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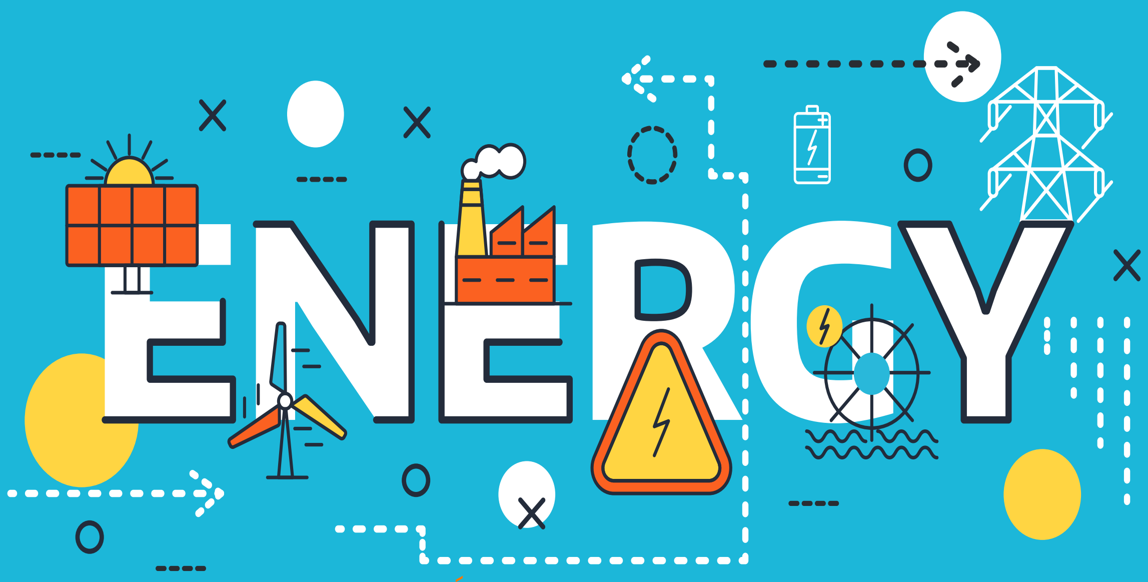

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PLENARY

Private Sector Interest and Participation in Fusion Energy Development

Howard Hornfeld, *Fusion Advocates, Switzerland*

Abstract

Fusion energy development (FED) has been a government-sponsored activity essentially since FED began, over 50 years ago. In 1998 the first significant private-sector fusion company began, followed four years later by the second. Both of these firms still exist, and they are amongst the five leading firms in the FED arena today. But although they are still around, and indeed are by far the largest FED companies worldwide, neither firm has ever made fusion happen – not even on a pilot-scale machine! But there are a large number – probably about a dozen or so - of smaller, dynamic, active companies doing FED, and of these there are perhaps 3 or 5 doing very serious work, and who have technologies and the other skills needed to bring FED to the commercial marketplace before then of this decade. The firms are worldwide – from Asia to the Americas, and from Australia to Europe. A description of these companies and their activities and will be elaborated during this presentation.

Biography

Dr. Hornfeld received his Bachelor of Science from MIT, and his Masters from University of California, before moving to Europe, where he earned his D.Sc at University of Sussex (UK). His studies in chemistry and other physical and materials sciences prepared him for consulting in high-performance polymers through his Geneva-based firm CONSULTEX SA, which he ran for over 20 years. He then moved to run the United Nations Economic Commission for Europe's Chemical Industry Program for six years. Since retiring from the UNECE, he created FUSION ADVOCATES in 2013, for which he has been tirelessly promoting the idea that YES, WE CAN do fusion!

Reducing Industrial Carbon Emissions: Creating and Operating an Industrial Demonstrator for Multiple Decarbonization Technologies

Merrie K. Barron[1] and Andrew R. Barron[1,2,3*]
[1]*Swansea University Bay Campus, Swansea, UK*
[2]*Universiti Teknologi Brunei, Brunei Darussalam*
[3]*Rice University, Houston, Texas, USA*

Abstract

A low carbon future needs not only a robust and sustainable systems but also effective ways of managing the inevitable carbon emissions from heavy industrial processes such as metals, cement, and chemicals manufacturing. It is vital to develop ways in which CO_2 can be used as a source of raw material rather than a waste product to be emitted into the environment. This conversion into value added products could involve permanent sequestering the carbon into an alternative form or providing an entry into a circular economy. This project tests how CO_2 produced from heavy industrial processes can be innovatively used to make high value products and industrially important chemicals as well as implementing technology for the production of green hydrogen,

which can be used in energy production processes, further helping to reduce carbon footprint. The operation focuses on delivering transformational change through the translation of innovative processes to reduce Wales' CO emissions and decrease Welsh heavy industry's energy & raw material consumption, enabling the creation of new business and lowering the barrier to adoption. The demonstrated industrial concepts ensure the techno-economic feasibility of the entire value chain and have the potential for a significant social and economic impact, notably in terms of job creation, economic growth and safe and innovation of energy systems technologies. The presentation will focus on the issues associated with large scale technology implementation and the successful delivery of multiple demonstrator sites.

Biography

Prof Barron is the Sêr Cymru Chair of Low Carbon Energy and Environment at Swansea University, and Director of the Energy Safety Research Institute. As author of over 500 publications, his research focused on fundamental problems in energy and the environment. He is a Fellow of the Royal Society of Chemistry, and the recipient of the Star of Asia International Award and the World Technology Award. His latest commercialization ventures are technologies for water purification of produced water and an anti-viral mask for the COVID crisis. For relaxation Barron races cars on both sides of the Atlantic.

Exergy Methods and the Environment

Marc A. Rosen, *University of Ontario Institute of Technology, Canada*

Abstract

The use of exergy methods is described as tools for addressing environmental impacts so the benefits can be appreciated more fully and attained in practice. Exergy can be used to understand environmental impacts and climate change measures and to assess and improve energy systems. Exergy methods also can help better understand the benefits of utilizing sustainable energy by providing more useful and meaningful information than energy methods provide. Exergy clearly identifies efficiency improvements and reductions in wastes and environmental impacts attributable to sustainable energy. Exergy methods thereby allow rational statements of the potential for improvement of any system, based on the laws of thermodynamics. Exergy can also identify better than energy the environmental benefits and economics of energy technologies. Exergy should be applied in addressing environmental impacts, as a complementary tool to more conventional methods.

Biography

Dr. Marc A. Rosen, Ph.D., is a Professor at University of Ontario Institute of Technology in Oshawa, Canada, where he served as founding Dean of the Faculty of Engineering and Applied Science. Dr. Rosen has served as President of the Engineering Institute of Canada and of the Canadian Society for Mechanical Engineering. He has acted in many professional capacities, including Editor-in-Chief of various journals and a Director of Oshawa Power and Utilities Corporation. With over 70 research grants and contracts and 900 technical publications, Dr. Rosen is an active teacher and researcher in sustainable energy, sustainability, and environmental impact. Much of his research has been carried out for industry. Dr. Rosen has worked for such organizations as Imatra Power Company in Finland, Argonne National Laboratory near Chicago, the Institute for Hydrogen Systems near Toronto, and Ryerson University in Toronto, where he served as Chair the Department of Mechanical, Aerospace and Industrial Engineering. Dr. Rosen has received numerous awards and honours, and is a Fellow of numerous societies.

Optimization in Electric Power Distribution Systems

Panos M. Pardalos, *University of Florida, Gainesville, FL*

Abstract

Planning the operation and expansion of power distribution systems (PDS) is essential to assure that the growing demand can be satisfied with a reliable service at affordable costs. Given the size of these systems, the minimization of overall costs can be a considerable challenge. For instance, finding the topology or overall least-cost plan for a PDS can be a difficult task, since thousands of feasible design options can arise from a feeder design definition. The difficulty in solving PDS optimization problems relies on the combinatorial nature and the large solution space. In this context, the development of models and solution techniques is of great importance for power utilities, and Engineer's understanding of the system and its costs, performance, and trade offs can be facilitated with optimization concepts.

Significant changes are being imposed to PDS in the recent years, given the growing presence of distributed energy resources and the smart grid implementation. The abilities to dynamically optimize the operation, integrate diverse distributed generation types, and integrate demand response and energy resources are needed in this modern power system era. As a result, significant research efforts have been dedicated to the optimal expansion and operation planning of modern distribution networks. Several models and techniques are proposed in the literature, covering the allocation of new substations, reinforcement of the existing ones, reconductoring or construction of new distribution lines, distributed generation placement, network reliability improvement, among other problems. In this lecture, we will discuss some optimization problems applied to PDS, ranging from theoretical contributions to practical applications. Finally, future research problems are presented and discussed.

Biography

Prof. Pardalos is a world renowned leader in Global Optimization, Mathematical Modeling, Energy Systems, and Data Sciences. He is a Fellow of AAAS, AIMBE, and INFORMS and was awarded the 2013 Constantin Caratheodory Prize of the International Society of Global Optimization. In addition, Dr. Pardalos has been awarded the 2013 EURO Gold Medal prize bestowed by the Association for European Operational Research Societies. This medal is the preeminent European award given to Operations Research (OR) professionals for "scientific contributions that stand the test of time." He has been awarded a prestigious Humboldt Research Award (2018-2019). The Humboldt Research Award is granted in recognition of a researcher's entire achievements to date – fundamental discoveries, new theories, insights that have had significant impact on their discipline. He is also a Member of several Academies of Sciences, and he holds several honorary PhD degrees and affiliations. He is the Founding Editor of Optimization Letters, Energy Systems, and Co-Founder of the International Journal of Global Optimization, Computational Management Science, and Springer Nature Operations Research Forum. He has published over 500 journal papers, and edited/authored over 200 books. He is one of the most cited authors and has graduated 64 PhD students so far.

Solar Thermal Production of Hydrogen and Carbon Black as a Promising Environmentally Clean Supply for Fuel Cells

Nesrin Ozalp, *Purdue University Northwest, Hammond, IN*

This presentation is based upon the speaker's following paper: Ozalp et al. "A critical assessment of present hydrogen production techniques: is solar cracking a viable alternative?" Current Opinion in Chemical Engineering. 2018, 21:111–115."

Abstract

Fuel cells convert chemical energy of fuels directly into electrical energy without thermal. Intermediate step, therefore, they are not limited by the Carnot efficiency allowing theoretical efficiencies of 100% per Gibbs-free energy and enthalpy of formation ratio. Other advantages of fuel cells include their compatibility with renewable sources and energy carriers such as hydrogen and their inherent modularity allowing a wide range of applications from less than 1 W to several MW. Solar thermal production of hydrogen and carbon black via methane cracking is a promising process for charging fuel cells (HFC and CFC) with efficiencies of 50–60% and 70–75%, respectively. This method has the potential to double the current commercial solar conversion efficiencies as most of the CSP plants implement the Rankine cycle to convert heat to electricity with typical efficiencies of 35–40%. However, higher efficiencies may be reached via solar cracking of the natural gas coupled with HFC and CFC for a combined efficiency of 60–70%. This presentation describes a promising combined system featuring a solar reactor, HFC and a CFC. In proposed system, hydrogen is used in a HFC to generate electricity for the grid and the carbon is easily segregated for use in a continuously operating CFC with excess carbon used for energy storage during low demand. As the only gas released from this FC, practically pure CO2 discharged from the CFC can be readily captured for storage, or used as a feedstock for syngas production via dry reforming of natural gas. Because carbon constitutes 75% by mass of the natural gas cracking product stream, the natural gas cracking process powered by the CFC has the potential to maintain full production during long term unavailability of solar energy. Such a system offers an alternative to the current state of the art of thermal storage and would change the perception of solar energy. The proposed system also offers options for continuous or intermittent operation as economics dictate. The combined solar reactor with fuel cells has the flexibility of working strictly as an electricity production unit by keeping both fuel cells explicitly for power generation and excluding the reactor when sufficient carbon and hydrogen are produced. An efficiency analysis of this hybrid system yields an optimal efficiency of 68% via perfect natural gas decomposition when accounting for compressor losses and lower heating value of natural gas. It is envisioned that this disruptive technology can serve to provide high efficiency distributed power generation and replace existing low efficiency peaker plants where high frequency response and intermittent operation are required.

Biography

Dr. Nesrin Ozalp is a Professor and Chair of Mechanical and Civil Engineering at Purdue University Northwest, a Full Professor by Courtesy at the School of Mechanical Engineering of Purdue University West Lafayette, and Editorin-Chief of Thermopedia by Begell House. She received her Ph.D. from the University of Washington's Mechanical Engineering Department and her MSc in Mechanical Engineering from Stanford University. Dr. Ozalp specializes in the areas of designing novel solar reactors for emission-free generation of fuels. She is the Lead Principal Investigator of research projects totaling $5M+, the corresponding author of 120+ peer reviewed journal, book chapter, and conference papers, Co-PI of completed Phase I of Solar Carbon Black commercialization with Fraunhofer. She is the vice chair of ASME Solar Energy Executive Committee, and the recipient of many research and teaching awards including the Outstanding Reviewer Award by the ASME Heat Transfer Division, and the College-Level Distinguished Teaching Award by the Texas A&M Association of Former Students. Dr. Ozalp is an ASME Fellow.

Directions and Challenges for Next Generation Energy Storage Materials and Technologies

Jun Liu

Pacific northwest National Laboratory, Richland

University of Washington, Seattle

Abstract

Energy storage is very important for modern computation and communication, electrification of transportation, renewable energy and secure electric infrastructures. Currently Li-ion batteries

are the most prominent candidates for energy storage, while other traditional technologies such as pumped hydro and compressed air offer much cheaper solutions if available. Large scale deployment requires significant cost reductions in both capital and long-term operation cost. Many different approaches are pursued for next generation energy storage materials and technologies, but most studies have been conducted on the materials and component levels. Among the different materials, Li metal is a key electrode material for developing high energy batteries with a much higher specific energy and a lower cost. Despite of intensive efforts, significant challenges remain in direct utilization of Li metal anode in realistic high energy cells. This talk will summarize our current understanding of the scientific and technological challenges,discuss recent progresses and propose potential directions based on a high-energy cell design, fabrication and testing. The fundamental relationship between different components in the system, especially electrolytes, is explored at the cell level in order to inspire new ideas to effectively address the grand challenges in high energy and cost-effective solutions.

Biography

Dr. Jun Liu is a Washington Foundation Innovation Chair and Campbell Chair Professor at the University of Washington (UW), and a Battelle Fellow at the Pacific Northwest National Laboratory (PNNL). He also serves as the Director for Innovation Center for the Battery500 Consortium and President of the International Coalition for Energy Storage. Dr. Liu received the PNNL Life-Time Achievement Award, Battery Division Technology Award from The Electrochemical Society (ECS), two R&D100 Awards and the DOE EERE Exceptional Achievement Award. He is an elected member of Washington Academy of Science, a Materials Research Society (MRS) Fellow, an Electrochemical Society (ECS) Fellow, and an American Association for the Advancement of Science (AAAS) Fellow. He has been ranked as a highly cited researcher in the world since 2014. He was named a Distinguished Inventor of Battelle in 2007, and was two times selected as PNNL's Inventor of the Year.

KEYNOTE

Advanced Multiphase Flow Characterization in an Annulus of an Extended Reach Well

Aziz Rahman, *Texas A&M University, Qatar*

Abstract
The hydrocarbon reserves of conventional/unconventional sources will remain a major source of the world's energy supply even with the fastest growth of other energy sources including renewable energy. The petroleum and energy industry must be capable of low-energy intensive extraction and transportation of these resources, in an environmentally benign manner. Drilling wellbores is one of the most important part of extracting petroleum resources from the reservoirs. Very complex spatio-temporal flow patterns of multiphase flow, which are often observed in annuli during drilling fluid circulation and wellbore production, are not fully understood. Fundamental understanding of the effects of complex multiphase flow regime on hydrodynamic scaling and geometric scaling is an open challenge. This understanding is essential for substantial economic growth of oil and gas industry. The talk will be based on an experiments and numerical simulations project that helps to understand the multiphase (gas/liquid/solid) flow behavior in annuli under various operating, hydrodynamic and geometric conditions. The objectives of the project are as follows: 1) to develop a tool or model which will optimize and suggest meaningful surface operating parameters for efficient wellbore cleaning and drill cuttings transmittal to surface, particularly during horizontal drilling wells (cuttings settling in the tangential section), 2) to predict multiphase volume fractions (flow metering) and pressure loss in annuli with a wide range of operating, hydrodynamic and geometric conditions.

Biography
Dr. Mohammad Azizur Rahman received his PhD from University of Alberta, Canada in 2010. Dr. Rahman is currently an Associated Professor in the Petroleum Engineering Program at Texas A&M University at Qatar (TAMUQ). Prior to his appointment at TAMUQ, he was an Assistant Professor at Memorial University of Newfoundland and an Instructor at University of Alberta, Canada. Dr. Rahman has received around 2 million research funding from Qatar Foundation, Natural Sciences and Engineering Research Council of Canada, and Newfoundland Research & Development Corp. He has been involved in a number of research collaborations with companies, including Total, Qatargas, Intecsea, NEL, Syncrude Canada, GRI simulations, and Petroleumsoft. He is also involved in with a number of professional organizations, including SPE, and ASME. He is a registered Profession Engineer in Alberta, Canada. Dr. Rahman established two multiphase flow loop in pipe/annulus and core flooding set-up in his lab. He has contributed to more than 120 refereed journals and conference publications related to multiphase flow experiment and computational fluid dynamics simulation. He supervised several postdoctoral fellows and graduate students.

Mechanics of Swelling: A Diffusion Based Approach

Sayyad Zahid Qamar*, **Maaz Akhtar** and **Tasneem Pervez**
Sultan Qaboos University, Oman

Abstract
Swelling elastomers are special polymers that increase in volume when exposed to water or oil. In petroleum drilling and development, these elastomers have been successfully deployed for applications such as isolation of water-producing zones, cementless completions or partial replacement of cementing in well completion, slimming down of wells, etc. Several factors are essential for a swelling elastomer application to succeed: proper selection of elastomer and application type for a given set of field conditions; continuous improvement in design and manufacture of swell packers; evaluation of seal integrity in harsh environments; modeling and simulation for performance analysis and design improvement; etc. None of these can be successfully attempted without proper knowledge of the material response of these elastomers under specific field/operating conditions. In collaboration with regional and international petroleum companies, an elastomer research facility has therefore been established at Sultan Qaboos University for material characterization and performance evaluation of swelling elastomers and swell packers through experimental, analytical, and numerical investigations. The mechanism of swelling can be either diffusion or osmosis, initiating the imbibition of fluid inside the elastomer and progressively swelling it. Work presented here investigates diffusion as the swelling mechanism. Swelling experiments are conducted at different temperatures in brine solutions of different salinities. Measurements are carried out at various stages of swelling. As expected, volume, thickness, and mass of the elastomer increase with swelling time, while hardness shows a decreasing trend. More variation is observed for all quantities in low-salinity brine as compared to high salinity. Stokes-Einstein formula is used to determine the diffusion coefficients. Viscosity is measured using a Cannon–Fenske apparatus. Larger values of diffusion coefficient are found in low-salinity water at both temperatures, consistent with the higher amount of swelling and the faster swelling rate. These results and the diffusion-based approach can help in understanding the mechanics of swelling. This work can aid in the development of new analytical and semi-analytical models that can predict seal pressure and other performance factors for applications in oil and gas wells.

Biography
Dr. Sayyad Zahid Qamar is currently working as a Professor at the Mechanical and Industrial Engineering Department, Sultan Qaboos University (SQU), Muscat, Oman. He has over 25 years of academic and research experience in different international universities. He has also worked as a professional mechanical engineer in the field for over 6 years in the heavy engineering and fabrication industry (Manager Research and Development; Deputy Manager Design; Production Engineer; Quality Control Engineer). On top of his experience as a researcher/academician, he has been actively involved in research and accreditation work related to engineering education. His technical research areas are Applied materials and manufacturing; Applied mechanics and design; Reliability engineering; and Engineering education. As part of the Applied Mechanics and Advanced Materials Research group (AM2R) at SQU, he has been involved in different applied research funded projects in excess of 4 million dollars. He has over 200 research/technical publications to his credit (research monographs/books, edited book volumes, book chapters, publications in refereed international journals and conferences, and technical reports). He has recently edited one volume (Renewability of Synthetic Materials) for the Elsevier Encyclopedia of Renewable and Sustainable Materials. He has served as Associate editor, Guest editor, and Member editorial board for different research journals (including Materials and Manufacturing Processes, Journal of Elastomers and Plastics, the Journal of Engineering Research, American Journal of Mechanical and Industrial Engineering, etc).

