaapp = 32 + 2 kj mol^{1-}).

Keywords: Ammonia-borane, dehydrogenation, nickel, oleylamine.

[**Abstract:0094**]

Bimetallic PdM (M: Au, Fe) Alloy Nanoparticles Assembled on Reduced graphene oxide as Highly Efficient Catalysts for Hydrogen Evolution Reaction

***Melike Sevim*[1], J.a.s.b Cardoso[2], D.s.p. Cardoso[2], D.m.f. Santos[2], Önder Metin[1]**

[1]Atatürk University, Scıence Faculty, Chemistry Department,25240,Erzurum,Turkey
[2]CeFEMA, Instituto Superior Técnico, Universidade de Lisboa, 1049–001 Lisbon, Portugal

In order to overcome most of the technical and economic issues associated with hydrogen production via water electrolysis, the development of novel and efficient electrocatalysts is required. Herein, Pd-based alloy nanoparticles (NPs), namely AuPd and FePd, assembled on reduced graphene oxide (rGO) are investigated as cathode electrocatalysts for hydrogen evolution reaction (HER) in alkaline water electrolysis. TEM, XRD and ICP-OES are used to carry out the structural and morphological characterisation of the as-prepared rGO-AuPd and rGO-FePd nanocomposites and their electrocatalytic activity is studied by voltammetric methods. A Tafel slope value of 149 mV dec-1 was evaluated for rGO-AuPd at 25 °C, suggesting that HER is limited by Volmer step, with rGO-FePd showing much worse performance. It is shown that rGO-AuPd nanocomposites are good candidates for application as novel electrocatalysts for the HER in alkaline media.

Keywords: bimetallic alloys, palladium nanoparticles, electrocatalytic activity.

[**Abstract:0097**]

Synthesis of CoB Nano-Powder as Electrode Material

***Nilüfer Küçükdeveci*[1], *Mustafa Anık*[2]**

[1]Departmant of Metallurgical and Material Engineering, Nevsehir Haci Bektas University, Nevsehir, Turkey
[2]Departmant of Metallurgical and Material Engineering, Eskisehir Osmangazi University, Eskisehir, Turkey

In this work CoB nano-powders were synthesized in order to investigate the potential usage of them as negative electrodes in nickel based rechargeable batteries. CoB nano-powders were synthesized by both mechanical alloying and chemical reduction methods with the average powder sizes of 900 nm and 70 nm, respectively.

The initial discharge capacity of CoB synthesized by mechanical alloying was 225 mA h g-1. After fifth charge/discharge cycle, the capacity decreased to 160 mA h g-1 and stabilized at around this value with a capacity retaining rate of 75 %.

The initial discharge capacity of CoB synthesized by chemical reduction was 695 mA h g-1. After third charge/discharge cycle, this capacity decreased to 225 mA h g-1. Although the capacity retaining rate is 33 %, this discharge capacity is higher than that of CoB nano- powders synthesized by mechanical alloying.

The charge/discharge mechanism of CoB nano-powders was determined as it will be provided in detail at presentation.

Keywords: CoB powder, mechanical alloying, chemical reducing, charge/discharge

[**Abstract:0098**]

Electrocatalytic Hydrogen Production on GCE/RGO/Au Hybrid Electrode

Didem Balun Kayan, Merve Ilhan, Derya Koçak

Chemistry Department, Science and Arts Faculty, Aksaray University, 68100, Aksaray, Turkey

Designing clean, sustainable and environmentally-friendly energy sources is a very urgent research issue for the future of the world. Molecular hydrogen is known as an ideal energy carrier for future energy resources due to its high energy density and environmentally friendly production possibilities [1-2]. The methods of depositing active materials such as graphene on electrode surfaces are important for electrosensing and electrocatalytic applications [3]. Graphene, a single layer of sp2-bonded carbon atoms, has attracted enormous attention owing to its unique structure and its exceptional electronic, mechanical, and thermal properties [4]. In this study we have investigated the electrocatalytic hydrogen production performance of glassy carbon electrode (GCE) modified by reduced graphene oxide (RGO) and Au nanoparticles, denoted as GCE/RGO/Au. The graphene layer was achieved on the GCE by electroreducing graphene oxide dissolved in phosphate buffer solution at -0.9 V constant applied potential. The electrodeposition of Au nanoparticles was obtained by cyclic voltammetry between −0.5 and +1.3 V at 50 mV.s−1 for 2 potential cycles after electrodeposition of graphene on GCE. The surface properties of the film-modified electrode were investigated by SEM images. The Au nanoparticles are uniformly dispersed on the graphene layer. Combining the advantages of graphene such as high surface area and conductivity, of Au nanoparticles with their excellent electrical conductivity, the hybrid film effectively enhanced the electron-transfer and promoted the hydrogen evolution reaction (HER). The hydrogen production performance of the GCE/RGO/Au hybrid material was tested by cyclic voltammetry, Tafel polarization curves and electrochemical impedance spectroscopy techniques.

