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BOOK OF ABSTRACT

7th ISEES

International Workshop

on

Sustainable Energy, Environment & Safety with Railway Centric Theme

21st-23rd December, 2015

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The International Society for Energy, Environment and Sustainability (ISEES) was founded at IIT Kanpur in January, 2014 with an aim to spread knowledge in the fields of Energy, Environment, Sustainability and Combustion. In this changing environmental scenario, the time has come where more emphasis has to be laid on renewable energy resources. Moreover, in this dynamic scenario of swelling competition and reducing profits, staying environmentally responsible can be extremely challenging for any organization. More efficient systems have to be developed to meet the increasing energy demands keeping in mind its environmental impact. People have to become more aware and concerned about the environmental challenges which the world is facing today to make it a better place for us and our future generations. The society aims to spread knowledge in the above mentioned areas among people and make them more aware about the environmental challenges which the world is facing today. The Society is involved in various activities like conducting workshops, seminars, conferences, etc. in the above mentioned domains. The society also recognizes young scientists and engineers for their contributions in this field. It comprises of experts from leading research institutions working in various domains related to energy.

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Invited Speakers

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Invited Speaker's Biographies and Abstracts

Prof. Abhijit Kushari
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Dr. Abhijit Khusari is a Professor of Department of Aerospace Engineering at Indian Institute of Technology Kanpur. He obtained his B Tech in Aerospace Engineering from IIT Kharagpur in 1994, M.S. in Aerospace Engineering from Georgia Institute of Technology, Atlanta, USA in 1995 and also doctoral degree in Mechanical Engineering from Georgia Institute of Technology, Atlanta, USA in 2000. Prof. Kushari's research interests include Combustion, Liquid Atomization, Active Flow Control, Turbo-machinery, and High Speed Flows. He is a consulting fellow of World Innovation Foundation, member Review Editorial Board of Frontiers in Interdisciplinary Physics and member editorial board: Recent Patents on Mechanical Engineering, Bentham Publications. Prof. Kushari has several international journal publications and has supervised a number of masters and doctoral thesis.

Lean-Premixed Prevaporized Combustion with Non-Circular Inlets

Kiran Raj Goud, Abhijit Kushari
Department of Aerospace Engineering
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Abstract

Increasing stringent rules on the emissions of NOx from combustors of gas-turbines are forcing us to look into advancement in design of combustors or to switch to alternatives. One such novel technology that is recently becoming more popular is Lean-Premixed Prevaporized Combustion. It is found to be the best possible alternative to the current diffusion flame combustors in terms of NOx and other pollutant emission. But, these combustors are prone to instability, with a narrow operational envelope. The source of this instability is from the large scale structures coupling to produce sudden heat release. Research is going on to control this instability using active and passive methods. Literature shows that use of non-circular combustor inlet geometries as passive control technique increases fine scale turbulence and suppresses instability. In this work, we compare different inlet cross-sections with circular geometry and with each other for their effectiveness and reason for it. We found that rectangular inlet proved to most effective in providing uniform and stable combustion and moderate Reynolds number and all the cornered shapes showed same effectiveness at higher Reynolds number. Investigations to find the most dominating geometric parameter showed that increase in number of corners shows negligible effect on lift-off length, and increase in perimeter of the inlet decreases the lift-off length, but the effectiveness is less compared to an elongated inlet like rectangle.