Novel Material Strategies to Ultraselective Membranes for CO_2 Capture

Richard J. Spontak[1]*, Liyuan Deng[2], Luca Ansaloni[3] and Marius Sandru[3]
[1]*North Carolina State University, USA*
[2]*Norwegian University of Science & Technology, Norway*

[3]SINTEF Industry, Norway

Abstract
Climate change, attributed largely to atmospheric CO2, continues to threaten the global environment and its inhabitants. Numerous efforts have endeavored to design membranes to

remove CO2 from both flue gas and natural gas, and have recently emphasized permeability rather than selectivity. In this work, two approaches starting from different ends of the permeation spectrum are used to fabricate organic membranes that afford ultraselectivity (i.e., CO2/N2 selectivity > 100). In one instance, the starting point is micro/nanofibrillated cellulose (MNFC), which by itself acts as a barrier to gas permeation. Upon addition of a hydrophilic ionic liquid (IL) to coat MNFC fibrils and break up their packing and subsequent use of humidified feed gas, a "gate-opening" mechanism can be activated at intermediate relative humidity levels so that CO2 is permitted to selectively permeate through the hydrated IL. In the second case considered here, the starting point is a low-selectivity, ultrapermeable (CO2 permeability > 1000 Barrer) membrane that is surface-functionalized to introduce CO2-philic groups. By integrating these components together, the surface moieties concentrate CO2 from the mixed-gas feed and retain high permeability, in some cases yielding ultraselective and ultrapermeable membranes. The performance of these membranes, as discerned from a selectivity-permeability trade-off plot, lies above a new upper bound proposed on the basis of recently published results.

Biography
Dr.Richard Spontak, a Distinguished Professor at NC State University, received his B.S. and Ph.D. degrees in Chemical Engineering from Penn State and UC Berkeley, respectively. He has >290 peer-reviewed journal publications and >35 book chapters and invited works, and his research has been featured on 30 journal covers and cited over 13,000 times. He has received numerous honors including the ACS Chemistry of Thermoplastic Elastomers Award, the IOM3 Colwyn Medal and the SPE International Award. He is a fellow of the American Physical Society and the Royal Society of Chemistry, and a member of the Norwegian Academy of Technological Sciences.

Modeling Asphaltenes as Glassy Materials

Angelo Lucia, *University of Rhode Island, Kingston, USA*

Abstract
Asphaltenes do not have critical properties, mostly because they decompose before reaching a critical state. In this keynote address, I will cover several aspects of modeling asphaltenes as glassy materials and compare numerical simulation results with available experimental data. In the first part of this talk, a novel and rigorous numerical methodology for determining the glass transition temperature, the boundary condition for the energy parameter for the multi-scale Gibbs-Helmholtz Constrained (GHC) equation of state, and thermo-mechanical and physical properties for compounds without critical properties is presented. Using the glass temperature and boundary condition, the multi-scale GHC equation is used to predict thermo-mechanical properties of a model asphaltene fluid proposed by Mullins (2010). It is shown that computational results for the multi-scale GHC equation for the model asphaltene over the temperature range [263.15, 593.15 K] give accurate mass densities, coefficients of thermal expansion, and isothermal compressibilities for the model asphaltene that compare favorably with available experimental data for asphaltenes reported in the open literature.

The second part of this talk will focus on the fluid phase behavior of mixtures involving asphaltenes since phase behavior of alkanes, aromatics and asphaltenes is very important in oil recovery and

flow assurance. It is shown that liquid-liquid equilibrium computed by the GHC equation for n-heptane/toluene/asphaltene mixtures is consistent with well-known behavior (i.e., the model asphaltene is insoluble in n-heptane and soluble in toluene). In addition, the GHC equation predicts that asphaltene solubility in the toluene-rich phase increases with decreasing n-heptane concentration.

Biography

Dr. Angelo Lucia is the Chester H. Kirk Professor of Chemical Engineering at the University of Rhode Island, a position he has held for the last 25 years. His main interests are in the area of computational thermodynamics, subsurface flow processes and more recently metabolic pathway analysis. He has over 100 publications in archival journals, 200presentations, has received considerable funding from the National Science Foundation, Department of Energy, Petroleum Research Fund and many other organizations, and has been the recipient of the outstanding university researcher at two separate universities.

Using the Synergy Between Lipid-rich and Protein Rich Biomass to Enhance Economic Viability of Biofuel Production

Farideh Pahlavan, **Amirul Islam**, **Rajib and Elham Fini***
Arizona State University, Tempe, AZ

Abstract

To enhance economic viability of biofuel production and to enhance biomass value chain, this seminar will introduce the concept of applying chemically balanced feedstocks informed by computational modeling and laboratory experiments. This in turn leads to creation of a multi-product platform utilizing material by design approach. To better elucidate the abovementioned concept, we will examine the merits of co-liquefying a balanced feedstock of high-protein algae with high-lipid swine manure to form a bio-oil. The latter bio-oil has a high concentration of nitrogen-containing fused aromatics to intercalate into oxidized asphaltene nanoaggregates. Such bio-oil named as Swilgae bio-rejuvenator is an effective rejuvenator for aged asphalt. To do so, several combinations of high-protein algae and high-lipid swine manure were used to develop bio-rejuvenators having different concentrations of alkane chains, nitrogen-containing functional groups, and fused aromatics in order to determine the balanced feedstock. The mentioned structural features have vital roles in both parts of rejuvenation; deagglomeration and dispersion. The study results showed that although all the algae-manure combinations are effective rejuvenators, the one obtained by liquefaction of a feedstock containing a 4:1 ratio of algae and swine manure is the most efficient combination studied. We called this bio-rejuvenator “Swilgae” through the paper. A combination of computational and laboratory experiments is employed to evaluate the rejuvenation capability of the co-liquefied bio-oil to deagglomerate the oxidized asphaltene assembles found in aged bitumen. Our computational analysis showed that molecules present in the Swilgae bio-rejuvenator have a potential at weakening the π-π interactions within asphaltene stacks and decreasing the size of oxidized asphaltene nano-aggregates. In addition, they have a peptizing effect on oxidized asphaltene molecules and are capable to distribute small asphaltene aggregate through medium. The observed behavior leads to a significant decrease in the radial distribution function of oxidized asphaltene molecules. This is attributed to the latter bio-rejuvenator’s having a balanced combination of molecules that effectively de-agglomerate oxidized asphaltenes while restoring colloidal stability. Accordingly, the co-liquefaction of the two sources led to a bio-rejuvenator with significantly higher efficiency than either of them individually owing to the synergy between lipid-rich swine manure and protein-rich algae.

Keywords: aged bitumen, rejuvenation, oxidized asphaltene, density functional theory (DFT), molecular dynamics simulation, co-liquefaction.

Biography

Dr. Elham Fini is a Professor at Arizona State University, an Invention Ambassador at the American Association for the Advancement of Science, a Fulbright Scholar of Aalborg University of Denmark, a Senior Sustainability Scientist at the Global Institute of Sustainability and Innovation and Director of the Innovation Network for Materials, Methods and Management. Her research focuses on the production, characterization and atomistic modelling of sustainable novel materials for use in construction. In addition to more than 200 scholarly publications and numerous invited talks, her research has been featured by Science Nation, Wired Magazine, and CNBC. She is editor of the ASCE Journal of Materials and Journal of Resources, Conservation & Recycling. She has served as the president of ASCE's North Carolina Northern Branch and a program director of the National Science Foundation. Her achievements have been recognized via multiple awards including an NSF CAREER award, ASEE Gerald Seeley award, BEYA Emerald STEM Innovation award, NC BioTech Research Excellence award and WTS Innovative Transportation Solution award to name a few.

Getting to Zero: Preparing for Deep Decarbonizing

Ripudaman Malhotra, *Malhotra Energy Consultancy, Lake Oswego, OR*

Abstract

Sustainability shares its root with sustenance. Our society is sustained by energy use, which it derives from many sources: oil, coal, natural gas, hydroelectric, nuclear, wind, solar, and biomass. Each year the world consumes an equivalent of 60,000 TWh of primary energy. By the middle ofthis century, the energy demand will increase to over 110,000 TWh. More than 80% of the energy is currently derived from fossil fuels: oil, coal, and natural gas, which entails emitting carbon dioxide and the attendant climate change. This presentation will focus on how we can drastically reduce global emissions to avert the catastrophic effects of climate change. We will begin by estimating energy needs for the future and considering a scenario in which nearly all energy services are obtained by electricity. Much emphasis has been placed in recent years on resources like wind and solar to provide clean electricity. Proponents of these renewable resources point to technological advances that have led to dramatic reductions in their costs and propose a future powered entirely by them. However, these costs do not include the cost of storage, currently provided by natural gas, nor do they consider the environmental cost of mining for the materials needed for their installation. Scaling to a 100%renewables scenario will strain the global supply of commodities like steel, concrete, glass, and aluminum; clearly not a sustainable scenario. Sustainability demands a scalable source of clean and cheap electricity. Nuclear power can deliver that. It has the smallest environmental footprint and the best safety record but first public opposition to nuclear power must be overcome. I will address the concerns typically voiced in opposing nuclear power such plant safety, longterm storage of waste, fuel supply, and cost. Getting the public to embrace nuclear power is a Herculean task, but it must be undertaken. We have to (i) educate the public (ii) stop closing functional nuclear power plants; (iii) expand the fleet of nuclear power plants; and (iv) develop and deploy the next generation of walk-away safe plants that can also use the spent fuel as a resource.

Biography

Ripudaman Malhotra, PhD, is an organic chemist, and during his 36yeartenure at SRI worked extensively on the chemistry of processing fossil fuels. In 2005 he joined Hew Crane and Ed

Kinderman to coauthor "A Cubic Mile of Oil: The Looming Energy Crisis and Options for Averting It," which was published by the Oxford University press in 2010. Among his technical works are over 100 papers in archival literature. He is a section editor of Encyclopedia of Sustainable Science and Technology. In 2005 he was named an SRI Fellow, in 2015 he was awarded the Storch Award for Fuel Sciences by the Energy and Fuel Division of the American Chemical Society (ACS), in 2018 he was named an ACS Fellow, and in 2019 he was inducted into the SRI Hall of Fame.

Shale Gas Production, Underground Longwall Coal Mining, and Miner Safety and Health Implication

Daniel. W.H. Su, *CDC/NIOSH/PMRD/MSSB, Pittsburgh, PA*

Abstract

This presentation summarizes the results of a unique study conducted by the National Institute for Occupational Safety and Health (NIOSH) from 2016 to 2020 to evaluate the effects of longwall-induced subsurface deformations and permeability changes on shale gas well casing integrity and underground miner safety and health. At both deep-cover and shallow-cover instrumentation sites, surface subsidence measurements, subsurface in-place inclinometer measurements, and underground pillar pressure measurements were conducted as both longwall panels mined by. Subsurface permeability measurements within the abutment pillar were also conducted at the shallow cover instrumentation site. Results from the deep cover and shallow cover instrumentation sites are compared to the results from a similar previous study under medium cover, which clearly indicate that under shallow and medium covers, the measured horizontal displacements within the abutment pillar are at least one order of magnitude higher than those measured under deep cover. However, FLAC3D simulations of the casings indicate that, in all three cases, the P-110 production casings remain intact under longwall-induced deformations, which has serious implications for future mine design in areas where shale gas wells have been drilled ahead of mining.

Biography

Dr. Daniel Su received his Ph.D. Degree in Mining Engineering from West Virginia University in 1982. Upon graduation, he was employed as an assistant professor in the Mining Engineering Department of West Virginia University. In 1985, he joined CONSOL Energy Research and Development as a Research Engineer, and eventually became Manager of Geo-mechanical Engineering. Over his 30-year career with CONSOL Energy, Daniel has conducted numerous application-oriented coal mine ground control research as well as gas well stability research. In May 2015, Daniel retired from CONSOL Energy and Joined the Pittsburgh Mining Research Division of NIOSH in August 2015 as a Senior Service Fellow.

100% Renewable Energy

Andrew Blakers, **Matthew Stocks**, **Bin Lu** and **Cheng Cheng**

Australian National University, Australia

Abstract

Solar PV and wind comprehensively won the global energy race. They account for two thirds of global net annual capacity additions, with coal, gas, nuclear, hydro and other technologies accounting for the remaining one third (https://ieeexplore.ieee.org/document/8836526). China, USA, the EU, the UK, Japan, Korea and many other countries have committed (or are likely to commit) to zero emissions in 2050-60. This necessarily entails growth in solar deployment from 0.1

Terawatts of new capacity per year to 3 TWh per year by 2030, worth trillions of dollars per year. Australia is a global renewable energy pathfinder. Data from the International Renewable Energy Agency show that Australia is deploying new renewables 10 times faster per capita than the global average and 4 times faster per capita than in Europe, China, Japan or the USA. In Australia, the economic advantage of PV and wind over fossil fuels is compelling. Solar PV and wind are 99% of new generation capacity (6-7 Gigawatts per year of wind, rooftop solar and utility solar for a population of 25 million). Australia is tracking towards 50% PV/wind electricity in 2026, and the state of South Australia is already at 60% PV/wind. This is causing Greenhouse emissions to fall. Multi-Gigawatt-scale new transmission, demand management, utility batteries and pumped hydro is being deployed in support of PV and wind. ANU published a global atlas of 616,000 off-river pumped hydro sites with combined storage of 23 million Gigawatt-hours (http://re100.eng.anu.edu.au/global/index.php), which is 100 times more than needed to support 100% renewables. Together with batteries this solves the storage problem for renewables.

Biography

Dr. Andrew Blakers is Professor of Engineering at the Australian National University where he founded a solar PV research group. In the 1980s and 1990s he was responsible for the design and fabrication of silicon solar cells with world record efficiencies. He was co-inventor of the PERC silicon solar cell which has 70% of the global solar market, cumulative module sales of US$50 billion and is mitigating 0.5% of global Greenhouse gas emissions through displacement of coal. Prof Blakers also engages in analysis of energy systems with 50-100% penetration by wind and photovoltaics with support from pumped hydro energy storage.

SESSION I

Distributed Hybrid Energy Storage Systems, the Nanogrid for Home Application (NGfH) to Provide Network Ancillary Services

Anna Pinnarelli*, **Daniele Menniti**, **Nicola Sorrentino**, **Giuseppe Barone**, **Giovanni Brusco**, **Pasquale Vizza** and **Gaetano Polizzi**
University of Calabria Arcavacata of Rende – Cosenza, Italy

Abstract
Generation from synchronous machines power system is decreasing as variable renewable energy penetration increases. In the future there will be more wind, solar and small-scale hydropower and the existing condensing power plants may be rarely connected to the network. In addition, an increased number of HVDC links will increase import and export capacity. Also, the consumption characteristics will change, and rotating motors are more often connected to the grid through frequency converters. All these changes will have an impact on the system frequency and dynamic stability. As well known in literature, the energy storage systems act in a way to soften the unbalance between the supply and demand of power in microgrid contest. Using battery and ultra/supercapacitors has been demonstrated successfully on grids such as in island networks to provide ancillary services. A new design framework using hybrid energy storage systems (battery and Supercapacitor (SC)) is proposed in literature.

In this framework, the nanogrid for home application (NGfH) find application, equipped with opportune control strategy based on DBS. The NGfH is a hybrid power supply system with a nominal power not exceeding 5 kW, which interconnects generation and PV systems and combines heat and power with Stirling engine or natural gas micro-turbines, fuel cells, energy storage systems (ESSs) and loads on a common DC bus.

Operating in grid-connected or in stand-alone mode, it is capable of simultaneously managing several types of generation sources and different storage system technologies, as well as the exchange of power flows with the electrical grid to provide ancillary services.

Biography
Dr. Anna Pinnarelli is Assistant Professor at the DIMEG of University of Calabria, Italy from 2007. The field of her expertise are in FACTS technology, harmonic analysis, electrical system automation and decentralized control, electrical power systems control and management, smart grid, microgrid, nanogrid technologies and demand response, market model and aggregator framework for energy district. She is co-authored over 100-refereed International conference and journal publications and hold a national patent. She is one of founders of a spin-off company working in the field of renewable energy sources. She is reviewer for several international journal and lead/guest editor of several special issue.

Thermal Conductivity of Water Ih-ice Measured with Transient Hot-Wires of Different Lengths

Brian Reding* and **Mohamed Khayet**, *Universidad Complutense de Madrid, Spain*

Abstract

Presented in this paper is an investigation on the dependence of wire-length with transient hot-wire calorimetry, a technique generally used to measure the thermal conductivity of materials. In particular, the measurement protocol includes the use of a calibration fluid that is designed for wires of reduced lengths; allowing for a reliable application of the transient hot-wire method to materials exhibiting a solid-liquid phase transition within the temperature range studied. Additionally, an experimental study of the onset of convection was conducted, including a comparison between measurements performed in the liquid and solid phase regions. For the purpose of validation, experimental measurements of the thermal conductivity of water Ih-ice at 0.1 MPa are presented, within a temperature range of 259–T266 K, along with that of n-eicosane within the temperature range of 259–348 K, which encompasses its melting point.

Biography

Dr. Brian Reding was a senior researcher and Marie Skłodowska-Curie Fellow, and an Associated Professor in the Faculty of Physics, Department of Material Structure, Thermal Physics, Electronics Membranes and Renewable Energies Research Group at the Universidad Complutense de Madrid in Madrid, Spain. He received his Bachelor of Science in Mechanical Engineering from the University of Miami in 2006 and his Doctor of Philosophy in Mechanical Engineering from Florida International University in 2013. He was awarded the Marie Skłodowska-Curie Fellowship in 2017 to study Using Phase Change Materials for the Base Suspension in the Creation of NanoFluids (PCMNano).

INL's Approach to Integrated Energy Systems

Anne M. Gaffney, *Idaho National Laboratory, United States*

Abstract

The traditional energy supply chain uses multiple, primarily centralized, generation sources to deliver electrons to the grid. While this supply chain is becoming more distributed with the increased deployment of smaller capacity renewable generation sources and natural gas-fired peaking plants, this supply chain still focuses primarily on the delivery of electrons. IES are cooperatively controlled systems that dynamically apportion energy in various forms (e.g., thermal and electrical) to provide responsive generation to the electricity grid while also supporting the production of other energy products. IES are comprised of multiple subsystems, which may or may not be geographically co-located.

INL has demonstrated a unique ability to model and evaluate IES that incorporate flexible generation and demand portfolios. INL is the benchmark for how advanced nuclear energy can provide alternative products and at what cost. The laboratory houses one-of-a-kind facilities in its Energy Systems Laboratory (ESL), where integrated resources support electrical and non-electrical networks and the logistics of energy delivery. In addition, integrated power and energy system R&D capabilities within INL allow researchers to study how energy could be stored and transmitted across vast distances to address grid disruptions and demand imbalances. These capabilities are essential to the future development and deployment of next-generation microreactors and other energy solutions.

Biography

Dr. Anne M. Gaffney is the Chief Science Officer of Idaho National Laboratory and Distinguished National Lab Fellow (2014 – present). She has thirty-four years of experience working in industry inventing and commercializing new technologies for major chemical manufacturing companies including Koch Industries, Lummus Technology, Dow, Dupont and ARCO Chemical Company. She has authored 134 publications and 255 patents. Dr. Gaffney is also a distinguished Joint

Appointment Fellow at the University of South Carolina (2018 – present) where she is the Technical Director of the National Science Foundation Center for Rational Catalyst Synthesis. Some of her recent awards include: the 2019 American Chemical Society, Energy & Fuels, Distinguished Researcher Award in Petroleum Chemistry; the 2015 Eugene J. Houdry Award of the North American Catalysis Society; the Chemical Heritage Foundation, Women in Science Inductee, 2014; and the American Chemical Society, Industrial Chemistry Award, 2013. Dr. Gaffney received her BA in chemistry and mathematics from Mount Holyoke College and her Ph.D. in physical organic chemistry from University of Delaware.