Acknowledgements: This research has been supported by Aksaray University Scientific Research Projects Coordination Unit (ASU-BAP, 2016-034).

References:

[1] Y. Yang, C. Han, B. Jiang, J. Iocozzia, C. He, D. Shi, T. Jiang, Z. Lin, Mater. Sci. Eng. R. 102, 1-72, (2016).
[2] B.Gupta, A.A. Melvin, T. Matthews, S. Dash, A.K. Tyagi Renew. Sust. Energ. Rev. 58 1366-1375 (2016).
[3] J. Ma, L Liu, Q, Chen, M. Yang, D. Wang, Z. Tong, Z. Chen, Appl. Surf. Sci. 399, 535-541,(2017).
[4] C. Lee, X, Wei, D. J.W. Kysar, J. Hone, Science, 321(5887), 385–388, (2008).

Keywords: Hydrogen Evolution Reaction, Graphene, Au Nanoparticles, Electrocatalysis

POSTERS

[**Abstract:0105**]

Noble Metal-Free Oxides for the Oxygen Evolution Reactions Prepared by Adam's Fusion Method

Nesrin Demir[1], Mehmet Fatih Kaya[1], Mehmed Selim Çögenli[2]

[1]Department of Energy Systems Engineering, Faculty of Engineering, Erciyes University, Kayseri, Turkey
[2]Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum, Turkey

Performance and efficiency of energy production or storage systems are highly depended on the properties of electrocatalysts. Noble metals, such as RuO_2 and IrO_2 are still extensively using due to their great stability and kinetic characteristic. Furthermore, there is a big interest for non-precious electrocatalyst to maintain the oxygen evolution reaction (OER) at lower overpotentials and more economically. In the literature, several noble metal-free electrocatalysts are reported, such as $NiCo_2O_4$, $LaNiO_3$, $LaCoO_3$, Nb_2O_5, Co_2O_3., etc. They are used in alkali media, li-air batteries, water electrolysis and fuel cell reactions.

This study was firstly executed to identify usability of MnO_2 and CuO_2 for oxygen evolution reactions. These oxides can be found commonly and known as cost-effective and good stability in alkali media. Adam's Fusion method is used to prepare metal oxide compounds. In this method, required quantity of precursor is dissolved in 2-Propanol and stirred for 3-4 hours. Finely grounded $NaNO_3$ is added to the solution and stirred together for 4-8 hours. This solvent is dried in 75 °C slowly to obtain a dry mixture. Afterward, the sample is transferred to a high-temperature furnace in a silica crucible at 500 °C, 1 hours. Throughout the heat treatment process in the high-temperature oven, $NaNO_3$ transforms to nitrates with reacting the precursor. Excess salt is dissolved in deionized water and washed a few times after each centrifuge. Then the sample is dried in 75 °C all night. Properties of synthesized powders are characterized by XRD measurements. Electrochemical measurements are conducted using Cyclic Voltammetry.

Keywords: Electro-catalyst, Oxygen Evolution, Noble Metal-Free Oxides

[**Abstract:0107**]

Monodisperse Pd Nanoparticles Assembled on rGO-Fe3O4 Nanocomposites as a High-performance Electrocatalyst for Borohydride Fuel Cells

***Buse Sündü*[1], *Melike Sevim*[1], *Marta Martins*[2], *Biljana Šljukić*[2], *Diogo M.f. Santos*[2], *Önder Metin*[1]**

[1]Department of Chemistry, Faculty of Science, Atatürk University, 25240 Erzurum, Turkey
[2]CeFEMA, Instituto Superior Técnico, Universidade de Lisboa, 1049–001 Lisbon, Portugal.