Prof. Achintya Mukhopadhyay

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Dr. Achintya Mukhopadhyay is a Professor of Mechanical Engineering at JadavpurUniversity, Kolkata (Calcutta), India. He also served as Professor of Mechanical Engineering at Indian Institute of Technology Madras. Dr. Mukhopadhyay also held visiting positions at Technical University of Munich where he was an Alexander von Humboldt Fellow and University of Illinois at Chicago. He obtained his Bachelors, Masters and doctoral degrees from Jadavpur University, Indian Institute of Science, Bangalore and Jadavpur University, all in Mechanical Engineering. Dr. Mukhopadhyay's teaching interests include thermodynamics, heat transfer, combustion, multiphase flows and design and analysis of thermal systems. Dr. Mukhopadhyay's major research interests are chemically reacting flows, multiphase flow and heat transfer and microscale flow and heat transfer. His current research activities include droplet and spray combustion, structure and dynamics of partially premixed flames, nonlinear dynamics and chaos in combustion systems, instability of liquid sheets and atomization, spray impingement heat transfer and electrokinetic and thermomagnetic microscale flows. Dr. Mukhopadhyay has over 200 research publications including 70 international journal publications and has supervised a number of masters and doctoral thesis. He has also served as reviewer of a number of international journals. Dr. Mukhopadhyay is a life member of Indian Society of Heat and Mass Transfer and Indian section of the Combustion Institute.

A Comprehensive Model for Estimation of Spray Characteristics

Souvick Chatterjee, Achintya Mukhopadhyay,
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Abstract

Atomization of liquid leading to spray formation is widely encountered in nature and finds application in different fundamental and industrial fields. In this work, we concentrate on an atomization configuration particularly useful in a gas turbine injector. An annular fuel stream is sandwiched on either side by air in a strong swirling environment. A comprehensive model is described in this work to analyze stability of annular swirling liquid sheets. The model include CFD studies to understand the internal hydrodynamics and nozzle exit velocity conditions which in turn is used for a linear stability analysis to study the growth rates of the instabilities leading to breakup. Experimental investigation shows different interesting regimes of spray formation. While experimental visualization shows topology of the sheets, insights on internal hydrodynamics and stability of the particular sheet structure is obtained through the model. Also, the growth rate and breakup length estimations from the model show similar trend as observed in the experiments with the early breakup mode as the most unstable and onion as the most stable mode.

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Dr. Akshai K Runchal is Chairman, IIT Kanpur Foundation Board and serves on the Advisory Board of IIT Gandhi Nagar. He is currently the President of ISEES and a Program Director for the Government of India on the Human Simulator (HuSim) National Initiative launched by the Information Technology Research Academy (ITRA) of Media Lab Asia. He is also the President and Director of the CFD Virtual Reality Institute (CFDVRi), Dharamsala, and the CEO of the ACRi Group of companies with offices in the US, France and India.

Dr. Runchal received a Bachelor of Engineering with Honors from Punjab Engineering College, Chandigarh in 1964. He received his Ph.D. in Fluid Mechanics and Transfer Processes from Imperial College (London University) in 1969 under the guidance of Prof. D. Brian Spalding. He was a key member of a small group of 3 persons led by Prof. D. Brain Spalding that invented the Finite Volume Method (FVM) of CFD in mid-1960's. He is the author or co-author of 7 books and over 200 technical publications.

Numerical Simulation of Railway Compartment Fires

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Abstract

This study aims to develop a predictive capability via application of CFD to the analysis of fires in railway compartments and thereby provide critial information to designers of associated fire safety systems. The CFD software, ANSWER [1], and the NIST FDS [2] have been used in these studies. The FDS software is very commonly used in fire safety studies. However, it supports only rectangular geometry and the LES models for turbulence, which is computationally intensive. Since the ANSWER code supports unstructured meshes, various combustion and turbulence models, it has been extensively used in this study. The CFD models have been validated against case studies available in literature [3 - 6]. Thereafter, predictive analysis has been carried out for a typical Indian Railways sleeper class coach for various operating conditions and fire scenarios.