Smart Bio-Inspired Wind Turbine Blade for High Efficiency Wind Energy Utilization

Xiong (Bill) Yu and **Jiale Li**, *Case Western Reserve University, Cleveland, OH, USA*

Abstract

Wind turbine blades have been designed to achieve high efficiency energy conversion. The further refinement are toward the multifunctional goal of high production, longer service life, and environmental friendliness. Biological systems are unique in terms of strategies for these purpose and serve as great source of inspiration. This paper describes a few blade design strategies inspired from the natural system in the lift improvements, drag reduction, noise mitigation and stress mitigation. Examples of design and performance using such inspired concepts in blade design are demonstrated.

Biography

Dr. Xiong (Bill) Yu is the Frank H. Neff professor of Civil Engineering, Case Western Reserve University. His research emphasizes the use of interdisciplinary approaches to address the engineering problems in geosystem, energy, and civil infrastructure. His research activities include multiscale and multiphysics processes in geomaterials, smart sensors and materials, intelligent infrastructure and systems, bio-inspired engineering. He isT the PI of over 40 research projects funded by federal, state agencies and private industry. He is a recipient of a NSF CAREER award in 2009. He has published around 300 papers in journals and referred conference proceedings, a number of which received awards and recognitions.

A Decentralized Energy Management Platform for High Smart Building Penetrated Distribution Systems

Meisam Ansari1*, Kate Kauffman2 and Hala Ballouz3

[1]*Southern Illinois University of Carbondale (SIUC), USA*

[2]*Univeristy of Texas, USA*

[3]*Electric Power Engineering Company, USA*

Abstract

Although the growth of smart buildings can increase the flexibility of a distribution system, without an intelligent control strategy, it can harm the system more than help it. In this paper, a decentralized energy management system (DEMS) is proposed to manage a distribution system penetrated by massive smart buildings for day-ahead operation. The management strategy is decentralized, with a central EMS (CEMS) bi-directionally in contact with several local EMSs (LEMSs). Each LEMS can control loads in a smart building with a large number of electric vehicles (EVs), rooftop photovoltaic systems (RPVs), and non-firm loads (NFLs). The main idea is for all LEMSs to schedule the day-ahead operation for their corresponding SB according to grid price.

Then the CEMS aggregates the submitted demands by LEMSs and solves an unbalanced optimal power flow to obtain the needed demand response (DR) for the next 24 hours. After receiving the DR vectors, including time and needed power reduction, each LEMS re-dispatches the building's local NFLs to prepare the proper response to the CEMS signal. The proposed framework is implemented in the modified unbalanced IEEE 123-bus test system with 50 SBs, 200 EVs, 2500 kW RPVs, 800 kW NFLs. The results show that the proposed DEMS can manage the operation cost properly. All technical constraints are considered thoroughly, and the average electricity cost for 24 hours was shown to decrease by 10%. Investigating the DEMS against deep load variation shows that the current framework can also dampen the impact of big step loads.

Biography
Meisam Ansari (S'19) is currently working toward the Ph.D. degree in the School of Electrical, Computer, and Biomedical Engineering, Southern Illinois University Carbondale, IL, USA. His primary research interest is modern power/distribution systems operation and planning.

HHeavy-Atom-Free Photon Upconversion using Thiosquaraine Systems

Cody W. Schlenker* and Sarah R. Pristash
University of Washington, Seattle, WA, USA

Abstract
Photon upconversion through triplet–triplet annihilation is of interest for diverse applications, notably as a potential means of exceeding the Shockley–Queisser limits in solar cells. We demonstrate a heavyatom-free triplet sensitizer based on a thionated squaraine. Using this all-organic sensitizer, we demonstrate upconversion through triplet sensitization of several organic annihilator molecules. Thionated squaraines provide an exciting new platform for developing heavy-atom-free upconversion systems.

Biography
Schlenker received his B.S. (Chemistry 2004) from Linfield College. He then earning his Ph.D. (Chemistry 2010) studying organic optoelectronics with Mark Thompson (USC). As an NSF SEES Fellow, Schlenker worked with David Ginger (UW), studying photophysics of semiconducting polymers. In 2014, Schlenker joined the UW Chemistry Faculty. His research focuses on energy conversion and storage in rechargeable batteries, photocatalysts, photovoltaics, and photon upconversion. He has been recognized with honors, including as an NSF CAREER Awardee, J. Am. Chem. Soc. Young Investigator, ACS Adv. Energy Mater. Young Investigator, Washington Research Foundation Innovation Assistant Professor, and Bernard and Claudine Nist Faculty Fellow.

Integrating Photovoltaics to Thermal Engineering Lab

Igor Tyukhov*, **Nicole Okamoto**, **Jesus Sanchez** and **Samuel Semahegn**
San Jose State University, CA, USA

Abstract
The transition to a new technological energy structures implies a qualitative redesigning of society and the economy. In order to keep pace with the rapidly changing world, the field of education requires inevitable revision. The novelty of the philosophy of education lies in the understanding that this sphere has ceased to be a conservative area of human activity. The next decades will be an era of radical changes in education: it will not even change the educational system itself, but the industries adjacent to it, coming with a change in the technological structure. California has approved a measure requiring all energy used in the sunshine state to be from renewable sources by 2045.

Crucial ME 115 Thermal Engineering Lab at Mechanical Engineering Departments in SJSU offers to students classical energy conversion technologies gaining practical knowledge on equipment which currently used by industry. Designing new labs will be a good respond for transition power energy engineering to clean green energy technologies. The four lab stations were created to teach students solar energy. Two labs are devoted to study fundamentals of photovoltaic conversion using real size solar cells (SC) and give opportunity to understand principles of creating modules and to do many experiments with SC. Other two lab stations with solar modules and balance of system allow to study principles of autonomous solar energy systems. The newest variety of components are used to simulate of different real power generation systems. This project will give to students one more direction for future activity.

Biography

Dr. Igor I. Tyukhov completed PhD from Moscow Power Engineering Institute (National Research University). More than 35 years teaching various physics disciplines (from general to solid state physics, photovoltaics, semiconductor lasers) and conducting research work on solar energy, solar concentrators, optical metrology, semiconductor physics and technology, renewable energy, solar cells, MPEI since 1975-2002. Deputy Chair Holder of the UNESCO "Renewable Energy and Rural Electrification" at the All-Russian Research Institute for Electrification of Agriculture, 1997-2017. From 2018 Adjunct Prof. of San Jose State University, Charles W. Davidson College of Engineering. He is the author of more than 300 papers, reports, patents (RF), book chapters and monograph.

3D Seismic, a KEY Tool for Design & Derisking of Dual Geothermal Boreholes in Stratified Aquifers and in Fractured Aquifers along Regional Faults

Y. Drouiller[1*], F. Hanot[2], E. Gillot[3], J-C. Ferran[3], L. Michel[3] and Bertrand SIX[3]
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[2]*CDP-Consulting, France*
[3]*CGG, France*

Abstract

The use of existing geological and structural maps, previous 2D seismic profiles, boreholes and correlation models between these data is sufficient to understand basin structure and thermal systems at a regional scale. However, this is not sufficient at a scale of a geothermal site to be sure of the hydraulic connectivity (or of the presence of a permeability barrier) between two boreholes 1.5 or 2 km apart.

To ensure that there is enough hydraulic connectivity, it is necessary to understand the controls on the network of fractures which affects the aquifer (fracture permeability) and the physical properties of the rock, namely the porosity and clay content in order to obtain a matrix permeability.

The latest generation of broadband (6 octaves) 3D seismic reflection will provide the following information:

- The similarity attribute will give an accurate structural map of the fault network at the seismic resolution and, in many cases, at a higher resolution than seismic.
- Seismic velocity anisotropy analysis techniques will make it possible to visualize a 3D volume of information on the fracture network.
- impedance inversion or petrophysical inversion techniques will predict the porosity throughout the whole volume of the aquifer from a porosity log recorded in a pilot-hole. It allows a real 3D mapping of predicted porosity inside the aquifer much more reliably than from modelling alone.

These seismic techniques were initially developed for petroleum exploration & development. They have rapidly progressed throughout the last decade, both in acquisition, processing and interpretation with new methodologies and high-performance softwares. They are efficient for modelling reservoirs to be produced.

And, consequently, they can be used for geothermal applications as a key tool to design dual deviated drillings with horizontal drains in carbonates and clastic reservoirs - not only for new projects, but also to revisit old ones to improve their performance or develop another reservoir. Broadband 3D seismic will secure the exploration of stratified aquifers as Triassic sandstones for deep geothermal projects. Other prospects are faulted aquifers as regional faults which overlap the substratum. Inside faulted zones, hydrothermal circulations arriving by convection at the top of granitic basement could be geothermal objectives, as in the Alsace Upper Rhine Graben. A production pilot site is suggested to test superimposed aquifers and a regional fault and, at the same time, two different architectures of boreholes doublets: horizontal drains for stratified aquifers and deviated wells for crossing a regional fault. The geothermal site could be instrumented and used as an experiment with a small addition of measurements and sensors. The objective of this experiment would be to determine the transit time, the heating time of the re-injected water and the circulation speed to define the optimal direction, spacing and length of drains, and to realize the thermal modelling of the site for different options of production.

At last, an unique 3D seismic dataset could allow to exploit several superimposed aquifers: stratified reservoirs and fractured aquifers along a regional fault affecting the granitic basement.

Keywords: 3D Seismic, geothermal borehole, design, derisking, stratified aquifer, fractured aquifer.

Biography

Bertrand is currently working as regional technical manager in the Reservoir Characterization group of CGG in Houston, developing new workflow using Machine Learning, Rock Physics and Petrophysics in both conventional and unconventional. He has held various positions for CGG in the last 10 years in Europe, the Middle East and North America. He worked on various integrated projects from exploration in the Berkine Basin, Algeria to 4D reservoir monitoring studies in the Middle East and West Africa (Removable and PRM systems). During his 6 years in the ME, he worked closely with processors to develop integrated workflow to improve PSDM imaging using petrophysics, rock physics and regional geology as well as detailed seismic attributes interpretation for strike slip fault identification in carbonate reservoirs. He holds a M.Sc. in Geology from LaSalle Institute, France and a M.Sc. in Petroleum Geoscience from Imperial College London.

Life Cycle Assessment of a Solar Still for Community Scale Desalination

Sai Kiran Hota*, **Marie-Odile Fortier** and **Gerardo Diaz**
University of California Merced, CA, USA

Abstract

Solar still is a renewable desalination technology that can be adopted as a stand-alone system for producing community scale freshwater (<100 m3/day) in less inter-connected remote, rural areas at lower costs compared to other technologies. While the process of desalination by a solar still is emission free, the raw material extraction, manufacturing, transportation, installation, and decommissioning processes involved along the life cycle of a solar still have some associated environmental emissions. The environmental carbon credits presented in the literature, typically, only consider the embodied energy of the materials, but it is important to measure the life cycle emissions of the overall system. A life cycle assessment (LCA) is carried out on a low-cost solar still for producing freshwater distillate in the state of California. The chosen materials are water resistant, durable, and locally available at low costs. We hypothesize that the solar still will have relatively low life cycle climate change impact compared to other means of freshwater provisions. A system area of 10,000 m2 is considered to produce freshwater for almost 400-500 households, and the impacts are calculated with a functional unit of 1 m3 of water desalinated. The distillate productivity is computed mathematically by considering hourly spaced real time solar irradiance, ambient temperature, and wind speed data within the LCA model. Cradle-to-grave methodology is adopted and the LCA is performed with life cycle inventories characterized by EPA TRACI from databases in SimaPro software.

Biography

Sai Kiran Hota is a Ph.D. candidate in the department of Mechanical Engineering at UC Merced. Dr Marie-Odile Fortier is an Assistant Professor in Civil and Environmental Engineering at UC Merced and an expert on geospatial life cycle assessment of energy systems.

Modelling Household Solar Adoption in Australia

Glen Thomas Currie, *University of Melbourne, Australia*

Abstract

Australia has seen the highest penetration of household solar in the world. Averaging across states over 25% of houses, and in streets nearing 100%. This generates peaks of electricity that destabilizes electricity systems, and overloads distribution assets. We can solve this by reinforcing distribution assets, but the cost of these upgrades has moved Australia from some of the lowest cost electricity, to some of the highest cost electricity in the world.

Ten years of Australian solar adoption on 2 million households was compared to 36 socio-economic drivers via an ARIMA model. The resulting model gave high accuracy for the past, but only a few months predictive power. The parameters that gave the most power were price, subsidy, economic confidence and the previous month of solar installation. Interesting conclusions were the 8-month delay between policy change and household installation, and the 4 month delay between solar equipment price change and household installation. This may apply to electric vehicle or home storage market dynamics and is a rich field for further research.

Biography

Glen Thomas Currie is a business manager and teacher with experience in 44 countries. A Fellow of the Australian Institute of Energy and active in the energy industry from electricity generation to retail including commercialization of new technologies. At Caterpillar, Glen was a Senior Consultant globally then he managed the business for CSIRO Energy and became passionate about the energy transition. Next, started up solar and energy technology businesses and recent PhD in Consumer Roles in the Future Electricity System. His PhD has been under the supervision of leading Professors Colin Duffield, Robin Evans and Iven Mareels.

Renewable Space Cooling Under Hot-humid Climate: Performance Study of a Building-integrated Earth-air Heat Exchanger System Applying Shallow Groundwater Energy

Li-Hao Yang[1], **Jiun-Wei Hu**[1*], **Yuan-Ching Chiang**[2] and **Sih-Li Chen**[1]
[1]*National Taiwan University, Taiwan*
[2]*Chinese Culture University, Taiwan*

Abstract

The effect of groundwater energy on renewable space cooling under the hot-humid climate has been scarcely studied. In the present study, shallow groundwater was pumped to the building foundation as the heat sink of a foundation-integrated water-based earth-air heat exchanger (FIWEAHE) system. With the retrofitting circulating water system, the FIWEAHE system has better cooling performance than a conventional soil-based EAHE system. Moreover, the retrofitted FIWEAHE system has significantly less power consumption and lower greenhouse gas emission compared to the traditional air conditioning system. The experimental and numerical studies were performed to examine the air conditioning performance of the FIWEAHE system. The simulated outlet air properties were validated with the experimental data in summer 2018. The experimental results show that the retrofitted FIWEAHE system has an average cooling potential of 4.84 kW, a mean dehumidification rate of 4.24 kg/h, and an average system COP of 10.5. The simulation results indicate that with the airflow velocity of 1.6 m/s, the fresh air passing through the immersed pipes had an average temperature drop of 7.4°C and a mean humidity drop of 0.006 kg/kg. Our conclusion points out that the retrofitted FIWEAHE system can provide comfortable air temperature ranging from 24-26°C in summer without auxiliary air conditioning equipment.

Biography

Jiun-Wei Hu completed his M.S. in mechanical engineering with a concentration in thermal and fluid science at National Taiwan University in 2015. Since 2015, his main research interests are on the application of renewable thermal energy systems, thermal-fluid science, and energy technology. During 2017-2019, he investigated thermal module and ventilation design for laptops as a thermal & aerodynamic engineer at ASUSTek Computer Inc. His academic memberships include the Geothermal Resources Council (GRC) and the International Geothermal Association (IGA). Currently, he is applying for a Ph.D. program focusing on the development of renewable thermal energy.

SESSION II

Development of Hybrid Heterogeneous Catalysts for Conversion of used Cooking Oil (UCO) to Biodiesel via Transesterification

Norzita Ngadi and Nurul Saadiah Lani, *Universiti Teknologi Malaysia, Malaysia*

Abstract

Biodiesel is typically produced through the chemical reaction between triglycerides in feedstock oil and methanol in the presence of catalyst, namely transesterification reaction. Recently, heterogeneous catalytic transesterification has emerged as an innovative and sustainable process to produce biodiesel. This is due to the to various restrictions associated with the application of homogeneous catalyst including separating difficulty and environmental pollution. Among all different types of heterogeneous catalyst, supported CaO catalyst have been reviewed as a promising catalyst in many papers due its high catalytic activity under mild condition. The utilization of natural sources, especially from waste materials to produce CaO is another factor that makes it highly advantageous compared to other catalysts. This approach has been created a way to more sustainable and ecologically friendly process in addition to reducing the capital cost of biodiesel production. In this study, CaO was synthesized from waste chicken eggshell by calcining at 900 °C for 3 hours and then impregnated with zeolite. The obtained catalyst was characterized using Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) analysis. Subsequently, their performance as catalyst was tested by carrying out the transesterification reaction of used cooking oil (UCO). A focus of this paper is to determine the optimum reaction conditions and evaluate their effect on the yield of biodiesel. The FTIR and XRD results of the supported catalyst confirmed the presence of both CaO and zeolite components. The optimum conditions, which gave biodiesel yield of 86.82%, were recorded to be a 3 wt% catalyst concentration, 15:1 methanol to oil molar ratio, 65 °C reaction temperature and 1 hour reaction time.

Biography

Dr. Norzita Ngadi is an Associate Professor in School of Chemical and Energy Engineering, Faculty of Engineering, Universti Teknologi Malaysia (UTM), where she has been a faculty member since 1999. She received her Ph.D. degree from University of Canterbury, New Zealand in 2010. She obtained her M.Eng in Chemical Engineering from UTM in 2002, after completion of her undergraduate study in Universiti Sains Malaysia. Her research interest includes wastewater treatment, catalytic reaction, renewable fuel, surface coating and protein fouling. She has published over 190 articles in journals and conference papers.

Renewable Energy Technology Implementation in Rural India: A Study with Special Emphasis to North East India

Plaban Bora*, Debdeep saha, Tonmoi Hazarika
Assam Science and Technology University, Assam, India

Abstract

This study primarily discusses the prospects of various renewable energy technologies in North East India. Rural population of this North Eastern Region (NER) constitutes 81.64% of the total population of the region and, therefore, the current investigation focuses mainly on rural areas of the region. The energy consumption pattern has been investigated for a village located in Biswanath district of Assam, which comprises of populations from different income groups. The total electrical energy consumptions for the households with different income groups are separately assessed. Business establishments and farms present in the locality were also considered for this study. The electrical energy consumptions in the village for winter and summer seasons per day were estimated to be as 1197.432 KW and 1050.125 KW, respectively. Occupant's energy use behavior was tried to understand on the basis of visual inspection and analysis of the variant of electric load usage which cater to life style and habits. Recommendations along with energy saving steps in the locality through implementation of renewable based technologies are proposed. Moreover, this study focuses on understanding the household level energy consumption pattern related to cooking activities. The study highlights the potential of biogas for using in cooking applications in the village households as an alternative to liquefied petroleum gas (LPG) and firewood. The current investigation also suggests that installation of community biogas plant may be an attractive option from the point of energy conservation and rural income generation.

Biography

Dr. Plaban Bora [PhD (Energy), M.Tech (Energy Tech), BE (Ch.E), LMIIChE, MIEI] is currently working as an Assistant Professor & His research interests include renewable energy technologies, bioenergy & biofuels. He has number of publications in international journals on energy. He was the editor of the books Current Trends in Renewable and Alternate Energy & Emerging Renewable Energy Technologies. He is also a reviewer of many energy and chemical engineering related international journals from Elsevier and Taylor & Francis Publications. He is currently an editor of two journals.

Reforming-Controlled Compression Ignition - a Novel Concept for Internal Combustion Engines

Amnon Eyal* and **Leonid Tartakovsky**, *Technion – Israel Institute of Technology, Israel*

Abstract

There is agreement among experts that the internal combustion engine (ICE) will remain a leading transportation propulsion tool for the foreseeable future. However, to be competitive, ICEs must significantly improve their energy efficiency, mitigate emissions, and use diverse low carbon-intensity renewable fuels. The Reforming-Controlled Compression Ignition (RefCCI) method enables all those requirements by combining the benefits of the high-pressure thermochemical recuperation and the advanced combustion concept, the Reactivity-Controlled Compression Ignition. According to the RefCCI method, a part of the primary fuel is reformed in a catalytic reactor to create a hydrogen-rich reformate. Both, the non-reformed high-reactivity primary fuel and the low-reactivity gaseous reformate are injected directly into the cylinder in a controllably varied ratio. Varying the ratio between the injected hydrogen-rich reformate and the primary fuel can solve the controllability issues of compression auto-ignition (CAI) engines. This work discusses this novel RefCCI approach and analyses it primarily from the second-law point of view. New insights on ways of improving RefCCI system efficiency are provided. A promising renewable fuel dimethyl ether is analyzed as the primary RefCCI fuel. A comprehensive analysis of various factors influencing exergy destruction in the RefCCI system in their complex interdependence is performed, as well. Exergy mapping results show that approximately 33% of the exergy supplied to the system is destroyed owing to irreversible processes in the cylinder itself, and approximately 5% is destroyed in the reforming system. The analysis results show that the RefCCI system efficiency improvement due to second-law optimization exceeds 7%.