5 nm palladium nanoparticles (Pd NPs) are synthesized and assembled on reduced graphene oxide-magnetite nanocomposite (rGO-Fe3O4) for oxygen reduction reaction (ORR) and borohydride oxidation reaction (BOR) studies in alkaline media. The structure and morphology of the resulted rGO-Fe3O4@Pd hybrid meterial is characterized by transmission electron microscopy (TEM), powder X–ray diffraction (PXRD) and energy dispersive X–ray spectroscopy (EDS) analyses. The electrochemical behaviour of rGO-Fe3O4@Pd hybrid material for the ORR and BOR is investigated by voltammetry with rotating ring disc electrode and electrochemical impedance spectroscopy, enabling evaluation of number of exchanged electrons, Tafel slope, exchange current density and activation energy. Thus, ORR at Pd/(Fe3O4–rGO) proceeds as a 4-electron process with Tafel slope of 168 mV dec–1. BOR at rGO-Fe3O4@Pd proceeds as a 5.6-electron process with Tafel slope of 0.31 and 0.67 V dec–1 depending on the overpotential range, and exchange current density of 1.38 mA cm–2. BOR activation energy was found to be 12.4 kJ mol–1. These results demonstrate the good efficiency of rGO-Fe3O4@Pd hybrid material for both ORR and BOR compared the similar electrocatalysts reported in the literature.

Keywords: Palladium nanoparticles, borohydride oxidation

POSTERS

[Abstract:0116]

Development of Tungsten or Ceria Incorporated Mesoporous Alumina Supported Nickel Catalysts for Hydrogen Production through Diesel Steam Reforming Reaction

***Arzu Arslan Bozdağ*[1], *Arife Derya Deniz Kaynar*[2], *Naime Aslı Sezgi*[1], *Timur Doğu*[1]**

[1]Middle East Technical University
[2]Vestel Defense Industry

Hydrogen is an ideal energy carrier. On-site hydrogen production is becoming an attractive area of research for fuel cell powered stationary or mobile auxiliary power unit applications, as the developments in fuel cell technology proceed. High hydrogen content of the product gas makes diesel steam reforming (DSR) an advantageous reaction. Catalyst deactivation caused by coke deposition is a major problem in DSR and this problem was targeted in this work with developed tungsten or ceria incorporated mesoporous alumina supported nickel catalysts. Nickel-alumina catalysts have been used in reforming reactions for their activity and stability at high temperatures. CeO_2 and W are preferred to minimize coke formation in DSR process with their good redox potential [1]. Mesoporous alumina (Al_2O_3) and CeO_2 or W incorporated Al_2O_3 were synthesized through evaporation induced self-assembly method [2]. Synthesized supports loaded with nickel and tungsten or ceria were tested towards DSR reaction at 800°C with a H_2O/C ratio of 2.35. Catalytic activity of the materials was analyzed according to their hydrogen and carbon dioxide production capabilities. According to characterization results, incorporation of CeO_2 or W to the support enhanced reducibility of NiO and dispersion of Ni°. Catalytic activity tests showed that incorporation of CeO_2 significantly improved catalytic activity towards diesel steam reforming and coke resistance of Ni/Al_2O_3 catalyst. In conclusion, CeO_2 and W were shown as highly promising promoters for Ni/Al_2O_3 catalysts in DSR reaction to be used in long-term hydrogen production for fuel cell powered APUs.

Acknowledgements: Financial supports of TUBITAK through project number 213 M 027, Middle East Technical University Scientific Research Projects and Vestel Defense Industry are gratefully acknowledged.

References:

[1] A. Arslan and T. Doğu, Int. J. Hydrogen Energy, vol. 41, no. 38, pp. 16752–16761, 2016.
[2] S. Gündüz and T. Dogu, Appl. Catal. B Environ., vol. 168–169, pp. 497–508, 2015.

Keywords: Diesel, Steam Reforming, Ceria, Tungsten

[**Abstract:0117**]

Sorption Enhanced Steam Reforming of Ethanol with Ceria-SBA-15 Supported Nickel Catalysts

Merve Sarıyer, Arzu Arslan Bozdağ, Naime Aslı Sezgi, Timur Doğu

Department of Chemical Engineering, Middle East Technical University, Ankara, Turkey