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Dr. Anirudh Gautam belongs to the Indian Railways Service of Mechanical Engineers. He has served initial years on the Indian Railways in the maintenance of the carriage and wagon, maintenance and operation of steam locomotives, operation and maintenance of diesel locomotives and train and crew management in the challenging Eastern Sector of Indian Railways. He then worked in the area of manufacture of diesel locomotives at Diesel Locomotive Works, Varanasi and moved to the niche area of design and development of diesel engines for the locomotives. He is credited with design of the first hotel load feature on an export locomotive and was instrumental in building the first indigenous EMD design locomotive in India at DLW. He has been working on the research and development of locomotive diesel engines and use of alternative fuels on these engines. His main areas of interest are combustion, performance and emissions development of locomotive engines, control systems development and structures optimization. He is recipient of various awards by the Ministry of Railways, including the coveted National Award for Outstanding service by the Minister of Railways. He is currently working on development of highly fuel efficient engine technologies for locomotive engines, design and development of natural gas engine technologies, use of biodiesel on locomotive engines and reduction of emissions from locomotive engines. He is an Alumnus of the prestigious SCRA scheme of Government of India and holds a Masters in Quality management from BITS Pilani, a Masters of Engineering in Engine Systems from University of Wisconsin, Madison, USA and a PhD in IC engines from IIT Kanpur.

Development of an Emission Measurement Car for Measuring Emissions from Diesel Locomotives of Indian Railways

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Abstract

Measurement and control of harmful pollutants from diesel locomotives is a mission area for Indian Railways. Indian Railways have a fleet of about 5000 diesel locomotives based in various diesel maintenance sheds spread all over India. It is not possible to create a central emission measurement facility to measure emissions from these diesel locomotives. Therefore, it was planned to develop a mobile emission measurement car which is capable of measuring regulated emissions from diesel locomotives of Indian Railways by going to the different diesel shed. As the measurements are to follow the International emission standards and the emission equipments currently available are mainly for stationary applications, a challenge was to modify these emission measurement equipments so that these can withstand the shocks and vibrations experienced by a typical railway vehicle. Also the sampling of the exhaust posed a problem since there are restrictions on the length of the sampling line from the engine to the measurement equipment. A sampling system was designed and implemented to comply with the International emission standards and a vibration and shock damping system was devised to be fitted on the emission measurement system. A layout of the emission test car was made after several iterations. Methods adopted and the work done in the above development is detailed in the paper.

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Dr. Ashok Pandey is Deputy Director at CSIR's National Institute for Interdisciplinary Science and Technology at Trivandrum and heading the Centre for Biofuels and Biotechnology Division there. His current major research interests are on bio-based economy development (biomass-based bio refinery) for the production of fuels and chemicals. He has >1050publications/communications, which include 15 patents, 40 books, 110 book chapters, 410 original and review papers, etc with h index of 71 and >21,000 citation (Goggle scholar).

Professor Pandey is recipient of many national/international awards and fellowships, which include Fellow of International Society for Energy, Environment and Sustainability; National Academy of Science(India); Biotech Research Society, India; International Organization of Biotechnology and Bioengineering and Association of Microbiologists of India; Honorary Doctorate degree from Univesite Blaise Pascal, France; Thomson Scientific India Citation Laureate Award, USA; Visiting Professor in the Universite Blaise Pascal, France, Federal University of Parana, Brazil and EPFL, Switzerland, etc. He is Founder President of BRSI (www.brsi.in); International Coordinator, IFIBiop (www.ifibiop.org) and Vice-President of ISEES (www.isees.org) & AIBA (www.aibaonline.com). Prof Pandey is Editor-in-chief of Bioresource Technology, and Honorary Executive Advisor of Journal of Water Sustainability and Journal of Energy and Environmental Sustainability.

Waste to Energy - Production of Biobutanol from Agro-Industrial Residues

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Abstract

Biobutanol has gained significant attention for its properties as a liquid transportation fuel, but its production from lignocellulosic biomass is facing challenges both technically and economically. Volatile fatty acids (VFA) and hydrogen produced during butanol fermentation can be considered as an added advantage, when an efficient process is in place. The formation of various industrial products from a single substrate in a single run can be considered beneficial for lignocellulosic biorefinery processes. However, despite of its superior fuel properties, butanolis facing challenges to compete with existing renewable fuels, due to its process complications and large amounts of acetone production. Low cell densities during anaerobic fermentation and toxicity of end products are common draw backs that result in low yields and productivity of butanol.