Biography

Amnon Eyal had acquired his BSc in Mechanical Engineering at the Ben-Gurion University in the Negev, in 2013. He received an ME degree from the Technion – Israel Institute of Technology in 2016. Currently, Amnon is a Ph.D. candidate at the Faculty of Mechanical Engineering at the Technion – Israel Institute of Technology and is expected to graduate soon. His research interests lie in the fields of advanced combustion, renewable fuels, onboard hydrogen production through thermochemical recuperation, and its application in internal combustion engines.

Geomechanical Characterization of CO2 Storage Sites: A Case Study from a nearly Depleted Gas Field in the Bredasdorp Basin, South Africa

Eric Saffou, *University of the Western Cape, South Africa*

Abstract

Geomechanical analysis and integrity assessment of hydrocarbon reservoirs upon depletion and injection are crucial to ensure that CO2 storage projects can be safely implemented. The Bredasdorp basin in South Africa has great potential for CO2 storage, given its hugely available exploration data. However, there has not been any geomechanical characterization carried out on this basin to determine its integrity issues. The aim of this study is to provide a guideline as to how geomechanical analysis of depleted fields can be done for a safe CO2 sequestration practice. The results obtained from the geomechanical model constructed for the depth of 2570 m indicated that the magnitude of the principal vertical, minimum, and maximum horizontal stresses in the field are respectively 57 MPa, 41 MPa, and 42-46 MPa, indicating the presence of a normal faulting regime in the caprock and the reservoir. However, according to the pore pressure-stress coupling assessment, this normal faulting is much severe in compartment C3 of the reservoir. Fault reactivation and fracture stability were also investigated after depletion, and it was found that faults in the compartments C1 and C2 are stable after depletion. However, normal faults (FNS8 and FNS9) in compartment C3 dipping SW were critically stressed and maybe reactivated without proper injection planning. Fractures in compartment C3 were also critically stressed, highlighting a great potential of leakage from this compartment upon injection. It was also revealed that the sustainable maximum fluid pressure of 25 MPa would not induce any fractures in the reservoir during CO2 storage.

Fuel-Oil-to-Gas Conversion in Industrial-Size Boilers Driven by Computational Fluid Dynamics

Antonio Gómez1, Carlos Montañés1, Miguel Cámara1 and Norberto Fueyo2
[1]*Nabladot, S.L., Spain*
[2]*University of Zaragoza*

Abstract

This work presents the application of an innovative and comprehensive model of the boiler. This numerical approach combines a Reduced Order Model of the Air Distribution System with a CFD model that solves, in the same computational domain, not only the combustion and radiant furnace heat transfer but also the heat transfer in the convective pass (approximately 10,000 pipes), providing results of the boilers performance for the flue gas and steam.

This approach is well adapted to the challenges existing in the replacement of the fuel in a boiler, in this case from fuel-oil to natural gas. One of the main impacts of replacing oil by gas is the different heat distribution. The emissivity of natural gas firing flame is lower than that for oil. Therefore, the heat transfer in the furnace (water wall) will decrease, causing an increase of the furnace exit gas temperature and a reduction of the steam mass flow generated. The lower steam mass flow produced and the higher temperature of the flue gas will increase the exit temperature of the superheated and reheated steam. To avoid these adverse effects, changes in the burner design and operation, air distribution, steam mass flow operation (e.g. attemperator performance) and, even, the radiant/convective heat exchangers must be carried out. In this work, using the

numerical approach developed, we analyze and quantify the differences in a boiler performance employing fuel-oil and natural gas. And, finally, we propose the changes needed to achieve a successful conversion from fuel-oil to natural gas.

Biography

Antonio Gómez is a founding partner and R&D manager of Nabladot, S.L., a Spanish reference company in the application of CFD techniques to the energy, industrial and civil sector. Its innovative models applied to the combustion and heat transfer makes Nabladot, S.L. the Spanish leader company in this sector (more than 70% of the coal boilers installed in Spain have been modeled by Nabladot). Dr. Antonio Gómez combines his work at Nabladot, S.L. with the adjunct professor position at the University of Zaragoza. Additionally, He has co-authored 17 articles in international journals and 11 papers in international conferences.

Novel Metal-Organic Framework Membranes for Gas Separations

Zhiping Lai, *King Abdullah University of Science and Technology, Saudi Arabia*

Abstract

Gas separations involving CO2, H2, olefin/paraffin, and p-xylene/o-xylene, to name a few, are important processes in the petrochemical industry. Conventional methods such as distillation are energy-intensive. Membrane technology is a promising method that has the potential to save up to 90% of energy in these challenging separation systems. However, the conventional polymeric membranes have suffered from low selectivity and low permeability. Metal-organic frameworks (MOFs) are a new type of ordered porous materials that contain uniform pores on the molecular level. It can function as a molecular sieve to separate gases in high efficiency. We developed a ZIF-8 type of MOF membrane, which showed superior separation performance in the separation of propylene/propane and C2/C3 hydrocarbon mixtures. We improved both the membrane selectivity and permeability by orders of magnitude compared to other types of membranes. In this talk, I will discuss the synthesis methods for preparing high-quality MOF membranes and the engineering aspects in practical applications.

Biography

Zhiping Lai is a professor of Chemical Engineering at King Abdullah University of Science and Technology. He received his B.E. and M.S. from Tsinghua University China and Ph.D. from the University of Massachusetts Amherst. Before joining KAUST, he was a research associate at the University of Minnesota Twin Cities and an Assistant Professor at Nanyang Technological University. His research focuses on developing high-performance membranes out of ordered porous materials and their applications in the separation of hydrocarbon mixtures, seawater desalination, lithium-sulfur batteries, and low-grade heat recovery. He is the SABIC presidential chair from 2013 to 2016 and the 2020 AIChE Industrial Gases Award recipient.

Low-Cost Middle Infrared Sensor for the Characterization of Alcohol and Gasoline Blends

Maldonado Gil M.[1], Barreiro Elorza P[1*], Wang Z[2], Gutiérrez Osuna R.[2] and Vergara Ogando G[3]

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[3]*New Infrared Technologies, Spain*

Abstract

This study is focuses on the use of a MID Infrared low cost and uncooled sensor in gasolines, improved to classify and quantify blends with ethanol, methanol and butanol in percentages

that range from 10 to 30 % of alcohol (most frequently used for blending or adulteration). This application is a prospective for detecting adulteration qualitatively and also to quantify that the additive ratio. The mid infrared spectra of each blended mixture were pre-processed and quantitative predictive analysis applied (via SIMPLS). The method was validated afterwards, using a test set. In addition to the quantitative analysis, a qualitative SIMPLS predictive model was applied to the spectra according to their types of adulterant/additive and the proportions of each one in the mixture. The results obtained from this analysis were not accurate enough to include them in this paper. So on, a new supervised discriminating analysis through MANOVA algorithm was performed first on percentage of chemical as categorical variable. The segregating power of this method was evaluated by measuring the area inside the polygon formed by the four clusters (butanol, ethanol, methanol and pure gasoline). The segregating power was evaluated by the position of the samples in the triangle formed. This algorithm was trained and validated using the same train and test sets than for the SIMPLS. The optimal pre-treatment of spectra was assessed as an important point of the study. Normalization to the maximum absorption peak was the pre treatment used as it gave back the most reproducible results.

Biography

Barreiro Elorza P research interests focus on the development and implementation of smart sensors, mechatronics and robotics in the framework of agricultural mechanization and postharvest technology; an activity that also gathers several active projects on educational innovation. Lately in this area we have incorporated CLIL as a way of improving English engineering lectures, and as a mean for understanding the innovation process: patent analysis and technological surveillance.

From Biogas to Biomethane: Absorption Tests and CO2 Recovery Perspectives

Carla Asquer*, **Emanuela Melis** and **Sardegna Ricerche**
Sardinia Research, Italy

Abstract

Biomethane is a renewable fuel constituted primarily by methane (CH_4) with a huge potential to play a role in the low carbon energy economy. It can be produced from the biogas generated by the anaerobic digestion of organic feedstock. Several technologies allow upgrading biogas into biomethane. The chemical absorption of carbon dioxide (CO_2) in alkaline solutions, such as sodium hydroxide (NaOH), is one of the first major technologies for CO_2 capture. It allows converting biogas into biomethane efficiently, and the captured CO_2 could be recovered for successive uses. However, international quality standards for both the biomethane injection into the gas grid and the use as a vehicle fuel have been released, whose general requirement is the CO_2 concentration in the biomethane below 2.0÷3.0%vol., depending on the considered specifications. Therefore, the absorption process should be considered to comply with these quality standards. This paper focuses on the generation of biomethane via chemical absorption, on the features of its effective employment as a fuel, and on the CO_2 recovery for further applications. To investigate the CO_2 absorption process, a pilot-scale upgrading plant was used where a bubble column reactor was filled with NaOH solutions and synthetic biogas (50%vol CH_4 and 50%vol CO_2) was diffused through a porous sparger. The yield of the CO_2 absorption was calculated. Measurements of pH and the carbon balance were presented. The formation of carbonate species was analyzed to discuss the chemical composition obtained in the reacting solution. Perspectives of recovery the CO_2 absorbed were also provided.

Biography

Carla Asquer is a Public Officer at Sardegna Ricerche, a Regional Government agency promoting research and innovation, I have been working at the Renewable Energy Platform since its foundation in 2010, and I'm actually in charge of the Biomass and Biofuel Laboratory. As an

Environmental Engineer I previously worked in foreign research centers and multinational corporation. During my Ph.D., I deeply studied biomass combustion ash generated by thermal power plants and related recovery options in accordance to the Circular Economy principles, particularly referring to the reuse as an additive for composting of the organic solid waste and as a substrate for CO2 capture.

Colloidal Scale Inhibitor Materials for Oilfield Scale Control: Synthesis and Laboratory Testing

Ping Zhang1* Yuan Liu1, and Mason B2
[1]*University of Macau, Taipa, Macau*
[2] *Rice University, Houston, Texas, USA*

Abstract
Oilfield production chemistry mainly deals with managing unwanted solid precipitation into the production system. Together with material corrosion and gas hydrate blockage, mineral scale deposition is one of the top three water-related oilfield production chemistry threats. Mineral scale is the hard inorganic solid precipitated from the produced water due to change in operating conditions leading to solution oversaturation. The formation and deposition of scale solids can lead to a considerable reduction in pipeline throughput and reservoir formation damage. As an alternative scale control method, colloidal scale inhibitor materials including scale inhibitor nanomaterials have been reported in literature as early asten years ago. These colloidal materials were reported to have a better migration capacity and return behavior compared with conventional inhibitor chemicals. However, the synthesis approaches of these colloidal materials are generally complicated to follow. In this presentation, metal-phosphonate colloidal inhibitor (MPCI) material was prepared in a facile and economical manner. This method is based upon a citrate-assisted approach where a low solubility MPCI material can be fabricated. Both laboratory transport experiments and laboratory squeeze simulation tests suggest that MPCI materials are advantageous over the conventional inhibitor chemicals. Furthermore, magnesium and zirconium based MPCI materials were prepared and tested for their performance in scale control. This study expands our understanding of the colloidal inhibitor materials and promotes the potential field application of such materials for oilfield scale squeeze treatment.

Biography
Dr. Ping Zhang is an assistant professor in Faculty of Science and Technology, University of Macau. He obtained his M.S. and Ph.D. degrees both in Civil and Environmental Engineering from Rice University in Houston, Texas, in 2008 and 2011, respectively. He obtained his professional engineer (P.E.) license in the dual disciplines of Chemical/Environmental Engineering in the State of Texas in 2016. He is also a Chartered Chemist (CChem) of Royal Society of Chemistry of the U.K. since 2017. His research interests are solid precipitation and deposition, oilfield mineral scale control and environmental aquatic chemistry.

Effects of Operating Pressure on Combustion and Pollutants of Shale Gas

Mehmet Salih Cellek, *Bingol University, Turkey*

Abstract
In this study, non-premixed combustion characteristics and soot formation of various shale gaseous have been investigated in a combustion chamber under different pressure conditions. Flame characteristics considering flame lengths and diameters, intermediate species, temperatures, and pollutants of shale gaseous have been compared. The study shows that although the flame temperatures of the studied fuels are close to each other, they differ slightly. Besides, flame

lengths, flame reaction zones, and intermediate product concentrations differ similarly, and these differences play an active role in the formation of soot and pollutants.

Biography

Mehmet Salih CELLEK was born in 1986 in Siirt/Turkey. He received his BSc. degree in Mechanical Engineering from Sakarya University in 2010 and MSc. degree in Energy branch at the same university and Ph.D. degree in Heat-Process branch from Yildiz Technical University in 2017. Mehmet Salih CELLEK is an assistant professor at Bingol University from 2018 to now. His main research areas are turbomachinery, combustion, energy audit and recovery system, heat exchangers, heat transfer, and computational fluid dynamics (CFD).

The Role of Natural Gas in Low Carbon Energy Transition in Isolated Systems in the State of Amazonas

Mariana Oliveira Barbosa* and Drielli Peyerl, *University of São Paulo, Brazil*

Abstract

Energy access and its utilization are essential tools for developing and improving a society's well-being, including the most territorially isolated communities. The state of Amazonas in Brazil has some intrinsic characteristics the great dispersion of communities, low total electricity charge and a dense tropical forest. These have consequences such as the lack of technical and economic feasibility for linking these communities to the National Interconnected System. Consequently, these communities have autonomous generators, and they are known as isolated systems. Due to the characteristics of waterway transport and installation costs, almost all of these isolated systems are oil-based generators. However, the state of Amazonas has extensive natural gas resources in the Brazilian territory. It can expand the total capacity of isolated systems that already have this fuel supply and, also, substitute electricity generation for a cheaper fuel that generates lower carbon dioxide emissions. Therefore, this study seeks to define cities close to the natural gas production and transportation infrastructures (producing or under development fields and gas pipelines) so that economic comparisons on operating and environmental costs are made to quantify the advantages of using natural gas. Finally, these advantages reach a 40% cost reduction and a 24% reduction in CO2 emissions. Thus, it is possible to characterize a more sustainable development in the isolated systems and opportunities for investments in more efficient generators or, even, the implantation of natural gas plants in other communities through the substitution from oil-based to natural gas-based generators.

Biography

Mariana Oliveira Barbosa graduated in Geology at the Institute of Geosciences of the University of São Paulo (IGc / USP) in 2018. She is currently a master's student in the postgraduate programme in energy at the Institute of Energy and Environment at the University of São Paulo (IEE / USP) with support from FAPESP (São Paulo Research Foundation). She works in the field of research on the use of natural gas in the state of São Paulo, energy transition and environmental issues.

Cu-MOR for the Direct Methane Conversion: AIMD, XAS Simulations, and Experiments

M. S. Lee[1], I. Lee[2], L. Tao[2], E. Khramenkova[3], G. Li[3], R. Khare[2], A. Jentys[2], O. Gutierrez[1], N. Govind[1], E. Pidko[3], J. Fulton[1], V.-A. Glezakou[1], R. Rousseau[1], M. Sanchez-Sanchez[2] and **J.A. Lercher[1,2]**

[1]*Pacific Northwest National Laboratory, USA*

[2]*Technische Universität München, Germany*

[3]*Delft University of Technology, Netherlands*

Abstract
Increased availability of light hydrocarbons from shale gas raises the interest of methane, the main component of natural gas, as a C1 feedstock for the chemical industry. Copper-exchanged zeolite have been attracted a great attention due to their activity in the selective oxidation of methane at temperature below 200 . Among the variety of zeolite topologies, MOR with its specific structure of straight 12-MR channel with intersecting 8-MR side pockets have shown high methanol productivity. Dimeric and trimeric Cu-oxo species with Al pairs at the 8-MR side pockets of MOR have shown to be the most favorable active sites in Cu-MOR. Recently, Dyballa et al. reported an increased activity of methane oxidation in the presence of higher concentrations of extraframework aluminum (EFAl) on Cu-MOR. However, the exact nature of this interaction of EFAl with active Cu species, and the mechanism of this activity enhancement is still not known. In this talk, I will present structural properties and composition of active sites of Cu-Al-oxo clusters on Cu-MOR obtained from ab initio molecular dynamics (AIMD), simulated ensemble averaged Cu K- and L3-edge X-ray absorption near edge structure (XANES) and extended X-ray absorption fine structure (EXAFS) spectra using AIMD trajectories along with experimental results. This talk will demonstrate the critical importance of including both statistic and dynamic configurational complexity in our models for interpreting XAS spectra.

Biography
Mal-Soon Lee is a senior scientist at Pacific Northwest National Laboratory, Washington, USA. She has been working in the field of computational physics/chemistry with an emphasis on studying the phase behavior, reactivity at complex interfaces and confined systems. Her areas of application include studies of catalysis, surface science, nuclear waste disposal, and high-pressure physics. To understand reactivity of heterophase materials, large-scale high-performance computing techniques such as ab initio molecular dynamics are employed. With obtained data, various statistical mechanics techniques are applied to calculate various properties such as reaction enthalpies/entropies, spectroscopic properties, which can be directly compared with experimental observations.

Nanostructured Molybdenum-based Catalysts for Carbon Dioxide Upgrade into Deoxygenated Products

Vasiliki Zacharopoulou[1*], **Efstathia Tsarouchi[1]** and **Athanasios G. Konstandopoulos[1,2]**,
[1]*Aerosol and Particle Technology Laboratory/CERTH, Greece*
[2]*Aristotle University of Thesaloniki, Greece*

Abstract
As the increased global energy consumption results in excessive CO2 emissions, the investigation of routes for the effective CO2 valorization is of high importance. Mo-based catalysts are promising materials for oxygen removal. Thus, this works focuses on the catalytic performance of molybdena-based materials and it's correlation with key properties acquired as a result of the synthesis process.

Aerosol Based Manufacturing has advanced in the last 20 years from this laboratory to an efficient one-step synthesis method that enables production of advanced materials in an integrated fashion. By selecting appropriate precursor solutions and process parameters, nanoparticle catalyst powders can be obtained. In the present work, the method is applied for the synthesis of molybdenum-based catalysts; the basic catalyst structure is that of molybdenum oxides or carbides, which will also be supported on various substrates (e.g., zeolites, carbon, alumina) to enhance bi-functional properties and thus effectively promote carbon dioxide conversion into added-value products (e.g., methane, C1-C3 deoxygenated products).

The focus of the research is to understand and describe quantitatively the factors that affect the synthesis process of the catalyst nanoparticles and devise rational methods for improving

their catalytic performance. The produced particles are characterized with respect to their morphological and catalytic properties employing various methods.

Acknowledgements

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Biography

Vasiliki Zacharopoulou (MEng ChE, MSc Adv. Mater., PhD ChE Aristotle University) is an Affiliated Researcher at the Aerosol & Particle Technology Laboratory with experience in catalytic reaction engineering, material synthesis & characterization, as well as functionalization of monolithic porous media. She has an engineering background with a MEng and a PhD in Chemical Engineering and a MSc in Advanced Materials from Aristotle University. She is also experienced in project management of dissemination events and innovation activities/workshops.