Hydrogen is considered as an environmentally clean energy carrier, which can be produced from fossil and renewable resources. Bio-ethanol produced from cellulosic bio resources through fermentation is considered as a promising resource for hydrogen production. Hydrogen production through ethanol steam reforming reaction (SRE) has the potential to be used for its on board production, in fuel cell powered motor vehicles. However, thermodynamic limitations may cause reduction in hydrogen yield. In the sorption enhanced process (SESRE), use of CaO for in-situ removal of produced CO2 increases hydrogen yield and shifts the SRE reaction towards to the products [1]. SBA-15 with high surface area and ordered pore structure attracted interest as a catalyst support. Nickel draws attention due to its high activity, low cost and availability. Ceria attracted significant attention as a component in SRE catalyst supports, with its high oxygen storage and release properties [2]. In this study, nickel impregnated SBA-15 and nickel–ceria impregnated SBA-15 catalysts were synthesized and tested in both SRE and SESRE. For SESRE experiments, effect of two different mixing procedures of CaO+catalyst on the hydrogen production was also investigated to reach maximum H2 and minimum CO and CO2 production. In the first mixing procedure CaO was mixed with the powder catalyst. In the second one, placement of CaO and catalyst was in the order of 0.05 g catalyst-0.75 g CaO keeping total amount of catalyst and CaO same. BET surface area values of SBA-15 and Ce@SBA-15 were found to be 856 and 382 m2/g, respectively. Ceria incorporated, high surface area SBA-15 supported nickel catalysts are promising for the production of hydrogen from ethanol. Activity test results showed that in-situ removal of CO2 with CaO significantly enhanced hydrogen production by minimizing equilibrium limitations. H2 production is lower in the mixed arrangement of catalyst and CaO compared to the ordered arrangement of them. However, adsorption period of CO2 is higher in the mixed arrangement. Results proved the advantages of sorption enhanced process for the production of high purity hydrogen from ethanol.

Acknowledgement: Financial supports of Tubitak (111M338), METU-BAP and TUBA are gratefully acknowledged.

References:

[1] S. Gündüz and T. Dogu, Appl. Catal. B Environ., vol. 168–169, pp. 497–508, 2015.
[2] A. Arslan and T. Doğu, Int. J. Hydrogen Energy, vol. 41, no. 38, pp. 16752–16761, 2016.

Keywords: Hydrogen, Steam reforming, Sorption enhanced steam reforming, Ethanol, Ceria, Nickel

[**Abstract:0130**]

Fabrication, Characterization and Hydrogen Evolution Activity of Three-Dimensional Nickel Nanodomes

Bedia Semra Taşçı, Handan Yüksel, Ramazan Solmaz

Bingöl University, Science and Letters Faculty, Chemistry Department, 12000 Bingöl, Turkey

Three-dimensional (3D) Ni nanodomes (NiNDs) were fabricated and characterized for alkaline water electrolysis. The nanodomes were prepared by a combined method of soft lithography-nanosphere lithography and physical vapor deposition (PVD) using polydimethylsiloxane (PDMS) as template. The 3D-NiNDs nanostructures were characterized using scanning electron microscopy and atomic force microscopy. Their hydrogen evolution activities were tested in 6 M KOH solution using electrochemical techniques. The similar studies were repeated for bulk Ni for comparison. The data obtained showed that well-structured and homogenously distributed NiNDs could be fabricated using this combined method. The NiNDs perform excellent hydrogen evolution activity. The higher activity of the domes was related to their large real surface area and good intrinsic electrochemical activity of Ni.

Acknowledgements: This study was supported by Bingöl University Scientific Research Projects Coordination Unit (BÜBAP) (Project Number: BAP-FEF.2016.00.008). The authors are greatly thankful to BÜBAP for financial supporting. The authors also would like to thank to Assoc. Prof. Dr. Mehmet Kahraman for his kind helps to prepare PDMS templates and Bingöl University Central Laboratory for characterization measurements.

Keywords: Three-dimensional nickel nanodomes, nanostructures, electrolysis, hydrogen evolution.

[**Abstract:0136**]

Bimetallic Nanoparticles for Alcohol Oxidation

Hilal Demir Kıvrak[1], Özlem Gökdoğan Şahin[2]

[1]Department of Chemical Engineering, Yüzüncü Yıl University, Van /Turkey
[2]Department of Chemical Engineering, Selcuk University, Konya/Turkey

Metal nanoparticles (NPs) have investigated in the last decade due to their chemical, physical and mechanical properties as well as their potential applications in catalysis, biology, electronics and optics. Alloying of metals is an effective way of developing new materials that have better technological usage than their monometallic ones. Alloy nanoparticles display different structural and physical properties than bulk samples. Bimetallic alloy nanoparticles received great attention because of nanoparticle catalytic activity depends on their structural features. These nanoparticles could display both the single properties of two metals and new properties due to the synergy between two metals. Moreover, these bimetallic particles could be in a core shell structure or alloy form depending on the preparation method. Core-shell bimetallic nanoparticles can reduce the noble shell metal and retain similar or superior catalytic activity compared to bulk alloy catalysts. Shape and size of mono and bimetallic nanoparticles are strictly dependent on the preparation methods and conditions and affects the physicochemical properties of synthesized material. Electronic structure of nanoparticles could be tuned by synthesizing core-shell structured nanoparticles, leading to produce nanoparticles having controlled shape, size, and structure. It is possible to tune electronic, crystal and surface structure of the nanocatalyst by employing effective nanocatalyst preparation methods. Various methods have been employed to obtain different classes of core -shell nanoparticles, being one of them the dendrimer template route. It is one of the most useful methods to control the particle size, compositions, and structures. This method consists of two main steps: mixing the metal ions with dendrimer and chemical reduction. This method is the best method for preparing small catalytically active nanoparticles. In the present study, the application of palladium bimetallic alloy nanoparticles as electrocatalysts and the comparison of the electrocatalytic activity of alloy and core-shell structures of different bimetallic catalysts for electro-oxidation of alcohol oxidation has been discussed.