We have isolated a novel strain of Clostridium sporogenes which does not produce acetone during the fermentation, forming mainly butanol. The culture has unique capability of producing butanol from rice straw hydrolysate without minerals and vitamins supplementation. In batch fermentation under optimized conditions, Clostridium sporogenes produced 7.0 g/L of VFA and 1.2 L of hydrogen during butanol fermentation in rice straw hydrolysate with 30 g/L of glucose. A total of 7.3 g/L solvents were produced, of which 5.0 g/L was butanol. Electro-chemical analysis by cyclic voltammetry revealed that $CaCO_3$ supplementation stimulated electron transport system mediated by protein bound FAD and flavoproteins. Two-stage fermentation with cells immobilized on to ceramic particles was very efficient and high conversion of sugars to solvents and VFAs was achieved. Detailed results will be presented.

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Dr. Ashoke De is currently working as Assistant Professor in the Department of Aerospace Engineering at Indian Institute of Technology Kanpur. He is the recipient of IEI-Young Engineer's Award-2014, DST Young Scientist award-2015, and P K Kelkar Research Fellowship from IIT Kanpur. He is a member of ASME, SIAM, FMFP, ISHMT and Combustion Institute. Dr. De received his Masters' degree in Aerospace Engineering from IIT Kanpur in 2004, and PhD degree in Mechanical Engineering from Louisiana State University, USA in 2009. Before joining IIT Kanpur, he has worked as post-doctoral scholar at Technical University of Delft (TU-Delft), Netherlands and as Research Engineer in GE Global research at Bangalore. Dr. De leads large scale initiatives in the modeling of turbulent reacting and non-reacting flows at IIT Kanpur and has been actively involved in teaching and diversified field of research. So far, he has authored more than 60 peer reviewed articles in journals and conferences. His current research interests include combustion modeling, hybrid RANS/LES model development, supersonic flows and Fluid-Structure interactions (FSI). He is actively pursuing research projects from various organizations like ISRO, ARDB, DST and PWC. His primary research focus is the emerging field of computational mechanics with particular interest in combustion and turbulent flows.

Soot Modelling in Turbulent Diffusion Flames

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Abstract

Modeling of soot in turbulent combustion systems is a challenging task as it involves the resolution of small scale interactions among turbulence, chemistry and particle dynamics. The high intermittency associated with soot due to infinite Schmidt number and restriction of Polycyclic Aromatic Hydrocarbons (PAH) to locations of small scalar dissipation rate complicates modeling. Description of soot precursors such as acetylene and PAH by the combustion model imposes additional constraints as it involves the resolution of a large number of reactions involving stiff chemistry. Considering radiative transfer further increases the complexity, as it affects the kinetic rate associated with soot precursors and creates a two way coupling between combustion and soot models.

In the present work, the turbulent-chemistry interactions and soot precursors are described by the steady laminar flamelet model (SLFM). The truncated series expansion in spherical harmonics (P1 approximation) is used to solve the radiative transfer equation. The absorption coefficient is modeled using the weighted sum of gray gases model considering four fictitious gases. The soot volume fraction is predicted using acetylene based soot inception model (Moss-Brookes model). The model accounts for inception, surface growth and oxidation processes of soot. A single variable PDF in terms of temperature is used to include the turbulence-chemistry effects on soot.

The combined tool is used to determine the soot formation in hydrocarbon flames. The primary objective of the study is to determine the effect on soot inception rate with different soot precursors (like, C_2H_2 and C_2H_4) and examine the ability of different approaches for determining the O radical concentration; required for soot oxidation. The results can be used to quantify the role of soot precursors and O radial prediction on soot yield. The comparison with the experimental results will also elucidate the effect of gray and non-gray radiation modeling approaches on soot formation; it also indicates the effect of temperature on the kinetics of soot. The study is further extended to understand the effect of turbulence on soot and indicate the effect of temperature and composition fluctuations on soot formation rate.