Passive Small Direct Methanol Fuel Cells as a Sustainable Alternative to Batteries in Hearing Aid Devices – an Overview

M. H. de Sá*, **A. M. F. R. Pinto** and **V. B. Oliveira**
University of Porto (FEUP) / Transport Phenomena Research Center (CEFT), Portugal

Abstract

Passive small direct methanol fuel cells (PS-DMFCs) are compact, stand-alone electrochemical devices that convert chemical energy in the fuel (methanol) into electricity, in a sustainable and simple manner [1]. Therefore, PS-DMFCs are considered promising alternatives to conventional batteries, as small power sources (milliwatts to watts), very suitable for the next generation portable consumer electronics, such as wearable gadgets and small medical devices, like hearing aids (HA) [2]. HAs are used to overcome the deficits associated with the hearing loss (HL), the commonest sensory disability. The World Health Organization estimates that by 2050 over 900 million people (one in every ten) will have disabling HL, and an overwhelming majority of those live in low- and middle-income countries [3]. Hence, the availability of PS-DMFCs to power-up the HAs, provides the advantages of high energy for a longer time, as well as fast refueling and lower costs in the long run. This is particularly useful in developing countries and isolated areas where the grid to recharge the batteries is unreliable or unavailable. However, PS-DMFCs have some drawbacks that have hinder their commercialization, such as higher costs and lower performances, stability and durability [4]. This presentation aims to give an overview on the technological issues associated with modern HA power-up options and on the challenges to be overcome in the pursuit of more sustainable devices by using the PS-DMFC technology, namely within the NewPortCell project.

Acknowledgments

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Biography

Maria Helena de Sá is a Chemist/Materials Scientist, with a Ph.D. in Electroanalysis from the University of Porto (Portugal, 2002). She has worked as science teacher and as a researcher in the field of Materials Science and Nanotechnology, for several national and international projects. Currently, her research mainly focuses on advanced nanomaterials toward sensing and catalysis applications. In 2018, she joined CEFT at FEUP, as postdoctoral researcher to support the NewPortCell project. Where she is engaged in developing and characterizing new electrocatalysts, to optimize the performance of fuel cells for a sustainable energy production in portable applications.

Thermolytic Conversion of Waste Polyolefins into Fuels Fraction with the Use of Reactive Distillation and Hydrogenation with the Syngas under Atmospheric Pressure

Adam Hańderek[1], **Krzysztof Biernat**[2] and **Anna Matuszewska2**

[1] Handerek Technologies, Poland

[2] Łukasiewicz Research Network - Automotive Industry Institute, Poland

Abstract

Authors will present an innovative technology for processing waste plastics (polyolefins) into hydrocarbon fuels fractions. Thermolytic process is conducted with the use of packed bed reactor which operates on the principle of a distillation column. Waste polymers are cracked on the shorter chains with a boiling point below 360 °C and the vapours are transported to the next reactor where they are catalytically hydrogenated. The hydrogenation process takes place at atmospheric pressure in the presence of syngas. The final products of this process are: solid, liquid and gaseous fractious. Liquid product can be distilled into fuels (diesel oil, gasoline, kerosene) fractions which can be used for fuels production or fractions that can be used in the chemical industry.

Biography

Anna Matuszewska graduated from the Faculty of Chemical Technology, and defended her doctoral thesis at the Faculty of Mechanical Engineering. She works at the Łukasiewicz Research Network - Automotive Industry Institute in Warsaw as a Leading Specialist and at the Cardinal Stefan Wyszyński University in Warsaw as an associate professor. She is a scientific consultant and a member of the Scientific Council at Handerek Technologies. Specialty – tribochemistry, fuels and alternative fuels.

Natural Gas Conversion to Value-Added Carbon Materials by Microwave Plasma Technology

Randy Vander Wal[1*], **Raju R Kumal**[1], **Akshay Gharpure**[1], **Aayush Mantri**[2], **Kurt Zeller**[2], **Vignesh Viswanathan**[2] and **George Skoptsov**[2]

[1]The EMS Energy Institute, Penn State University, USA

[2]H Quest Vanguard, Inc., USA

Abstract

Advanced plasma technology practically and cost-effectively converts natural gas to value-added chemicals and premium carbon materials such as graphene and conductive carbon black analogues (CCBA) with no CO2 emissions and low capital and infrastructure expenditures. A microwave driven plasma drives hydrocarbon decomposition – producing a variety of carbon nanostructures without the use of catalyst. With lower-energy requirements than conventional thermal plasmas, reactions in microwave plasmas are driven by electron kinetics rather than thermodynamics, and their non-equilibrium energy distribution opens reaction pathways that are unavailable with conventional chemical or thermal plasma processes. The form and purity of carbon material can be controlled by optimizing the several interrelated parameters that include methane to hydrogen ratio in the feed stream and reactor conditions such as input energy and formation temperature. Primary products include nanographene comprised of 2-6 sheets per stack with lateral dimensions between 100 and 500 nm, and graphitic carbon particles with structure analogous to conductive carbon blacks. Analytical techniques including high-resolution transmission electron microscopy (HRTEM), X-ray diffraction (XRD), thermogravimetric analysis (TGA), Raman spectroscopy and electrical conductivity measurements are utilized to study the form and quality of these valued carbon materials. Optical spectra are collected and analyzed to determine the formation temperature of these carbons using blackbody radiation and C2* Swan band emission. The electrical conductivity of the as-produced CCBA material is higher than that of commercially available conductive carbon blacks. These results highlight the importance of advanced plasma technology for the economic utilization of natural gas by producing premium carbon materials.

Biography

Dr. Vander Wal is a professor in the John and Willie Leone Family Dept. of Energy and Mineral Engineering at Penn State University. His general research theme is nanomaterials for energy engineering. Under this rubric his research has encompassed the areas of energy control, conversion, efficiency, generation and storage, with focus upon carbon allotropes and materials. Related environmental interests lie in combustion-generated soot: its measurement via laser-based methods, complemented by flame synthesis of nanotubes, characterizing each carbon form by microscopic and spectroscopic techniques. Parallel analytical interests are micro-plasma-based environmental and mineral analyses.

Pathways to Low-Cost, Low-Carbon Hydrogen Production

Scott Koonce, *BayoTech On-Site Hydrogen, Houston, TX*

Abstract

Hydrogen is expected to play a pivotal role in reducing carbon emissions in a number of highly polluting industries that now face strict climate targets and Natural Gas Utilities and Developers have an opportunity to play an important role in the developing hydrogen economy – including creating demand for low-carbon hydrogen, decarbonizing the gas grid, and serving emerging markets by providing an alternative transportation fuel.

As the hydrogen economy continues to take shape there is an increasing demand for hydrogen supply as well as the infrastructure to help deliver hydrogen to its end use applications. This presentation explores the ways the oil and gas industry can participate in the developing hydrogen economy.

Biography

Scott Koonce leads BayoTech's global sales group working with customers to understand their challenges in order to develop consistent, cost-effective solutions for on-site hydrogen production. He is focused on the Oil & Gas, Energy, and Chemicals markets where our goal is to develop long-term relationships with our customers. Scott has over 23 years of experience working in sales organizations and has spent almost 20 years in the gas industry. He has worked for tier 1 industrial gas manufacturers and has held various roles and responsibilities including Account Management, Sales Management and previously as Vice President of Bulk Gas Sales.

Slow Pyrolysis as a Method for Bitumen and Used Plastics Disposal and Valorization

Marco Maniscalco*, **Alberto Brucato**, **Franco Grisafi**, **Francesca Scargiali**, **Giuseppe Caputo**
Università Degli Studi di Palermo, Italy

Abstract

Nowadays the importance of using a circular economy model is well known. There are several good reasons (environmental, economic and social) that encourage recycling. However, any material can be recycled indefinitely due to contamination and deterioration. If waste cannot be recycled, there are other alternatives for their treatment and/or valorization. In particular, Waste to Energy (WtE) model, based on advanced thermal conversion, heat recovery and air pollution control, offer a sound opportunity for sustainable waste management in the recycling society. The main goal of modern WtE units has shifted from "waste treatment" to "resource conservation and recovery". They could be better described as Waste to Resources (WtR) units, since they are able to provide a safe recovery of energy, an efficient recycling of inorganic materials, and a crucial saving of space for landfilling, in full compliance with the protection of human health and the environment. WtR units include pyrolysis. This work focuses on bitumen and plastic slow pyrolysis. Slow pyrolysis of the aforementioned feedstocks was carried out in a semi-batch reactor under atmospheric pressure and nitrogen atmosphere and different pyrolysis temperatures were investigated. H2, CH4, C2H4, C2H6 and C3H8 are the main components of the produced gas phases, while the produced oil phases have high heating values comparable with commercial fuels. Moreover, kinetics and thermal degradation characteristics were investigated with the aim of obtaining data on the process and further deepening the know-how about this technology. All of these aspects will be beneficial for industrial application.

Biography

Marco Maniscalco graduated in 2016 at the University of Palermo, Italy, with a master thesis on high-pressure separation of bi-component gaseous mixtures. I'm at the last year of a PhD course in Technological Innovation Engineering at the University of Palermo, Italy. My research focuses on thermal and hydrothermal processes for the valorization of biomass and waste.

Legal Issues for Implementing Carbon Capture Utilisation and Storage (CCUS) Technologies in the Asian Pacific Region

Akihiro Nakamura[1*], **Eiji Komatsu**[2] and **Yanagi**[2]
[1]*IOM Law, Norway*
[2]*Meiji University, Japan*

Abstract

There has been wide discussion about Carbon Capture, Utilization and Storage (CCUS) considered as one of the significant approaches to greatly reduce CO2 from the global atmosphere. Particularly, it is believed that application of CCUS will significantly become effective in fossil fuel-based CO2 emissions. It is a key challenge for nations and investors to understand the technology and benefits, and governments are responsible to prepare both for a relevant legal framework for CCUS, to operate practically and successfully at the global and regional levels. In terms of the emission levels in the Asian Pacific region (APr), during the past two decades, a few governmental reports have clearly indicated that greenhouse gas emissions from the region, particularly CO2, have been dramatically increased, due to rapid industrialization and population growth. There

is a need to build strong governance for facilitating more cooperative climate action between developed and developing countries at the regional level beyond the efforts that have been achieved by the United States and the European Union.

This paper aims at suggesting the region will need to act on regional, technological development to reduce CO2. This will address legal issues for implementing CCUS technologies in the APr. This study will not only contribute to overcoming the potential and future barriers to legal framework for CCUS development in the region but can also be applied in other technological development such as renewable energy development both at the global and regional levels.

Biography

Akihiro Nakamura, the presenter, is a Senior Policy and Legal Analyst-Asia Pacific (APAC) Region at IOM Law, Norway. Dr. Eiji Komatsu is the CEO of LERCS (Research Institute) in Japan and a research specialist at the Center for Environmental Law at Meiji University. Professor Kenichiro Yanagi is a project leader at the School of Law, Meiji University. He specializes in the field of comprehensive study of environmental consideration system, European environmental laws, and Asian environmental laws. His recent book publications are "Environmental Law and Policy" Seibunsha, 2015 and "Comprehensive Study of Environmental Assessment Law" Seibunsha, 2011.

Thermodynamics and Phase Relationship of Carbonaceous Mesophase Appearing During Coal Tar Pitch Carbonization

Mahnaz Soltani Hosseini, *Polytechnique Montreal, Canada*

Abstract

Carbonaceous mesophase appears as an intermediate product in production of electrical and mechanical carbon materials, needle coke for graphite electrodes used in electric-arc furnaces, pitch-based fibers and aluminum-smelting prebaked electrodes through carbonization process. A thermodynamic approach for phase behavior estimation of carbonaceous mesophase is presented to provide more insights and to lead to semi-quantitative modeling of this process. Phase behavior of binary, ternary and multi-component systems are described by minimization of the Gibbs free energy function proposed by Hu and Hurt for mesophase pitches which exhibits orientational energy contribution of molecules in mesophase. The model enables estimating the reversible phase transition of mesophase upon temperature cycling as suggested by Lewis. The capability of the model to estimate the molecular weight distribution of species in the phases in equilibrium and variation of mesophase content with thermal soaking time has been discussed. Estimated ternary isothermal sections showing isotropic-mesophase and isoiso immiscibility are presented for the first time. The phase behavior of ternary systems with average molecular weight in the range of average molecular weight of coal tar pitches are described. The application of the model to phase diagram prediction of the specific systems which exhibit the miscibility gap has been studied.

Biography

Mahnaz Soltani Hosseini: Ph.D. student, studying in Chemical Engineering at Polytechnique, Montreal, Canada. My research is aimed at modeling and optimization of carbon-based material production processes.

Nanomaterials for Nanofluid Enhanced Oil Recovery: Challenges and Perspectives

Wei Wang, *Aramco Research Center-Boston, Aramco Americas, Cambridge, USA*

Abstract

Applying nanomaterials in nanofluids flooding is an emerging research topic in nanomaterials and petroleum engineering research. In past a few years, various nanomaterials have been extensively studied and numerous laboratory results have shown that use of nanomaterials especially nanoparticles in displacement fluids can lower the interfacial tension (IFT), improve the rheological properties, alter the wettability of the rock, or change disjointing pressure. Some of nanomaterials have been proposed to use as nanofluid flooding agents for enhancing oil recovery. However, no field trial of EOR using nanofluids has been reported in technical literature to date. For successful implementation of nanofluids in the field, a complete understanding of field conditions and process variables is necessary. The difference between the field and laboratory conditions must be assessed that can be helpful in scale-up of laboratory experiments. In this review, we analyze the functions of nanomaterials during nanofluid flooding operations, compare different nanomaterials that have been reported to be used for nanofluid flooding in the lab, and discuss different factors that can control nanofluid flooding qualities.

Biography

Wei Wang is a Research Science Specialist and Founding Member in Aramco Research Center-Boston, Aramco Americas, and his current research focus is on applications of advanced nanomaterials and nanotechnology in reservoir engineering and technology. He had been a Staff Research Scientist at Oak Ridge National Laboratory since 2001, before joining the Aramco Americas in 2012. Prior to that, he worked as a Research Associate at University of Pittsburgh and as an Associate Professor at Ocean University of China. Wei holds his Ph.D. degree in Physical Chemistry from Chinese Academy of Sciences (CAS) in 1993 and has authored or co-authored 130+ peer-reviewed papers (H-index 43), 4 book chapters, 20+ US patents and 40+ invited presentations.

Energy and the Unfolding Boundary Constraints of Mechanical Design Theory

John R. Schramski, *University of Georgia, Athens, GA*

Abstract

Energy theory provides boundary conditions for engineering design outcomes in both society and the environment. Yet science has missed these conditions and the significance of civilization's growing energy consumption where the speed and magnitude of our recent 70-year consumptive flash is an explosion, whose evidence can plainly be seen from space. Because energy is the ability to cause change, the laws of physics obligate an exponentially rising energy discharge begets exponentially rising environmental impacts, and the rapidly rising earth transformations documented in the Age of Acceleration metrics are only some of the expected consequences now underway. As such, whereas science focuses on the amount, source, and quality of energy, the actual outcomes may be more directly linked to the act of energy discharge itself (e.g., per capita energy discharge). In other words, it is not the amount, source, or quality of the gas in your tank, but rather what you are doing with your truck. This is unfortunately a novel yet essential perspective for any credible engineering or system design for future technological goal functions. System and design theory with case studies are used to quantify and expand this cause-and-effect perspective.

Biography

Dr. John Schramski is a mechanical engineer and ecologist focusing on mechanical design and thermodynamic modeling. He currently leads the University of Georgia's Materials and Energy Systems Modeling program where his funded research includes theoretical ecology, complex systems analysis, and the thermodynamics and energetics of the natural biosphere, civilization, and industry. He completed his BSME at the University of Florida in 1989, his MSME at the University of Cincinnati in 1993 in conjunction with General Electric's Advanced Courses in Engineering, and his PhD in Ecology at the University of Georgia in 2006. He teaches undergraduate and graduate engineering thermodynamics and biosphere energetics.

Navigating the Politics of Fracking

Mark Truax, *Pac/West Strategies Communications, Denver, CO*

Abstract

Politics are an inescapable part of the industry, impacting all aspects of business from public perception to production. Through the last decade, natural gas has continually been attacked by an extreme minority. Recently, fracking politics have become increasingly complex due to a minority attempt to localize rulemaking and push for setbacks. The setbacks movement is looming over the industry and understanding how to navigate the politics of fracking is more important than ever. Across the country, cities are coupling the dangers of setbacks with a push to ban natural gas locally, harming the populations that rely on it and the industry. This will only continue to press on. Pac/West is well-versed in the politics of the industry and understands how to utilize both public opinion and stakeholders to fight back against these attacks on the industry. Political movements are nothing new; however, reframing electrification and setbacks as trends for young voters to latch onto makes this threat innately dangerous and challenging in a new way. Innovative communications and campaign strategies must be implemented. In this presentation, I will examine how to understand the political landscape, use the political landscape to benefit the industry, and utilize innovative messaging strategies to counteract the push for setbacks and electrification.

Biography

Mark Truax manages Pac/West's Denver office as well as oversees the firm's work in the energy sector, with a specific focus in oil and natural gas, agriculture, and federal affairs. Mark oversees the firm's largest client, Coloradans for Responsible Energy Development (CRED), where he handles the operations of the multi-faceted public education campaign around oil and natural gas development. In 2018, Mark served as the Deputy Campaign Manager for Protect Colorado's No on Proposition 112 campaign, successfully defeating Proposition 112, which would have inflicted irrevocable harm on the state's oil and natural gas industry, by a 10% margin.

Sustainable Alternatives to Plastics

Muhammad Rabnawaz* and **Zhao Li**, *Michigan State University, East Lansing, MI*

Abstract

Plastics are used in enormous amounts and the production of plastics has exceeded 2050 million tons, but merely 9% is recycled. The majority of plastics after use is sent to landfills, incinerated or end up in ocean. In the presentation, I will present alternative for single use plastics using coated paper. Biobased and sustainable chitosan-graft-castor oil and chitosan-graft-silicone oils are utilized as coating materials. The formulations were designed based on response surface methodology. The coated paper showed water and oil contact angles indicating a good water and oil resistance. Water vapor permeability and mechanical properties of the coated paper along with the surface analysis were performed for the coated paper. Considering the biobased nature of the coating materials and the simplicity of the fabrication strategy, this work offer environmental-friendly, economical and sustainable approach toward alternative for single used plastics.

Biography

Dr. Muhammad Rabnawaz, Ph.D., is assistant professor at Michigan State University since 2016. He has extensive expertise in sustainable materials, polymer synthesis, processing and. He has authored over 40 refereed publications in leading scientific journals. He also holds over 25 filed patents, including >7 that are licensed/optioned.

Are Net Zero or Negative CO_2 Emissions Possible for our Offshore Oil and Gas?

Lesley James, Memorial University of Newfoundland, Canada

Abstract

Carbon storage and sequestration is essential to reducing greenhouse gas emissions and halting anthropogenic climate change. While research is mostly focused on large emission sources there is a compelling argument to reduce carbon emissions from any source, certainly if the CO2 can be used to make the process more sustainable and efficient. The goal of this presentation is to investigate the CO2 emitted from offshore oil and gas production facilities and determine if the CO2 can be used for enhanced oil recovery (EOR). This presentation will highlight the technical process of capturing, separating, and injecting the CO2 for enhanced oil recovery. It will highlight and describe the different CO2 EOR mechanisms possible based on the amount of CO2 being generated, their potential recovery efficiencies, and when they can be used. Recommendations are given as to its feasibility and future work required.

Biography

Dr. Lesley James is an associate professor and former Chevron chair in petroleum engineering in the Department of Process Engineering at Memorial University. Dr. James' research focuses on sustainable oil production by increasing oil recovery rates through enhanced oil recovery and production optimization. Efficient and sustainable oil production comes from optimizing the integrated process and creating a circular economy by re-injecting natural gas and generated CO2 – both greenhouse gases and useful solvents for oil recovery. She was awarded the 2018 Dean's Award for Research Excellence along with awards for her volunteering efforts. She is a professional engineer with PEGNL, a member, technical committee member, and past president of the Society of Core Analysts (SCA); committee member and faculty advisor for the Society of Petroleum Engineers (SPE); and members of the Canadian Society of Chemical Engineers (CSChE) and European Association of Geoscientists and Engineers (EAGE).