Keywords: Bimetallic nanoparticles, alcohol oxidation, core-shell catalysts

POSTERS

[Abstract:0140]

Utilization of N-doped Carbon Materials Obtained from ZIF as Catalyst Support for PEM Fuel Cell

Niyazi Özçelik[1], Ayşenur Öztürk[2], Gamze Bozkurt[1], Mehmed Selim Çögenli[1], Ayşe Bayrakçeken Yurtcan[2]

[1]Department of Nanoscience and Nanoengineering, Ataturk University, Erzurum, Turkey
[2]Department of Chemical Engineering, Ataturk University, Erzurum, Turkey

Vulcan XC-72R is commonly used as carbon support in PEM fuel cell catalyst layer. However, in terms of catalyst durability, carbon particles based on carbon black usually degrade during cell operation and thus substantial fuel cell performance can't be obtained in the course of time. For this reason, the usage of alternative materials as catalyst support has interested many researchers in literature. Recently modified materials such as N-doped carbon or S-doped carbon have been notably in demand. In this context, N-doped carbon materials have been obtained with various methods. One of these methods is based on the calcination process in the condition of high temperature and inert atmosphere for the carbonization of zeolitic imidazole framework-8 (ZIF-8) or zeolitic imidazole framework-67 (ZIF-67) as metal organic frameworks. This method is preferential because of the utilization of imidazole that was used in the synthesis of ZIF as nitrogen source. Thereby, N-doped carbon was obtained with one-step. Additionally, it has been known that nitrogen atoms that are present in the structure of N-doped carbons obtained from ZIF provide extra catalytic activity. This information has been verified with achievement better fuel cell performance via carbonized ZIF supported catalyst in some studies. [1].

In this study, firstly, ZIF-8 and ZIF-67 materials were synthesized. N-doped carbon materials were obtained by the carbonization of ZIF-based materials. Physicochemical characterizations of these carbon materials were made by using FTIR, XRD, SEM, TGA and BET analysis. Pt was loaded over N-doped carbon materials via microwave irradiation technique. Physical characterizations of the catalysts were carried out via FTIR, XRD, TEM and TGA techniques. Electrochemical characterizations of the catalysts were performed by using cyclic voltammetry (CV) and PEM fuel cell tests.

Reference:

[1] F. Afsahi, S. Kaliaguine, J. Mater. Chem. A, 2014, 2, 12270.

Keywords: Catalyst support, N-doped carbon, ZIF, PEM fuel cell

[**Abstract:0145**]

Performance Analysis of a Conceptual Hydrogen Fueled Ramjet Engine: Exergetic Perspective

Yasin Şöhret[1], Selçuk Ekici[2], T. Hikmet Karakoç[2]

[1]Suleyman Demirel University
[2]Anadolu University

Ramjet engines are widely used devices in defense industry and military applications. A ramjet engine's working is thermodynamically based on Brayton cycle. It is known that exergy analysis is a beneficial tool to assess energy devices regarding operational conditions. In the current study, performance of a hydrogen fueled ramjet engine is evaluated by means of exergy. At the end of the study, exergy efficiency of inlet, combustion zone and nozzle of the ramjet engine are calculated to be 3.88%, 7.62%, and 0.03% respectively. Exergy efficiency of the ramjet engine is also found as 8.85%. The introduced methodology to the best of authors' knowledge and the results obtained from the present study can be useful for anybody who is interested in thermal sciences and aero-propulsion technologies.