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Dr. Ashwani K. Gupta is Distinguished University Professor at the University of Maryland. He received his PhD from the University of Sheffield, UK and higher doctorate (DSc) from the University of Sheffield and also from the University of Southampton. He was bestowed honorary doctorate from the University of Wisconsin Milwaukee and also from King Mungkut University of technology North Bangkok, bestowed by the Princess of Thailand. He is a Fellow of AIAA, ASME and SAE, and also ISEES. He is co-editor of Environmental and energy book series by CRC and Associate editor of 4 journals. He serves as Director of Propulsion and Energy group and also as member of the board of directors at AIAA. He has received several honors and awards from AIAA, ASME and University of Maryland. He has published over 700 technical papers, 3 books and edited 12 books. His research interests include high intensity distributed combustion, HiTAC, swirl flows, combustion, sulfur chemistry and sulfur recovery from acid gases, clean energy recovery from wastes, biomass and acid gases, high speed mixing, diagnostics and sensors, gas separation membranes, air pollution, biofuels and laser diagnostics.

Internal Entrainment Effects on High Intensity Distributed Combustion

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Abstract

Colorless Distributed Combustion (CDC) has been shown to provide ultra-low emissions and enhanced combustion performance of high intensity gas turbine combustors in terms of efficiency and stability. To achieve distributed combustion, the flowfield needs to be carefully tailored for adequate mixing between reactants and hot reactive species from within the combustor to result in high temperature low oxygen concentration environment prior to ignition. The distributed reactions result in uniform thermal field with hot spot zones mitigated to achieve ultra-low or near zero NOx emission. The impact of internal entrainment of reactive gases on flame structure and behavior is investigated with focus on achieving distributed combustion in high intensity combustors for stationary power generation. A mixture of nitrogen and carbon dioxide was introduced into the air stream prior to mixing with the fuel and subsequent combustion to simulate the recirculated gases. Increase in the amounts of nitrogen and carbon dioxide (simulating increased entrainment), led to volume distributed reaction over a larger volume in the combustor with enhanced and uniform distribution of the OH* chemiluminescence intensity. At the same time, the bluish flame stabilized by the swirler is replaced with a more uniform almost invisible bluish flame. The increased recirculation also reflected on the pollutants emission, where NO emissions were significantly decreased for the same amount of fuel burned. Reducing the oxygen concentration from 21% to 15% (due to increased entrainment) resulted in 80~90% reduction in NO with no impact on CO emission with sub PPM NO emission achieved at an equivalence ratio of 0.7. The same trend was seen at higher diluents injection temperature with significant reduction in pollutants emission to an oxygen concentration of 10%.

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Dr. Atul Dhar completed B.Tech. in Mechanical Engineering from HBTI Kanpur in 2004. He obtained M.Tech. in Fluid and Thermal Engineering from IIT Kanpur in 2006. After Masters, Atul Dhar got exposure of Industrial working environment at Mahindra and Mahindra Automotive Sector. He completed his PhD from Engine Research Laboratory, IIT Kanpur in 2013. He has also worked on characterisation of particulates emissions from biodiesel fuelled engines as Senior Research Associate (CSIR Pool Scientist Scheme) at ERL, IIT Kanpur. After that he worked as Post-Doctoral Researchers at LHEEA, Ecole Centrale de Nantes, France under the sponsorship of Heritage, Erasmus Mundus Scholarship by European Union. Dr. Atul Dhar is currently working as Assistant Professor at School of Engineering, IIT Mandi since december 2013.