Novel Hydrogen Evolution Reaction Electrocatalyst Design Using Low-Dimensional Material

Sichen Wei[1*], **Soojung Baek**[1], **Yu Fu**[1], **Chaoran Chang**[1], **Jihea Lee**[1], **Kristofer Reyes**[1], **Huamin Li**[2] and **Fei Yao**[1]

[1]*Department of Material Design and Innovation, University at Buffalo, USA*

[2]*Department of Electrical Engineering, University at Buffalo, USA*

Abstract

As a green and cost-effective technique, electrochemical water-splitting has drawn tremendous attention for hydrogen production. A high efficiency electrocatalyst is desired to minimize the energy to drive the hydrogen evolution reaction (HER). An exceptional HER catalytic activity can be provided by platinum group metals (PGM), but their broad applications are hindered due to extremely high cost and scarcity. Therefore, the investigation of economical substitution for PGM catalysts constitutes a crucial challenge in the deployment of hydrogen energy. As an earth-abundant material, molybdenum disulfide (MoS2) has been discovered with promising activity and stability for HER. However, the wide adoption of MoS2 is impeded by the limited number of active sites and poor conductivity. In this report, we focus on improving MoS2 HER efficiency via forming a MoS2/MXene/CNT hybrid structure by a simple, one-step solvothermal method. 1T/2H-MoS2 were successfully grown in the interlayers of titanium carbide (Ti3C2Tx, MXene) with carbon nanotubes (CNT) served as a crosslink in the network. The hybrid structure exhibited a large number of active edge sites with improved electrical conductivity. Furthermore, to trigger a deep phase transition of MoS2, n-Butyllithium (n-Buli) treatment was conducted on MoS2/MXene composite. The lithium intercalation induced the formation of 1T metallic phase MoS2 and allowed the functional group transition on MXene from HER inert -F to active -O. In addition, we introduced the Bayesian Optimization (BO) algorithm to predict the optimal hydrothermal synthesis condition based on a

limited number of experiment input. The optimal synthesis condition was given and verified by experimental approach.

Biography

Sichen Wei is a Ph.D student in Prof. Fei Yao's research group at the Department of Material Design and Innovation, University at Buffalo (UB), USA. He received his B.S degree in the Department of Applied Chemistry in 2016 at Beijing University of Chemical Technology and M.S degree in Materials Design & Innovation in 2018 at UB. His research interest includes low-dimensional materials synthesis and their applications in electrocatalysis and energy storage.

Bio-Mass Derived 5-hydroxymethylfurfural into Value Added Ester Products Using Plasmonic Metal Nanoparticles

Helapiyumi Weerathunga*, **Sarina Sarina**, **Huai-Yong Zhu** and **Eric R. Waclawik**
Queensland University of Technology, Australia

Abstract

Large-scale use of fossil fuel energy sources causes significant environment pollution and concerns regarding an energy crisis in the future. With the high availability of renewable carbohydrates in nature (cellulose and other sugars) particular attention has been given to conversion of agricultural waste into value added chemical commodities. Catalytic transformations of biomass derivatives such as 5-Hydroxymethylfurfuryl (HMF) can produce value added building-block chemicals for polymer industry and petrol-derived commodities. Furan-2,5-dimethylcarboxylate (FDMC) is one such product obtained by oxidation of HMF. Here we report an efficient direct oxidation-route to synthesize furan-based esters from HMF using a gold nanoparticle (Au NP) based catalyst. -Al2O3 fibers act as a reliable and a cheap catalyst support for heterogeneous Au NPs. This catalyst shows promising results for conversion of HMF to its derivative ester, selectivity, at remarkably mild conditions, having only one intermediate product in the synthesis mechanism. The catalyst can readily isolate esters without further oxidation to its acid or CO2. The 3D nano-catalyst architecture enhances the HMF oxidative esterification, since HMF reactant molecules can readily diffuse in this fiber structure and adsorb to the active catalytic sites, while ester product molecules can diffuse out. The catalyst can be used for 4 consecutive reaction cycles without a significant loss of HMF conversion and ester selectivity. Advantages to using this catalyst material include efficient conversion to product using minimum amount of base and mild reaction conditions that favored by the green synthesis.

Biography

Helapiyumi Weerathunga received her B.Sc. special degree from Uva Wellassa University, Sri Lanka in 2016. She was awarded the QUT Postgraduate Research Award (QUTPRA) QUT and HDR Tuition Fee Sponsorship in 2018. She is currently at her final year of PhD candidature at QUT under the guidance of Prof. Eric R. Waclawik. Her research interests include heterogenous catalysts for fine organic synthesis such as biomass derivatives.

A New Class of Bubble-Free Water Electrolyzer that is Intrinsically Highly Efficient

Gerhard F. Swiegers*, **Prerna Tiwari**, **George Tsekouras**, **Klaudia Wagner** and **Gordon G. Wallace**
University of Wollongong, Wollongong, Australia

Abstract
Highly efficient electrochemical splitting of water into hydrogen and oxygen constitutes the most critical capability needed for the development of a future hydrogen economy based on renewable energy. In this work we demonstrate that direct conversion of water into hydrogen and oxygen gas, without the intermediary of bubble formation, may notably decrease the energy required. We report the performance of "bubble-free" alkaline electrolyzers with electrodes comprising of Gortex gas diffusion layers coated with catalyst layers containing high-performing water-splitting catalysts. The hydrophobic, porous Gortex gas diffusion layer vigorously extracts and removes the gases as they are produced by the catalyst layer, before bubbles form. The Gortex exhibits a capillary action (~6.3 bar capillary pressure) in which the extracted gases coalesce on the PTFE surfaces present, thereby avoiding the energy penalties arising from bubble formation. At 80 oC (Eocell 1.18 V), the best electrolyzer exhibited an onset potential of only 1.28 V, with a total activation overpotential of 0.09 V. It needed only 1.31 V to endothermically generate 10 mA/cm2 over 1 h at 80 oC. A comparison with the best conventional and commercial "bubbled" water electrolyzers, suggests that bubble formation and release decrease the energy efficiency of those systems by ≥11.9% (LHV). To the best of our knowledge, the above cell constitutes the most intrinsically efficient water electrolyzer yet reported when the effect of impedance is stripped out.

Biography
Gerhard (Gerry) F. Swiegers is a Professor at the University of Wollongong, Australia. He leads an active research program focusing on electrochemical catalysis and the production of hydrogen from water using renewable electricity. He also works in the fields of electrocatalytic process engineering and industrial electrochemistry. He has founded 7 spin-off companies and licensed out 3 new technologies in the last 20 years. He has published 2 books, 135 scientific papers/chapters, and 51 patent families. His inventions have found use in the pharmaceutical, apparel, casino chip, agricultural, automobile, energy, and other industries.

Reverse Supply Chain Concept to Reduce Plastic Packaging Waste as Result of Increasing e-Commerce Sales during COVID-19 Pandemic

Yosi Agustina Hidayat* and **Baiq Elfa Desfira**
Bandung Institute of Technology, Bandung, Indonesia

Abstract
As the appetite of Indonesian consumers for online shopping rather than in-store continues to grow during Novel Coronavirus (COVID-19) pandemic, the amount of plastic packaging waste is getting higher. Today Indonesia's express delivery market faces primary challenges regarding this momentum, including rapid increase of parcels, over-packaging, and plastic package recycling. Current consumption trend leads to significant growth rate of parcels shipment causes express delivery players face over-packaging problem. Over-packaging was initiated in order to minimize damage during transportation. Furthermore, the thin low-quality plastic is still used as the main alternative for packaging. It has a low recycling rate of a great volume. Thus, it results in higher plastic packaging waste. Ellen MacArthur Foundation reported that there are estimated 150 million tons of plastics in the oceans. If current trends continue, the global quantity of plastics is projected to increase by 250 million tons. Therefore, it is very important to mitigate the increasing number of plastic packaging waste by implement sustainable waste management system. In order to gain necessary and valid information, the author applied several methods and techniques: 1) Understanding current situation and defining problem; 2) Collecting secondary data from reputable sources; 2) Processing data using Five Whys Analysis and PEST Analysis; 3) Interpreting and analyzing data using reverse supply chain approach and circular economy; 4) Evaluating collected data and propose recommendations as conclusions. The result of this study is that every element in the supply chain should contribute to build circular economy, particularly by redesign packaging of product and enhancing the use of plastic substitute or Post-Consumer Recycle (PCR) plastic.

Biography

Yosi Agustina Hidayat received Ph.D. in Engineering, from Hiroshima University, Japan in 2010. Currently, she is an assistant professor of Industrial System and Techno-Economics Research Group, Faculty of Industrial Technology, Bandung Institute of Technology (ITB), Indonesia and member of International Committee of International Symposium on Scheduling (ISS) held by JIMA (Japan Industrial Management Association) since 2013. In 2013, she received LOREAL-UNESCO for Women in Science award. Her research interests are specifically related to some topics of Supplier-Buyer Relationship in Supply Chain Management, Technology Transfer Process in Supply Chain Management, Decision Analysis using Management Science Approaches in High Prevalence Diseases, Decision Science in Healthcare Industry and Logistics and Supply Chain Management of Waste.

Baiq Elfa Desfira is a fourth-year undergraduate student at Engineering Management Department, Faculty of Industrial Technology, Bandung Institute of Technology (ITB). She is an assistant of Engineering Management Design Laboratory (LPMRI). She is selected as the course work coordinator, so she is responsible to manage team of 10 assistants to run Engineering Management Design 2 course work and assists total 49 participants of Engineering Management Design 2 and 3 course works, each for a semester. Her research interests are specifically related to business process improvement (BPI) for companies considering environmental factors.

The Relationship Between Energy Production and Simultaneous Nitrification and Denitrification via Bioelectric Derivation of Microbial Fuel Cells at Different Anode Numbers

Huang Shan*, **Zhu Guangcan*** and **Gu Xia**, *Southeast University, China*

Abstract

In this study, three microbial fuel cells (MFCs) with different numbers of anodes (i.e., 1A, 3A, and 5A) were constructed to study the effects of a multi-anode (MA) system on power generation performance and nitrogen (N) removal from low carbon (C)/N wastewater. The maximum power density of 3A-MFC was 236.7 mW m−3, which was 2.6-fold and 1.2-fold that of 1A-MFC and 5A-MFC, respectively. The 3A-MFC system produced the highest total energy output in one cycle, approximately 41.7 mW h, which was 1.5-fold and 1.3-fold that of 1AMFC and 5A-MFC, respectively. 3A-MFC also had the highest total N (TN) removal efficiency (71.1 ± 3.9%) and simultaneous nitrification and denitrification (SND) rate (93.5 ± 2.4%). An analysis of electron flow distribution in the 3A-MFC biocathode showed that electro-autotrophic denitrification accounted for 19% of the total denitrification in the last 135 h. Thereafter, the relationships between TN removal, anode number, and bioelectricity were systematically evaluated. TN removal efficiency had a good linear relationship with energy production (R2 = 0.97539); TN removal was mainly dependent on SND. Generally, the MA-MFC configuration proposed in this study produced more electrical energy and improved TN removal by enhancing nitrification and heterotrophic and electro-autotrophic denitrification of the biocathode. The proposed method is therefore effective for enhancing N removal.

Simultaneous Copper Migration and Removal from Soil and Water Using a Three- Chamber Microbial Fuel Cell

Jingran Zhang*, **Hui Wang**, **Xuan Zhou**, **Xian Cao** and **Xianning Li**
Southeast University, China

Abstract

In this study, we constructed a three-chamber microbial fuel cell (TC-MFC) that avoided the adverse

effects of H^+ diffusion on anode microorganisms in the acidic catholyte and the precipitation of heavy metals in the soil near the cathode side (S4), while also achieving migration of copper from the soil and reduction of Cu^{2+} in the catholyte. The removal efficiency of acid-soluble Cu from the soil near the anode region reached 42.5% after 63 days of operation at an external resistance of 100 Ω and electrode spacing of 10 cm, and Cu^{2+} in the catholyte was completely removed within 21 days. Heavy metal mobility index (MF) values indicated that the bioavailability and mobility of heavy metals were reduced by the TC-MFC. We found that changing the cathode potential and external circuit current in TC-MFC would affect the type (via XRD) and morphology (via SEM) of cathode deposits and the average removal rate of heavy metals. At the meantime, it should be noted that the interaction between the electric-field-dependent soil heavy metal migration and electron-dependent copper reduction in TC-MFC occurred, which was confirmed to have a relationship with the negative correlation between voltage and current during the test.

SESSION III

Role of Energy Efficiency in Energy Transition: A Decomposition Analysis of Energy-Use

Pooja Sharma
University of Delhi, India
Jawaharlal Nehru University, India

Abstract
A large number of countries across the globe adopted targets of reductions in carbon intensity that are primarily achieved by adopting two technology options. Shifting the energy regime from conventional to non-conventional, the renewable energy source is one form of technology, and the other is adopting energy-efficient technologies that reduce the energy intensity of a nation. An improvement in energy efficiency serves as a critical factor in reducing the overall use of energy or in other words, in reducing energy intensity. Energy efficiency and energy intensity are inversely related to each other. Therefore, energy intensity can serve as a good indicator of energy efficiency. In this backdrop, the study examines the decomposition of energy intensity by deploying an additive LMDI approach which allows for decomposition of the change in energy use in three components, namely, activity, structure and intensity effects. This method decomposes the overall use of energy into factors that influence energy consumption for the specific sector considered for the analysis — the decomposition of energy intensity effect. The economy is divided into four broad energy-consuming sectors, namely agriculture, manufacturing, services, transport and household sector. The decomposition of energy use is performed for the period 1990-2017 for the two selected countries, one a developed country such as Norway and a developing country India. The main aim is to analyze the change in energy use in the year 1990 and towards 2017 and examine whether this change has been attributed by activity, intensity or structure effect.

Biography
Pooja Sharma is a Senior Assistant Professor, Department of Economics, Daulat Ram College, University of Delhi, India. She did her Masters in Economics from Delhi School of Economics, she has an experience of teaching papers such as Environmental Economics, Econometrics, Public Economics. She has several research papers related to Energy Security, Energy transition, Renewable energy, Human Capital. She has currently submitted PhD thesis at Energy Studies Program, School of International Studies, Jawaharlal Nehru University at Delhi India, titled "Role of Renewables in Energy transition: A Comparative Study of India and Norway". She has been a PhD fellow at the University of Agder, Norway as an exchange program for PhD students.

K Model: A Web Based Software for Predicting Crude Oil Blend Compatibility and Blend Optimization for Increasing Heavy Crude Oil Processing

Rajeev Kumar[*1,2], Ravi Kumar Voolapalli[1], Pranab Kumar Rakshit[1], Sanjay Bhargava and Sreedevi Upadhyayula[2]
[1]Corporate R&D Centre, Bharat Petroleum Corporation Ltd., India
[2]Indian Institute of Technology-Delhi, India

Abstract
In a refinery operation, the profitability margin is increased when heavy crude fractions are blended with light crude without affecting its processability. High asphaltene content in heavy oils can affect

the Desalter operation by strong water emulsions with asphaltene, fouling in heat exchangers means excess fuel firing and emissions, and/or coking issues during processing. If this happens, refineries can lose more than the advantage of purchasing the heavy crudes. Thus the accurate prediction of crude compatibility can be a robust tool which refinery operators would like to use before starting any process. Current benchmark processes to determine compatibility of crude oils is done experimentally and takes minimum weeks' time to complete.

In the present work, a quick and accurate method for crude oil blend compatibility (K Model) is developed by coefficients obtained by regression analysis between the ratios of physical parameters of known crude oils and composite compatibility measure determined from multiple compatibility test results of the known crude oils. These compatibility tests are viz. colloidal instability index (CII), colloidal stability index (CSI), Stankiewicz plot (SP), qualitative-quantitative analysis (QQA), stability cross plot (SCP), Heithaus parameter (or parameter P), Heptane Dilution (HD), toluene equivalence (TE), spot test and oil compatibility model (OCM). K model requires few physical parameters of crude oils as input for optimization. The physical parameters of the crude oil include at least Sulphur, Carbon Residue, API and Kinematic Viscosity. The parameters included for blend optimization are viz. (a) compatibility, (b) viscosity, (c) pour, (d) acidity, (e) nitrogen, (f) total distillates, along with feedstock constraints.

Based on the innovation, a web based software is developed which runs over internet and predicts results rapidly .This enables feeding compatible and healthy diet to refinery to maintain equipment health, energy and environment.

Keywords: Crude oil blend compatibility, heavy crude oil, optimization and K Model

Biography

Rajeev Kumar is working as Chief Manager (R&D) at Bharat Petroleum R&D Centre, India. His research interests are development of new products / processes, modeling, simulation, scale-up and optimization for refinery processes. He has developed two software products related to efficient crude oil processing viz. (i) BPMARRK®: Real-time Crude Assay and (ii) K Model: A web-based software for crude compatibility. Products are commercially available for license. He has published over 20 research articles in reputed journals and has filed 15 Patents. He has won several Awards (National/International). His educational qualification, he is B. Tech in Chemical Engineering from BIT Sindri, Dhanbad, M. Tech in Chemical Engineering from IIT Kanpur.

Surface-Complex Mediated Photocatalytic Selective Oxidation of 5-Hydroxymethylfurfural to 2,5-Diformylfuran Under Visible Light

Ayesha Khan[1*], Michael Goepel[2], Juan Carlos Colmenares[1] and Roger Glaser[2]
[1]*Institute of Physical Chemistry, Polish Academy of Sciences, Poland*
[2]*Leipzig University, Leipzig, Germany*

Abstract

5-Hydroxymethylfurfural (HMF) is considered to be a versatile platform chemical and a key intermediate to link biomass resources and the chemical industry. However, the selective oxidation of HMF into high value-added products like 2,5- Diformylfuran via an environment friendly processes remain a significant challenge. Visible light-driven photocatalysis, is an economical and environmentally benign approach for the development of sustainable processes and products. Herein, we report the selective oxidation of HMF to DFF enabled by the formation of a visible light absorbing complex of the substrate on the titania surface. The resulting complex afforded high DFF selectivity (87 %) with 59 % HMF conversion after 4 hours of illumination. Mechanistic studies showed that the superoxide radical anion is a dominant active species responsible for the oxidation of HMF to DFF. Moreover, the photocatalyst is recycled and reused without any substantial loss

in the catalytic activity. Thus, the present approach of surface-complex mediated photocatalytic selective oxidation of HMF under visible light will have a significant impact on sustainable and economic production of bio-based chemicals to render biorefineries viable.

Acknowledgements

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Biography

Ayesha Khan received her M.Phil degree in Environmental Sciences (2012) from PMAS Arid Agriculture University, Rawalpindi, Pakistan. After completion of her M.Phil, she worked as a teaching professional (2013-2017) at APSACS Fort Road, Rawalpindi, Pakistan. She is now pursuing her PhD at the Institute of Physical Chemistry of the Polish Academy of Sciences, Warsaw, Poland. Her research interests primarily focused on the design of nanophotocatalysts and nanocomposites and their application in the field of heterogeneous photocatalysis for biomass valorization.

Harmonic Oscillator Tank: A New Method for Leakage and Energy Reduction in a Water Distribution Network with Pressure Driven Demand

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[4]*Laboratoire d'Informatique et des Systèmes, France*

Abstract

Leakage is not only associated with water loss and energy wastage, but its poses serious health and environmental problems. As pointed out by the World Health Organization, the risk of water contamination from the sewerage system and other sources entering through damaged joints, pipes and fittings (back-siphonage) is quite high. In addition, the increasing world's population, the changing climate and the emergence of new industries are simply exacerbating the situation by putting much stress on the ageing infrastructure of water distributions. In the light of the above problem, a novel concept known as the Harmonic Oscillator Tank has been developed for leaking networks whereby a short or medium-term solution is often required since infrastructure renewal requires time and a massive investment. In this research work, we investigate the energy efficiency of distribution in an experimental network which is embedded with two levels of leakage (low and high) using three different methods. They are analyzed and compared in terms of specific energy consumption and rate of leakage. The conventional hydropneumatic tank is pressure modulated so as to produce a constant output flowrate within the presence of leaks. Experimental results show that the throughput of the Harmonic Oscillator Tank for a heavy leaking network is highest (86.45%) with the lowest percentage leakage of 13.5% at a specific energy consumption of only 0.354 kWh/m3 /day when compared to the other two schemes namely direct pumping and pumping through a variable speed drive in a loop.

Biography

Dr. Lekhramsingh Latchoomun is currently the head of the Systems Laboratory at University of Mascareignes. The author earned his PhD from the University of Mauritius in the field of water systems control engineering in 2019, an M.Sc. in Information Technology in 2001 and a B.Eng in Electrical and Electronics in 1999 from the same university. As a member of IEEE for the past 7 years, he has been very active in region 8, middle East Africa, with the organization of several conferences. His current interest lies in the optimization of energy and energy efficiency of industrial systems.