Keywords: Alternative fuel, cycle analysis, exergy, hydrogen, ramjet, thermodynamics

[Abstract:0154]

Diamond like carbon (DLC) coated on TiO2-NT-Ag electrode by MW ECR plasma system for hydrogen production

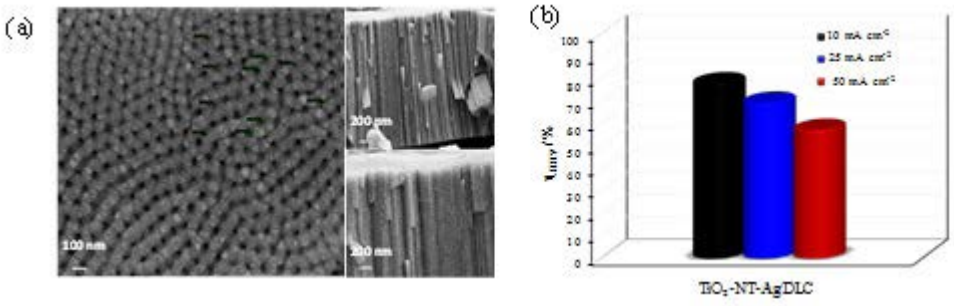
***Evrim Baran*[1], *Zeynep Baz*[2], *Ramazan Esen*[2], *Birgül Yazıcı*[3]**

[1]Department of Chemistry, Faculty of Science and Literature, Kilis 7 Aralık University, Kilis, Turkey
[2]Department of Physics, Science and Letters Faculty, Cukurova University, Adana, Turkey
[3]Department of Chemistry, Science and Letters Faculty, Cukurova University, Adana, Turkey

In this study, diamond like carbon (DLC) coating was deposited on the surfaces of Ag doped TiO2 nanotube (NT) using MW ECR plasma system. The morphology and structure of the obtained TiO2-NT-Ag/DLC electrode were characterized in detail by FE-SEM and XRD. It was determined that after the DLC coating, the tops of nanotubes were partially open and the pore diameter of hexagonal structure decreased from 165nm to a range of 38-80 nm. Moreover, the Vickers hardness and the water contact angle of TiO2-NT-Ag/DLC electrode were found to be 109 HV and 97.3°, respectively. In order to obtain information regarding the electrocataltic activity of TiO2-NT-Ag/DLC electrode toward the hydrogen evolution reaction, electrochemical measurements of the as-fabricated electrode were carried out in 1M KOH solution. Additionally, long term stability of the electrode and the energy requirement for the electrolytic hydrogen evolution were studied. The cathodic Tafel slope calculated for TiO2-NT-Ag/DLC electrode was found to be -135.0 mV dec-1. The calculated Tafel slope for the HER on the electrode suggests that rate-determining step is Volmer mechanism that the adsorption of H+ onto the active sites is slow step in the HER. The calculated energy efficiency for TiO2-NT-Ag/DLC electrode was found to be ranges from 57 % to 78 %.

Keywords: TiO2-NT-Ag/DLC, SEM, XRD, Hydrogen evolution, Energy consumptions

Figure 1.



FE-SEM images (top and cross section views) (a) and energy efficiency of alkaline electrolysis at diffferent current density (b) for TiO2-NT-Ag/DLC electrode

[**Abstract:0162**]

Steam Reforming of Triolein as a Model Compound of Edible Oil for H2 Production via Thermodynamic Analysis

Ömer Faruk Gül, Şeyma Özkara Aydınoğlu

Department of Chemical Engineering,Beykent University,Istanbul, Turkey

The edible oil industry is one of the largest industries in the World. Vast amount of hydrogen is needed in the processing of edible oil and supplying hydrogen demand for this process from internal sources is an ultimate goal for the process efficiency. In this study, steam reforming of triolein as a model compound of edible oil is investigated via thermodynamic equilibrium analysis for hydrogen production. Gibbs Free Energy Minimization Technique is used to explore the effects of process parameters such as temperature, pressure and steam-to-carbon ratios on product compositions and yields. For this purpose, the calculations are carried out at a temperature range of 200-1200°C and steam-to-carbon ratios varying between 0-1.Temperature versus steam/carbon ratio values that will maximize hydrogen product yield are investigated.The analysis is also performed at a pressure range of 1-10 bar in order to analyse the effect of pressure on process performance parameters. The results show that equilibrium conversion of reactants and yields of products vastly depend on process parameters, suggesting that steam reforming of triolein is controlled by different reactions with regard to the operating temperature, pressure and varying feed compositions.

Keywords: H2, Triolein, Steam Reforming

POSTERS

[Abstract:0163]

Hydrogen Storage Capacity of Palladium Doped Multi Wall Carbon Nanotubes Prepared via Supercritical CO2 Depostion Method

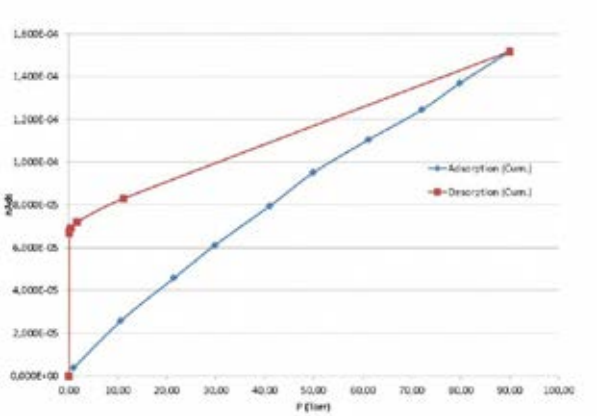
***Ebru Erünal*[1], *Fatma Ulusal*[2], *Deniz Kaya*[3], *Mustafa Y. Arslan*[3], *Bilgehan Güzel*[2], *Deniz Üner*[3]**

[1]Chemical Engineering Department, Çukurova University, Adana, Turkey
[2]Chemistry Department, Çukurova University, Adana, Turkey
[3]Chemical Engineering Department, M.E.T.U., Ankara, Turkey

The crucial role of hydrogen storage in energy technologies has recently increased the interest in Carbon Nanotubes (CNTs) which are known to be promising materials with their hydrogen storing capacities in respect to their high surface-to-volume ratios, high stabilities and light weights. However, their hydrogen storage capacities still should be improved for moderate pressure and ambient temperature applications. One of the common strategies to enhance hydrogen storage capacity of CNTs are to dope them with transition metals. In this work, Pd doped Multi Wall Carbon Nanotubes (MWCNTs) were prepared via superciritical cabondioxide deposition method in order to obtain a well dispersed nanoparticle material. Then temperature programmed desorption (TPD) and reduction (TPR) experiments were conducted. TPR measurements revealed an initial Pd hydride decomposition. Moreover, adsorption and desorption hysteresis at ambient temperature was also measured and results are shown in Figure. The cumulative adsorption was found as 1517 μmole/ g sample and 668 μmole of hydrogen storage capacity according to the desorption experiment at ambient temperature.

Keywords: Hydrogen Storage, Carbon Nanotubes, Temperature Programmed Reduction, Temperature Programmed Desorption

Adsorption-Desoprtion at Ambient Temperture



Adsorption-Desoprtion Hysteresis of Pd doped Multi Wall Carbon Nanotubes at Ambient Temperture

[**Abstract:0167**]

Preparation of a Novel Composite Hydrogel Loaded Cobalt and Hydrogen Production from Hydrolysis of NaBH4

Duygu Alpaslan, Tuba Ersen Dudu, Nahit Aktas

Yüzüncü Yıl University

The synthesis of poly(N,N-Dimethylacrylamide-co-3-acrylamidopropyl trimethyl ammonium chloride) (p(DMAAm-co-APTMACl)) hydrogels were carried out by redox polymerization technique at different mix amounts of DMAAm and APTMACl monomers. In hydrogel synthesis was used N,N′-methylenebisacrylamide (MBA) as the cross-linker, and ammonium persulfate (APS) as the initiator ajan. Then sythesized p(DMAAm-co-APTMACl) hydrogels were used as template for in situ Co metal nanoparticle preparation (composite hydrogels) and used as composite catalyst systems in hydrogen generation from hydrolysis of NaBH4 in ID water. Atomic Absorption Spectroscopy (AAS) measurements were employed to determine the metal particle content of p(DMAAm-co-APTMACl)-M (M: Co) composite hydrogels. The effects of different parameters such as the reaction temperature, the different mix ratios, and reusability of the prepared catalyst systems were investigated, and also the required activation energy at hydrolysis of NaBH4 for p(DMAAm-co-APTMACl) composite hydrogels calculated.

Keywords: Hydrogel, enegry, hydrogen

POSTERS

[**Abstract:0168**]

The Preparation of a Composite-catalyst System and Hydrogen Production from Hydrolysis of NaBH4