Review and Analysis of Historical Leakages from Storage Salt Caverns

Arnaud Réveillère*[1] and Pierre Bérest[2]
[1]*Geostock, France*
[2]*LMS, Ecole Polytechnique, France*

Abstract
Twelve incidents involving well casing and/or cement leaks in the salt caverns storage industry are described. The featured incidents are relatively few, when it is borne in mind that more than 2000 salt storage caverns have been operated successfully and without incident, sometimes for more than 50 years. However, lessons must, and can be, drawn to prevent further accidents. Mechanisms leading to a casing leak and consequences are discussed. In most cases, a breach in a steel casing occurred at a depth where a single casing was isolating the stored product from the geological formations. The origin of the breach was due in most cases to poor welding/screwing conditions and corrosion, or excessive deformation of the rock formation and casing overstretch. In this, the age of the well is often influential. In many cases, the leak path does not open directly at ground level; fugitive hydrocarbons first escape and accumulate in the subsurface prior to migrating through shallower horizons and escaping at ground surface. A pressure differential between hydrocarbons in the borehole and fluids in the rock mass favours high leak rates. A wellhead pressure drop often is observed, even when the stored product is natural gas. The incidents described suggest that thorough monitoring (including tightness tests) and a correct well design lessen considerably the probability of a casing leak occurring.

Biography
Arnaud Réveillère has graduated with a M.Sc. and Engineering degree from Ecole Centrale Paris. He worked 4 years as a research engineer in BRGM, the French Geological Survey, his main research topics being reservoir engineering applied to safety of CO2 geological storage and geothermal energy. He joined Geostock salt caverns department in 2012, worked as a solution mining and thermodynamic engineer or project manager in many industrial and R&D projects, has been managing Geostock Innovation for the last 4 years and is now deputy director of Geostock carbon-free storage solutions, Geostock Green Storage.

Microseismic Assessment and Fault Characterization at the Sulcis (South-Western Sardinia) Field Laboratory

Mario Anselmi[1]*, Gilberto Saccorotti[1], Davide Piccinini[1], Carlo Giunchi[1], Mario Paratore[1], Pasquale De Gori[1], Mauro Buttinelli[1], Enrico Maggio[2], Alberto Plaisant[2] and Claudio Chiarabba[1]
[1]*Istituto Nazionale di Geofisica e Vulcanologia, Italy*
[2]*Sotacarbo S.p.A., Italy*

Abstract
The general acceptance of the carbon dioxide geological storage by stakeholders is a challenging step, passes through the assessment and mitigation of risks, potentially induced or increased by the disposal activity. Injection of moderate to large quantities of CO2 in the sub-surface may unbalance local stress and trigger earthquakes if faults are critically stressed.

Pilot sites are therefore the best way to proceed further to address such challenging issues. In such cases, the reconnaissance of faults and seismicity in the sub-surface, before the onset of activity, is mandatory. In this presentation, we present studies carried out in the site where the “Sotacarbo Fault Lab” is going to be installed. This facility will be in a very low seismic hazard region of central Mediterranean, where reports on historical large earthquakes are poor. We show results from a series of experiments aimed to monitor the background seismicity around the pilot site. As expected, seismicity is almost absent down to small magnitude close to the future injection-test well. Further seismic imaging of the sub-surface layers obtained by ambient noise tomography offers the ability to resolve the presence of a seismicity-free fault located in the first 200 m below the surface, of which the last episode of activity is difficult to assess. Our results encourage the use of this site to follow the response of the system to injection of small quantity of CO_2.

Biography

Dr. Mario Anselmi is a permanent researcher in seismology at INGV in Rome, Italy. He is a Geologist and obtained a Ph.D. in Earth Science at University of Rome "La Sapienza". His scientific interests are in seismic monitoring by temporary seismic networks, seismic background baseline assessment, seismic location, seismic tomography and induced seismicity.

Development of a Concept Power Plant Using a Small Modular Reactor Coupled with a Supercritical CO2 Brayton Cycle for Sustainable Antarctic Stations

Joaquín Bustos[1*], **Julio A. Vergara**[1] and **Faustino A. Correa**[2]
[1]*Pontificia Universidad Católica de Chile, Santiago, Chile*
[2]*Universidad Técnica Federico Santa María, Santiago, Chile*

Abstract

Antarctica is the continent with harshest conditions on Earth, despite this it gathers a fairly large population due to its importance in scientific research dispersed in several bases. Because of its role in science, it may become more populated and new areas of research may be opened. Therefore, a sustainable energy system is needed in order to maintain the pristine condition of this continent. The objective of this work was to develop a concept power plant suitable for McMurdo-Scott, South Pole and South Shetland islands, the most relevant year-round Antarctic stations that rely almost fully on fossil fuels. After a thorough analysis of the energy requirements and energy conversion cycles we reviewed several advanced reactor designs and selected a very Small Modular Reactor coupled to a supercritical CO_2 cycle as an emissions free solution for Antarctica. A mathematical model was applied to optimize the heat cycle after an analysis of the total conductance value in the recuperators. The result was a Heat Pipe SMR with a supercritical recompression CO_2 Brayton cycle with net electrical power of 1500 kW and efficiency of 40, 55% cooled by air.

Biography

Joaquín Bustos works on sustainable energy development with applications to various backgrounds. A main area of research is energy for Antarctica and isolated places such as communities, isolated bases, and extra-planetary stations. He studied Mechanical Engineer alongside a M.S. degree at Pontificia Universidad Católica de Chile.

Investigation of Phase Reaction between $Pr_2NiO_{4+\delta}$ and $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ Under Solid Oxide Cell Sintering and Operating Temperatures

Chen-Yu Tsai*, **Catriona M. McGilvery**, **Ainara Aguadero** and **Stephen J. Skinner**
Imperial College London, UK

Abstract

$Pr_2NiO_{4+\delta}$, Ruddlesden-Popper phase, has been proved to possess a better air electrode performance than the conventional $La_{0.6}Sr_{0.4}Fe_{0.8}Co_{0.2}O_{3-\delta}$ material in the solid oxide cell applications. Nevertheless, there is an evident that $Pr_2NiO_{4+\delta}$ is not thermally stable and it tends to react with the $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ (CGO10) barrier layer which locates between the air electrode and the electrolyte interface. The research attempts to understand the reaction mechanism and kinetics of $Pr_2NiO_{4+\delta}$ and $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ mixture under various treating temperatures with the aim to develop a new composite air electrode which is more stable without compromising the performance. Overall, it was observed that the praseodymium of $Pr_2NiO_{4+\delta}$ was diffused to

CGO10 and form a new solid solution of Ce1-x-yGdxPryO2-δ (CGPO), leaving NiO as a secondary phase under electrode sintering condition of 1100°C in air. The amount of the newly formed CGPO depended on the sintering time and the contact between two initial phases. In addition, more than one CGPO was detected with various chemical compositions. The content of praseodymium incorporation in CGPO was correlated to how close the initial CGO10 particle location compared to the identified Pr2NiO4+δ/CGO10 interface. When further heating the composite under operating temperature of 800°C for 24 hours in air, the unreacted Pr2NiO4+δ was decomposed to Pr4Ni3O10±δ, the high order Ruddlesden-Popper phase, and Pr6O11. No change of content, however, was found for NiO and CGPO. It is believed that the resulting products are a suitable candidate to form a new composite air electrode.

Biography

Dr. Chen-Yu received his PhD degree at Department of Materials, Imperial College London in 2020. He was supervised by both Prof. Stephen J. Skinner and Dr. Ainara Aguadero. He also has a Master of Engineering (Chemical) qualification from the University of Melbourne. Chen-Yu is very passion about solid oxide cell investigation, especially for its potential application to produce synthesis gas and hydrogen using renewable/nuclear electricity. His research interests include solid oxide cell material development, electrode microstructure optimization, cell structure design, stack design and system design. The aim of his research is to further decrease the degradation rate and facilitate cell commercialization.

Fossil Fuel Production is Reaching Limits in a Strange Way

Gail E. Tverberg, *Our Finite World, Kennesaw, GA*

Abstract

Most people assume that the limit on fossil fuel production is determined by the reserves in the ground. They also expect that limits will be indicated by high prices. In fact, the economy is a self-organizing system, powered by energy (a dissipative structure, in physics terms). This allows the economic system to behave in a way that is almost "upside down" from what we would expect. Limits are reached when prices fall too low for producers for an extended period. In fact, the low price problem tends to happen at a similar time for oil, coal and natural gas. Rather than high prices, the true signs of energy shortages are excessive wage disparity, political unrest, collapsing governmental structures, and pandemics. The last time such an energy shortage occurred was in the 1913-1945 period. We seem to be at the beginning of another such unsettled time period. The way out would seem to be the rapid growth of a very high energy return product, similar to ramped-up oil production that rescued the world after World War II. Nothing of this type is on the immediate horizon, however.

Biography

Gail Tverberg in an independent energy researcher, giving a fresh look at problems from outside the field. Her background is as a Casualty Actuary. She has a M.S. in Mathematics and is a Fellow of the Casualty Actuarial Society. She writes primarily on her blog OurFiniteWorld.com. She has also written several academic papers, including the widely-cited article, "Oil Supply Limits and the Continuing Financial Crisis," published in Energy in 2012. She has been invited to give talks in many different countries. She has also taught a short course on Energy Economics at Petroleum University, Beijing.

The Perspective Electrode Materials for a New Generation of Lithium-Ion Batteries

Anna. V. Potapenko, *Joint Department of Electrochemical Energy Systems, Ukraine*

Abstract

Electrode materials for rechargeable power sources are an integral part of them and the development of new methods of preparation an effective composition for applying for various branches of industry is the actual task. Recently, lithium-ion batteries have been actively used for different electronic devices for the consumer market, medical and aerospace appointments.

The modified citric acid route has been used for the synthesis of the electrode materials with high-rate electrochemical performance. Thus, LiMn2O4, LiNi0.5Mn1.5O4, LiMn2O4/LiNi0.5Mn1.5O4 core shell structure have been prepared and studied as the perspective cathode materials with an excellent cycling characteristics. Recently, new classes of electrode materials have been perspective for commercial application. Among them NCM and NCA layered oxides are used effectively. In our last papers, the Li1.2Ni0.16Mn0.54Co0.08O2 - Al2O3 and Li1.2Ni0.16Co0.08Mn0.54-xVxO2 have been obtained by the modified precipitation and sol-gel methods. The atomic layer deposition (ALD) technique is used to coat Al2O3 on the lithium-rich cathode material. Coating impacts on bulk and local structure changes are investigated by XRD method. SEM images indicate that the surface of the Li1.2Ni0.16Mn0.56Co0.08O2 covered by Al2O3 has been protected from dissolution of cathode material and the modification of surface leads to formation of relatively rough layers of Li1.2Ni0.16Mn0.56Co0.08O2 particles in the composite. The initial capacity of coated material at 0.2C was 230 mAh·g-1 and the capacity retention of 93.6% was achieved after 100 cycles. Comparing the performance of uncoated Li-rich phase, there are significant improvements attributed to the Al O ALD process without significantly affecting high rate applications

Biography

Dr. Anna V. Potapenko is a Senior Researcher at Joint Department of Electrochemical Energy Systems, Kyiv, Ukraine. Her research interests lie in the field of synthesis, characterization and testing of electrode materials. She is defended her PhD thesis on lithium manganese spinels for high-rate electrochemical applications. She is a leader in projects for the development of new methods for the preparation of electrode materials with high capacity and energy performance

Nanoengineering of Optocatalytic Microreactor with Immobilized Catalysts for Selective Oxidation of Aromatic Alcohols

Swaraj Rashmi Pradhan[1*], Karolina Kawka[2] and Juan Carlos Colmenares[1]

[1]*Institute of Physical Chemistry, Poland*

[2]*Warsaw University of Technology, Poland*

Abstract

The development of a photocatalytic system for the valorization of lignin, a major by-product from paper and pulp industries and bio-refineries, is a challenge because of the high variability in its composition. Microreactor is a superior approach to carry out photocatalysis because of some properties like improved irradiation profile, sizeable surface-to-volume ratio, enhanced mass transfer characteristics, higher spatial illumination homogeneity, and better light penetration through the entire reactor depth compare to conventional batch1. The use of sonication for designing these reactors, especially deposition of catalyst inside a microreactor, is very new approach2. Recently, the conversion of aromatic alcohol into its aldehyde has attracted considerable attention due to its fundamental interest and potential applications. Alcohol oxidation to aldehyde is an important reaction, as the many aldehyde products find extensive application in the food, pharmaceutical, perfume, and agrochemical industries. The current work focusses on the selective photocatalytic oxidation of the lignin-based model compound in a polymer-based (PFA) microfluidic photoreactor. Photocatalysis based selective oxidation of benzyl alcohol has been carried out using commercially available, sol-gel synthesized TiO2 and monometallic (Copper) TiO2 photocatalysts. For this study, photocatalysts were taken and deposited internally on the walls of a PFA microtubes with the help of ultrasound. Evaluation of the photocatalytic activity of these microcapillaries carried out for selective conversion of aromatic

alcohol to its aldehyde.

Acknowledgements: This work is supported by the National Science Centre in Poland within Sonata Bis 5 Project No. 2015/18/E/ST5/00306.

Biography

Ms. Swaraj Rashmi Pradhan has completed her integrated masters in Chemistry from National Institute of technology, Rourkela, India. Currently, she is pursuing her PhD in photocatalysis for sustainable energy production and environmental protection under the supervision of Prof. Juan Carlos Colmenares Q.

Energy Security and Strategic Storage from a Financial Option Perspective

Lawrence Haar, *The University of Brighton, United Kingdom*

Abstract

There are many approaches to measuring energy security: some researchers use geologic and technical factors while others focus upon supply and demand. Common to these approaches is the emphasis upon exposure to supply disruption but not to the probability of its occurrence. As petroleum markets have shown themselves resilient to quite extreme secular events, we ask if an alternative approach might be useful in quantifying energy security. We apply financial option theory to three eventful periods to learn the expectations of market participants to disruptions. We find the forward-looking views of petroleum market participants to be accurate with regard to both price persistence and the resilience of markets to absorb shocks. Our results cast doubt upon the need for emergency inventories unless justified to dampen market volatility on public good grounds.

Biography

Lawrence Haar is a Senior Lecturer in Finance with Brighton Business School of the University of Brighton. Before academia, Dr Haar was a Director and Managing Director for Risk Management and Valuation with major banks, energy and mining companies. He was a Director for Audit Assurance with Deloitte. Dr Haar has expertise in the regulation of Financial Markets, having worked for the UK Authorities as a Senior Risk Specialist. He regularly appears in academic journals, such as Energy Policy, Energy Strategy Review and the publications of the Institute for Economic Affairs and the CATO Institute as well as the financial press, such as the Petroleum Economist.

Two-dimensional Materials for Electrochemical Applications

Fei Yao*, **Sichen Wei**, **Chaoran Chang**, **Maomao Liu**, **Yu Fu**, **Jihea Li** and **Huamin Li**
University at Buffalo, Buffalo, NY

Abstract

The fast development of modern technology requires matured energy storage and conversion devices to meet the demands of the ever-growing portable electronic and electric vehicle industries. As a result, electrochemical energy strategies including energy storage and electrocatalysis have attracted broad attention lately. Thanks to the fast development of nanoscience and nanotechnology, various structures and materials have been proposed with outstanding electrochemical performance. Low-dimensional materials including graphene, transition metal dichalcogenides, and MXene, etc., have demonstrated enormous potential as electrode materials for energy storage and conversion due to their robust properties of high electrical conductivity, large surface area, and superior chemical stability. In this talk, the electrochemical property of low-dimensional materials will be introduced. Advanced two-dimensional materials and their hybrids for the applications of electrochemical energy storage and electrocatalysis will be discussed.

Biography

Dr. Yao received her dual Ph.D. degree in Energy Science from Sungkyunkwan University, Korea and in Physics from Ecole Polytechnique, France, in 2013. From 2013 to 2015, she worked as a postdoctoral researcher in the Institute for Basic Science (IBS), Korea. From 2015 to 2017, she worked as a postdoctoral research associate in Electrical Engineering, University of Notre Dame, USA. Currently, she is an assistant professor in the Department of Materials Design and Innovation, University at Buffalo. Her research interests include low-dimensional materials synthesis, property engineering, and their applications in energy storage, conversion, and electronic devices.

The Role of Flexible Technologies in the Transition to Low-Carbon Power Systems

Ricardo Alvarez, *Universidad Técnica Federico Santa Maria, Chile*

Abstract

Several power systems around the globe are experiencing a rapid deployment of renewable energy sources (RES) such as photovoltaic and wind generation, in order to achieve climate change mitigation objectives. While this trend represents a unique opportunity to effectively combat climate change, it also poses significant challenges in power system planning and operation. Compared to conventional generating units, power plants based on RES are typically located in different parts of the network, often in weak areas of the system with sparse transmission capacity and have shorter construction times. The large-scale integration of RES in power systems has also been characterized by significant levels of uncertainty regarding both future capacity and allocation of new generating units and the generation feed-in of RES. The restructuration of power markets also increased and diversified the sources of uncertainty regarding generation expansion, since it is no longer coordinated with the transmission expansion. Consequently, network planners are facing a significant challenge to achieve a more adapted expansion plan, which involves a timely and cost-effective increase of the transmission capacity to accommodate future RES while providing secure and reliable electricity service to customers, enhancing competition and ensuring market efficiency. In this presentation, the role of flexible technologies as key enablers for achieving an economic and secure transition from conventional power systems to low-carbon ones is presented. The benefits of flexible technologies are accounted for in terms of increased operational flexibility, enhancing system robustness and allowing a fast increase of available transmission capacity.

Biography

Dr. Ricardo Álvarez was born in El Salvador, Chile. He received the degree in Electrical Engineering from the University of Chile, Santiago, Chile, in 2005 and the Ph.D. degree in Electrical Engineering from the RWTH Aachen University, Aachen, Germany, in 2016. He is currently Professor at the Universidad Técnica Federico Santa María and Researcher at the Solar Energy Research Center (SERC-Chile). His main interests are power system planning, operation, and optimization, large-scale integration of renewable energies and the use of Artificial Intelligence in power system applications.

Development of a Cost-Effective Ground Source Heat Pump System for Maximizing the Use of Renewable Energy

Yao Yu[1*], **Rui Miao**[1], **Xiaoou Hu**[1] and **Gaylord Olson**[2]
[1]*North Dakota State University, USA*
[2]*Seasonal Storage Technologies, USA*

Abstract

Ground Source Heat Pumps (GSHPs), as one type of electric heat pump in the marketplace today, have a greater potential of energy savings compared to Air Source Heat Pumps (ASHP) or other traditional systems that involve burning natural gas or oil, especially for space heating. The

downside (key market barrier) of GSHPs is they are more expensive to install and typically need incentives to be competitive, especially in the residential sector. This presentation examines the technical and economic tradeoffs of a newly developed, low-cost, high-efficiency heat pump system. This system consists of a ground source heat pump that is combined with a dry fluid cooler(s) with the intention of reducing the borehole size in order to eventually reduce the overall cost. The dry fluid cooler(s) can take some of the heating and cooling loads to allow the reduction of the borehole size, but its cost is typically much less than boreholes. This, therefore, provides an opportunity for developing a cost-effective GSHP system through the combined use of boreholes and dry fluid coolers. It is expected that the developed system can achieve similar or better performance and capacity compared to a conventional GSHP system at lower cost, and its wide application contributes to the maximum use of renewable energy.

Biography

Yao Yu earned his two Master degrees and one Ph.D. in Architectural Engineering, Civil Engineering, and Computational Science and Engineering in 2008, 2012, and 2014, respectively. After graduation, Dr. Yu worked in industry as an energy engineer to perform building energy modeling and simulation. He is a LEED Accredited Professional, an ASHRAE Building Energy Modeling Professional (BEMP) and Building Energy Assessment Professional (BEAP). Currently, Dr. Yu is working as an assistant professor in the Department of Construction Management and Engineering at North Dakota State University.