Tuba Ersen Dudu*, *Duygu Alpaslan*, *Nahit Aktas

Yüzüncü Yıl University

Hydrogen as an alternative potential is a carbon-free energy source. In this study, p(DMAAm-co-APTMACl) hydrogels at different mix amounts were synthesized by redox polymerization technique using N,N-Dimethylacrylamide (DMAAm), 3-acrylamidopropyl trimethyl ammonium chloride (APTMACl) as monomer. In hydrogel synthesis was used N,N′-methylenebisacrylamide (MBA) as the cross-linker, and ammonium persulfate (APS) as the initiator ajan. p(DMAAm-co-APTMACl) hydrogels were used in the preparation of a composite-catalyst system for hydrogen generation from hydrolysis of NaBH4. In situ Ni nanoparticles were prepared by chemical reduction of absorbed Ni (II) ions inside the hydrogel networks, and the whole composite was used as a catalyst system. Furthermore, these composite catalyst systems were employed in the generation of hydrogen from the hydrolysis of sodium boron hydride (NaBH4) in ID water. Atomic absorption spectroscopy (AAS) measurements were employed to determine the Ni (II) metal particle content of p(DMAAm-co-APTMACl)-M (M: Ni) composite hydrogels. The effects of different parameters such as the reaction temperature, the different mix ratios, and reusability of the prepared catalyst systems were investigated, and also the required activation energy at hydrolysis of NaBH4 for p(DMAAm-co-APTMACl) composite hydrogels calculated.

Keywords: Hydrogel, enegry, hydrogen

POSTERS

[**Abstract:0169**]

The Preparation of p(DMAAm-co-APTMACl) Hydrogel and Their Use as Catalyst for Hydrogen Generation from Hydrolysis of NaBH4

Duygu Alpaslan, Tuba Ersen Dudu, Nahit Aktas

Yüzüncü Yıl University

In this study, p(DMAAm-co-APTMACl) hydrogels at different mix amounts were synthesized by redox polymerization technique using N,N-Dimethylacrylamide (DMAAm), 3-acrylamidopropyl trimethyl ammonium chloride (APTMACl) as monomer. In hydrogel synthesis was used N,N′-methylenebisacrylamide (MBA) as the cross-linker, and ammonium persulfate (APS) as the initiator ajan. p(DMAAm-co-APTMACl) hydrogels were used in the preparation of a composite-catalyst system for hydrogen generation from hydrolysis of NaBH4. In situ Fe (III) nanoparticles were prepared by chemical reduction of absorbed Fe (III) ions inside the hydrogel networks, and the whole composite was used as a catalyst system. Furthermore, these composite catalyst systems were employed in the generation of hydrogen from the hydrolysis of sodium boron hydride (NaBH4) in ID water. Atomic absorption spectroscopy (AAS) measurements were employed to determine the Fe (III) metal particle content of p(DMAAm-co-APTMACl)-M (M: Fe) composite hydrogels. The effects of different parameters such as the reaction temperature, the different mix ratios, and reusability of the prepared catalyst systems were investigated, and also the required activation energy at hydrolysis of NaBH4 for p(DMAAm-co-APTMACl) composite hydrogels calculated.

Keywords: Hydrogel, enegry, hydrogen

[**Abstract:0179**]

Reliability of Numerical SOFC Tools for Computing Spatial Current and Temperature Variations

***Özgür Aydın*[1], *Hironori Nakajima*[2], *Tatsumi Kitahara*[2]**

[1]Department of Hydrogen Energy Systems, Graduate School of Engineering, Kyushu University, ITO Campus, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan

[2]Department of Mechanical Engineering, Kyushu University, ITO Campus, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan

Numerical tools are employed in diverse fields for computing characteristic properties spatially. In principle, they are obliged to be verified by benchmark experimental data for assuring the reliability of investigations. Although numerical tools are often employed for SOFCs (Solid Oxide Fuel Cells), they are hardly verified due probably to lack of experimental data. In fact, some of the models are validated with the conventional I-V (current-voltage) curves; however, it is a fact that an I-V validated model might predict a number of distinct temperature fields depending on the incorporated heat transfer processes. Since other processes e.g., diffusion, charge transfer, etc. are dependent on the local temperature, the computation-accuracy of the electrochemical performance is expected to be highly affected by the inaccurate temperature fields. This study has thus been devoted to investigating the accuracy of the spatially computed current and temperature variations in SOFCs. Herein the accuracy of the spatial current variations predicted by the I-V validated numerical model is assessed based on the current variations in situ acquired by the segmentation method in a microtubular-SOFC. In addition, the reliability of the temperature variations predicted by the I-V validated numerical model is evaluated leaning upon the longitudinal temperature variations in situ obtained by the segmentation method in a microtubular-SOFC. Finally, the impact of the temperature validation on the computation-accuracy of current variations is analyzed by comparing the data acquired based on the I-V validation and temperature-validation.

Keywords: Numerical Modeling, Model Validation, Current/Temperature Variations, Segmentation

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bilge.yuksel@brosgroup.net / www.brosgroup.net

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