Pressure Mediated Energy Storage in Electrolyte-Permeated Nanopores

Dusan Bratko1*, Serban Zamfir1 and Filip Moucka2
[1]*Virginia Commonwealth University, USA*
[2]*J. E. Purkyne University, Czech Republic*

Abstract

Compression of water in hydrophobic pores has been established as a viable mechanism for conversion of mechanical work to interfacial free energy as new form of energy storage or absorption. Reducing the hysteresis of the influx/outflow cycle is imperative for efficient energy recovery. In our molecular simulations, replacing water by concentrated electrolyte solution rises the expulsion pressure and nearly doubles the amount of recovered work. The simulations provide a theoretical perspective into the mechanisms involved in the process, and underlying structures and interactions in compressed nanoconfined solutions. Specifically, we consider aqueous NaCl in planar confinements of widths of 1-2 nm and pressures of up to 3 kbar. Open ensemble Monte Carlo simulations with fractional exchanges of ions are utilized in conjunction with pressure-dependent chemical potentials of bulk phases under pressure. Confinements open to pressurized bulk electrolyte phases show improved reversibility enabled by significant increases in the solid/liquid interfacial tension in narrower pores and associated infiltration and expulsion pressures. These changes are consistent with a strong desalination effects observed in the nanopores irrespective of external pressure and initial concentration. Guidelines for improving efficiency towards spring behavior include decreasing the nanopore size and increasing the concentration of ions through more soluble electrolytes such as LiCl.

Biography

Dr. Dusan Bratko is a Professor of Physical Chemistry at the Virginia Commonwealth University. He has previously held positions at the Department of Chemistry, University of Ljubljana, and in the College of Chemistry, University of California at Berkeley. His research concerns statistical mechanics and molecular modeling of ionic solutions, colloids and interfacial phenomena of interest in nanoscience, energy, and materials engineering.

Flash-enabled Synthesis of Graphene-based Electrodes for High-performance Supercapacitors

Huihui Zhang*, **Dan Yang**, **Han Lin** and **Baohua Jia**
Swinburne University of Technology, Australia

Abstract

Supercapacitors (SCs) hold the key to realize secured, reliable and sustainable energy supply, mainly because of their fast-charging speed, long lifecycle and benign environmental impact compared to batteries and fuel cells. However, the state-of-the-art SC devices face significant limitation in their energy densities, which are generally below 10 Wh/kg. Although many efforts have been made to improve the energy density of SCs through producing graphene electrodes, the fabrication usually involve toxic chemicals and/or complicated processes. To the best of our knowledge, it remains a major challenge to produce high-performance graphene-based SC electrodes through a fast and simple method. By introducing ultrahigh heating rate into thermally driven reduction process and ensuring a high local temperature via thermal management, we propose the production of such materials through using a camera flash. This simple and scalable method enables rapid gas generation and release process and creates sponge-like electrode materials with high ion-transportation quality. SCs based on the fabricated electrodes demonstrate high energy density of around 60 Wh/kg. This performance far exceeds the supercapacitor (9 Wh/kg) demonstrated by the state-of-the-art flash reduction method without thermal management, and it is also comparable to the best-demonstrated supercapacitors (71~85.6 Wh/kg) in the literature fabricated with a much-complicated process. Such simple flash reduction process can also realize one-step and ultrafast production of graphene/MnO nano-hybrids, which exhibited ultrahigh capacitance (1,706 F/g) beyond the theoretical limitation of both pure MnO and pristine graphene.

Biography

Huihui Zhang is currently a PhD candidate at Swinburne University of Technology. She received her B. Eng. degree in materials science and engineering from Wuhan University of Technology in 2017. Her research focuses on the design, preparation and application of advanced materials for energy storage.

The Research and Application of High-Temperature Retrofit on Subcritical Units

Weizhong Feng* and **Li Li**, *Shanghai Shenergy Power Technology Co., Ltd., China*

Abstract

Continuous pressure of global warming has profound effect on global energy structure. As wind power and solar energy soaring in recent years, coal-fired power plants are facing with unprecedented challenges, mainly on two aspects: one is improving efficiency to reduce carbon emission, and another is improving flexibility to better support the unstable wind and solar power. While new ultra-supercritical units are built with high efficiency, existing subcritical units with much lower efficiency level still account for the major part worldwide. Shutting them all down is not a practical solution, while retrofit is also very challenging. The high temperature retrofit, however, find a feasible solution for this problem. By improving the steam temperatures from 538°C to 600°C, combined with other energy-saving technologies, the unit efficiency will be greatly improved by more than 10%. The world first high-temperature retrofit project on a subcritical coal-fired power unit was initiated in April 2017 and finished in August 2019. According to the third parties' performance report, the unit net efficiency under rated condition is significantly improved from 38.6% to 43.5%, while the lowest stable load of the boiler without oil-firing support and with SCR operation is remarkably reduced from 55% to 19%. Despite the success in efficiency and flexibility, this retrofit can also greatly extend the unit's lifetime. Meanwhile, these achievements are based on reasonable cost. This project has set a benchmark for the retrofit of existing subcritical units and meets the demands of the latest Coal FIRST plan proposed by America's DOE in 2019.

Biography

Feng Weizhong, General Manager of Shanghai Shenergy Power Technology Co., Ltd., Vice Chairman of Shanghai Waigaoqiao No. 3 Power Generation Co., Ltd., Chairman of Huaibei Shenergy Power Generation Co., Ltd. (1,350 MW National Demonstration Project); Vice Chairman of China Energy Society; Director of Shanghai Engineering Research Center of Clean Coal-fired Power. He won the ASME "Prime Movers Award" in 2016 as the first Chinese winner since the establishment of the award in 1954. He has published over 50 papers, possessed 66 patents and been to Europe, USA, Japan and Australia to give academic reports on invitation for 12 times.

Synthesis of Graphene Mesosponge Using HCl-Dissolvable Materials as a Template

Shogo Sunahiro[1*], **Keita Nomura**[2], **Shunsuke Goto**[2], **Masanori Yamamoto**[2], **Junko Nomura KONDO**[3], **Takashi Kyotani**[2] and **Hirotomo Nishihara**[2]

[1]*Tokai Carbon Co., Ltd., Japan*

[2]*Tohoku University, Japan*

[3]*Tokyo Institute of Technology, Japan*

Abstract

Recently, energy storage devices have become more and more important towards the realization of a low carbon society. In energy storage devices, carbon materials are used for a variety of purposes such as electrode active materials and conductive additives. Thus, the development of new carbon materials with superior performances or properties is critical for device improvement. Graphene mesosponge (GMS) is a new class of mesoporous carbons consisting mainly of single-layer graphene walls. GMS is expected as a high-performance and highly durable electrode material from its excellent characteristics such as high specific surface area, high electric conductivity, high corrosion resistance, and mechanical toughness as well as flexibility. GMS is synthesized via chemical vapor deposition (CVD) of methane onto alumina nanoparticles which play the role of a template. However, the alumina template can be dissolved only by hydrofluoric acid or concentrated base that are environmentally not friendly and also costly. To industrialize GMS, it is important to find out alternative template materials. In this work, we investigate the preparation of GMS using template materials that are easily dissolved in hydrochloric acid. For this purpose, alkaline earth metal oxides were selected because their basicity may contribute to the catalytic activation of methane. As a result, we have found sufficient catalysis of alkaline earth metal oxides for carbon deposition from methane and succeeded in the synthesis of GMS with physicochemical properties comparable to those of the GMS prepared using alumina template. This research offers a potential pathway to the industrialization of GMS.

Biography

Shogo Sunahiro received the Master's degree in engineering of Chemistry for Materials from Mie University, Japan, in 2014. His research theme was rechargeable aqueous lithium–air batteries. After that, he joined Tokai Carbon Co., Ltd. and had engaged in the production of carbon materials for lithium ion battery for over five years. He contributed to the innovative cost reduction there. After working at the research center in 2019, he has started collaborative research on cutting-edge carbon materials at the Kyotani/Nishihara laboratory of Tohoku University.

The Use of Solar PV Technology on Artificial Oil Lift Methods

Lucas Bernhard Maisel, André Laurindo Maitelli, Carla Wilza Souza de Paula Maitelli and Marcos Allyson Felipe Rodrigues
Federal University of Rio Grande do Norte, Brazil

Abstract
This paper focuses in the use of renewable energies to feed oil producing fields using artificial lift systems. Around 10% of the produced oil is used inside the oil industry, number that can be reduced with the usage of renewable energy. Knowing that around 95% of oil wells use some method of artificial oil lift method, and that the change to a cleaner energy matrix is necessary, this study show the dimensioning and financial analyses of an on-grid photovoltaic system used to cover the energy costs of different artificial oil lift methods. Artificial oil lift is necessary when the oil well is no longer surgent, which means that the reservoir does not supply enough energy to oil production. So, extra energy is needed to lift and produce the petroleum. To that purpose different methods can be used, such as Electric Submersible Pumps (ESP), Gas lift, Sucker-Rod pumping and Progressive cavity pumps (PCP). On this paper, the utilization of solar energy on a high solar incidence location, shows up to be an viable alternative to the purpose described before, where was dimensioned a system with 2.225 photovoltaic panels distributed in 135 strings capable to supply energy to 40 wells using sucker-rod pumping and 1 using ESP. It is made also a financial analysis, taking in account the payback period, to that was utilized the System Advisor Model (SAM) software, where was found a period of 7.1 years, which was considered a good period considering the lifespan of the methods studied.

Biography
Lucas Bernhard Maisel is a fourth year Oil and Gas student at Federal University of Rio Grande do Norte in Brazil. He received a bachelor's degree in Science and Technology at the Federal university of Rio Grande do Norte. His main interests are in fossil and renewable energy and in energy transition.

A PV System for Coastal and Marine Applications: Design & Implementation

Yasna Schifferli
Gestener, Chile

Abstract
In the present paper the design of a photovoltaic system, made up of 40 subsystems and suitable for the marine environment, is presented as a proposal to replace the diesel generator that currently supplies electricity to the settlement of Caleta Camarones, Chile, only for a 2- hour period per day. The Caleta Camarones settlement is made up of 40 families dedicated mostly to artisanal fishing activities and that are in a situation of land grabbing. In order to verify the designed system performance, the results of the implementation of a PV subsystem in the city of Santiago are presented. From the results obtained and making a comparative analysis between the energy generated by the PV subsystem implemented in the city of Santiago and the expected energy variation in Caleta Camarones, it is concluded that the PV system designed is capable to generate a maximum of ~ 88% of the electricity currently supplied by the diesel generator to each home of Caleta Camarones. This percentage may increase to more than 100%, making minimal modifications to the system design.

Biography

Yasna Schifferli is an Electrical and Acoustic Engineer with a Postgraduate Certificate in Electrical Engineering from the University of Toronto and certified in Energy Management from the same University. She currently owns a Renewable Energy company called Gestener. She is also an active member of Electrical and Mechanical Engineering professional communities.

Biomass Conversation for Green Adsorbent Generation and Rapid Spectroscopy Technique for Its Characterization

Hesham A[1*] and Jahin H[2]
[1]Suez Canal University, Egypt
[2]National Water Research Center, Egypt

Abstract

In fact, biomass is an abundant and renewable organic resource as a raw material for the hydrochar and biochar production. The global environmental objective to solve the environmental problems using green techniques. Hydrochar during the last few years attracted the researcher's attention as an excellent solution for environmental application. This work aimed to prepare hydrochar from orange peels feedstocks and using the FTIR as rapid and accurate techniques to identify the functional groups of the hydrochar surface, which reflects the ability of hydrochar to be used as an adsorbent for environmental pollutants. In This work biomass feedstock from orange peels has been dried at 100 ˚ C for 200 min. Then, Hydrothermal Carbonization (HTC) process was done at 180 ˚C for 200 minutes for hydrochar preparation. Distilled water has been used as HTC medium. The yield, pH, density has been tested. FTIR spectra for feedstock, hydrochar differs, which shows the changes that took place during the HTC process. The appeared function groups in most biomass feedstocks aliphatic hydroxyl, carboxyl, C-H, C=O, C=C. After the hydrothermal carbonization process, this peak reduced indicating that the lignin only decomposed partially under the studied condition. Also, it is indicating distortion of the C-H bonds in aromatic compounds. The study concludes that, hydrochar from orange peels feedstock successfully prepared, from the FTIR spectrum it is be expected to have effective adsorption properties.

Keywords: Hydrothermal Carbonization, Environmental applications, Hydrochar, FTIR.

Biography

Before joining Suez Canal University for PhD obtaining, Ahmed obtained his M. Sc. in environmental chemistry from Ain Shams University. Since joining the University of Suez Canal, Ahmed has been involved with studies related to environmental application using both green and nanotechnology.

Tunable Hydrogen Production Using Gate-Modulated Two-Dimensional Transition Metal Dichalcogenide

Chaoran Chang*, Maomao Liu, Jihea Lee, Sichen Wei, Yu Fu, Huamin Li and Fei Yao
University at Buffalo, USA

Abstract

Despite the exciting progress for catalyst development, the advancement of electrocatalysis has been hampered for decades due to the absence of innovative attempts to enable the dynamic tuning of catalytic activity which has the potential to accelerate the deployment of clean energy technologies. As a zero-emission, eco-friendly fuel with the highest energy density, hydrogen (H2) gas can be produced using water electrolysis via hydrogen evolution reaction (HER). Nevertheless, the

wide adoption of H2 has been mainly constrained by the use of Pt group metals (PGM) as catalysts. Although novel materials such as two-dimensional MoS2 have been proposed as attractive PGM-free catalysts for HER, previous research efforts are mainly focused on the exploration of catalyst structure-property relationship. So far, dynamic tuning of HER activity has not been proposed which severely hinders the development of next-generation catalysis technology toward on-demand applications. In this work, we focus on the novel investigation of a variational approach targeted on the dynamic, continuous and reversible HER tunability by introducing electrostatic field effect on a MoS2-based microreactor platform. The fundamental physics of the electrostatic field effect on the catalysis tunability will be introduced. The application of electrostatic field effect as a tuning knob to precisely modulate the catalytic activity of MoS2 during the HER process was successfully demonstrated.

Biography

Chaoran Chang is a Ph.D. student in Prof. Fei Yao's research group at the Department of Material Design and Innovation, University at Buffalo (UB), USA. He received his B.S degree in Electrical Engineering in 2019 at UB. His research interest includes the design and characterization of low-dimensional materials and their application in energy storage and conversion.

Spatial and Temporal Evolution of the Sinian Strata and its Implications on Petroleum Exploration in the Sichuan Basin, China

Zhengshuo Miao[1*], **Yangwen Pei**[1], **Nan Su**[2], **Shouzheng Sheng**[1] and **Ben Feng**[1]
[1]*China University of Petroleum, China*
[2]*Research Institute of Petroleum Exploration & Development, PetroChina, China*

Abstract

In recent years, there has been a significant discovery of hydrocarbon resources of commercial value in the Dengying formation of the central Sichuan basin. However, the control of tectonic evolution on the hydrocarbon accumulation has not been appropriately documented. Therefore, in this study, we employed multiple methods, including seismic interpretation, balanced cross-section restoration, deformation quantification, erosion calculation, and paleo-uplifts/lows reconstruction, to investigate the tectonic kinematics, erosion distribution, paleo-uplifts/lows of the Sichuan basin. The quantification of deformation reveals that the Sichuan basin has experienced complicated tectonic evolution, with two rounds of transition from extension to compression since Sinian. Since late Triassic, intense contraction happened in the Sichuan basin, resulting in the development of its current structural pattern. By integrating erosion distribution, the reconstructed paleo-uplifts/lows maps of the Sinian strata (i.e., the Dengying formation) suggest the development of an inherited paleo-uplift in the central and southwestern Sichuan basin from Ordovician to present. The evolution of paleo-uplifts/lows has played critical control on the hydrocarbon accumulation of the Weiyuan and Anyue gas fields, which indicates that there could be high potentials for hydrocarbon exploration in areas with high slope gradient in the paleo-uplifts.

Keywords: Tectonic kinematics, deformation quantification, erosion distribution, paleo-uplifts/lows, Dengying formation, hydrocarbon accumulation

Biography

Zhengshuo Miao is a student from China University of Petroleum. In his study and work, he mainly involved in the following aspects: seismic interpretation, balance section restoration, quantitative evaluation of basin and geological three-dimensional modeling. At present, I have participated in three field geological expeditions, respectively: (1) Qinhuangdao, China (China University of Petroleum), 2015; (2) Anhui chaohu, China (China University of Petroleum), 2016; (3) The east of the Shandong Peninsula, China (China University of Petroleum), 2017. And there are two papers to be published.

Tectonic Evolution and Hydrocarbon Occurrence Conditions of Shandong Peninsula, China

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Abstract

The study area is located in the middle part of the Sulu orogenic belt, which belongs to the junction of North China and Yangtze craton. According to the field investigation and geophysical data, a residual Marine basin of the Late Mesozoic basin buried under the Cenozoic basin was discovered and named as the Riqingwei basin. In this study, based on field data, multiple methods (including stratigraphic chronology, structural geology, isotope geochemistry analysis) were employed to study the characteristics of tectonic evolution and source rocks (including organic matter content, organic matter type, organic matter evolution degree) in the Riqingwei Basin. Tectonic evolution presents that the tectonic stress in the study area has undergone three changes from extension to compression since the Cretaceous, forming a complex geological structure style. The petroleum geological conditions of Riqingwei Basin are identified based on the study of petroleum geological conditions of source rocks (organic matter content, organic matter type, organic matter evolution degree). Finally, three favorable hydrocarbon exploration areas are proposed to lay a foundation for future hydrocarbon exploration in Riqingwei basin.

Biography

Jing Wang is a student from China University of Petroleum (east China). In her study and work, she mainly involved in the following aspects: seismic interpretation, balance section restoration, evaluation of basin and isotope geochemistry analysis. She has a lot of field practice experience, mainly in the vicinity of Shandong Peninsula. And there are one papers to be published.

New Approaches to the Use of Plant Materials in Oil Refining

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Abstract

Currently, the world's major energy needs are met through traditional fossil fuels, namely oil, natural gas, coal and peat. However, these resources are classified as non-renewable, thus there is a need for a partial, and in the future, complete transition to new energy resources. The weighting of oil (as the main traditional source of energy), the ever-increasing complexity of its production, the increase in tar-asphaltene substances and sulfur, the increase in oil product consumption, the instability of prices for natural energy carriers, as well as the tightening of environmental requirements for motor fuels only confirm the importance of the development of alternative energy. One of the most promising ways of development is the diversification of raw materials for the production of petroleum products. In this regard, one cannot fail to note the increase in publications devoted to the use of vegetable oils as a component, and in some cases as the main source of raw materials, for the production of petroleum products. In addition, biofuels derived from plant materials have improved environmental characteristics, which is especially important in the present state of environmental protection.

One of the promising ways to integrate vegetable oil into oil refining processes may be to use them as a component of raw materials for the coking process. Due to the reduction of light oil reserves, thermo-destructive oil refining processes are becoming especcially popular. The most effective process from the point of view of obtaining light fractions from the tar is the coking process. This direction has many advantages compared to the process of obtaining fuels by transesterification of vegetable oils. Oil refineries have already been built, therefore, the capital cost of

upgrading equipment will be minimal. Also through co-processing vegetable oils and tar we may get a wide range of petroleum products, in addition to diesel fuel, in this way we can get gasoline, kerosene and marine fuel.

A promising direction may be the use of vegetable oils as a “softening agent” for oil binders. The most suitable component is castor oil. Due to its unique fatty acid composition (80-90% consists of 12-hydroxyoleic acid), castor oil has an increased viscosity (in comparison to other vegetable oils) due to the association of molecules due to hydrogen bonds of the hydroxyl group. Thus, when using castor oil as a component of petroleum binders, it can both dilute the dispersion phase and stabilize the heterogeneous structure.

In accordance with modern environmental requirements for diesel fuels, the content of sulfur compounds in them should not exceed 10 ppm. In order to achieve such low concentrations, deep hydrotreating of diesel fractions is carried out, while removing not only sulfur, but also other heteroatomic compounds providing high lubricating properties. To restore the lubricating properties of diesel fuels, anti-wear additives based on tall oil fatty acids are used in Russia, while in the countries of the European Union and United Stated of America biodiesel can be used for such purposes.

It is known that the effectiveness of oxygen-containing antiwear additives in diesel fuels decreases in the series: COOH> CHO> OH> COOCH3> C = O> C-O-C. Thus, the most preferred active ingredient are fatty acids, the effective concentration of which varies from 0.005 to 0.03% of the mass. In the case of the use of fatty acid esters, a reduction in the corrected diameter of the wear scar to acceptable value can occur at a concentration of 1%.

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