Exhaust Heat Recovery Options for Diesel Locomotives

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Abstract

Even by conservative estimates more than 20% fuel energy from internal combustion engines is wasted as exhaust heat. Currently organic Rankine cycles and thermoelectric generators are most widely investigated options for automobile exhaust heat recovery. Use of thermoelectric generators for recovery of exhaust heat in automobiles at concept level started few decades ago. Major advantages of this technology over Rankine cycles are little noise and vibration, high durability, environmental friendliness, and low maintenance cost for converting low quality thermal energy directly into high quality electrical energy. Major challenges are lower efficiency (~8%), drop in efficiency at lower temperatures, performance optimization in synchronization with multiple constraints of after-treatment devices, silencer, back pressure reduction, turbocharging etc. Larger size of diesel locomotives compared with space available for automobile engine's mounting on vehicles makes the installation of exhaust heat recovery system in diesel locomotives more practical. In this paper I will discuss about feasibility and suitability of various exhaust heat energy recovery methods for diesel locomotives.

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Dr. Avinash Kumar Agarwal joined IIT Kanpur in 2001 and is currently a Poonam and Prabhu Goyal Endowed Chair Professor. Prof. Agarwal is a Mechanical Engineering graduate from MREC, Jaipur. He received his Master's and Doctoral degrees in Energy from IIT Delhi and he worked at Engine Research Center, University of Wisconsin, Madison, USA as a Post-Doctoral Fellow (1999 - 2001). His areas of interest are IC engines, combustion, alternative and conventional fuels, lubricating oil tribology, optical diagnostics, HCCI, emission control, and large bore engines. Prof. Agarwal has published 125+ peer reviewed international journals papers. He is associate editor of ASME Journal of Energy Resources Technology, and International Journal of Vehicle Systems Modelling and Testing and member of editorial board of several reputed automotive journals. He has edited "Handbook of Combustion" (5 Volumes; 3168 pages), published by Wiley VCH, Germany, which is the most updated compilation on combustion globally.

Prof. Agarwal is a Fellow of SAE (2012), Fellow of ASME (2013) and a Fellow of INAE (2015). He is recipient of several prestigious awards such as NASI-Reliance Industries Platinum Jubilee Award-2012; INAE Silver Jubilee Young Engineer Award-2012; Dr. C. V. Raman Young Teachers Award: 2011; SAE International's Ralph R. Teetor Educational Award -2008; INSA Young Scientist Award-2007; UICT Young Scientist Award-2007; INAE Young Engineer Award-2005. At IIT Kanpur, Prof. Agarwal has established a state-of-the art "Engine Research Laboratory" (www.iitk.ac.in/erl).

Use of Lasers and Optical Diagnostics for Next Generation IC Engine Development: Ushering New Era of Engine Development

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Abstract

Researchers are constantly trying to improve engine efficiencies and control emissions in a very challenging environment. This demands complying with ever-increasing requirement of tightening emission norms in addition to fuel economy globally, which are prime driving forces in automotive industry globally. The first part deals with laser ignition of combustible charge and the second part deals with application of optical diagnostics such as PIV, PDI and endoscopy to engines. The combustion and emission behavior of hydrogen-air mixture and methane-air mixture in an engine and control of NOx emissions using laser ignition is covered in the first part of this talk. A conventional electrical spark ignition system and a laser ignition system were used for comparative study of performance and emission characteristics of a customized hydrogen fuelled engine prototype developed in ERL.

Laser diagnostics has emerged as a very valuable diagnostic tool in development of engine power-train and emission control technology development in last one decade. Laser based measurements in real time in the engine combustion chamber have ushered a new era of finding answers to some of the intriguing in-cylinder processes, which were only speculated until recently. This strength has enabled engine researchers to sharpen their modeling tools using experimental data from realistic geometry engines firing under varying loads. Airflow structures developed inside the engine combustion chamber significantly influence the air-fuel mixing. In-cylinder air flow characteristics of a motored, four-valve diesel engine were investigated using time-resolved Tomographic Particle Imaging Velocimetry (TR-Tomo-PIV) in ERL. Fuel-air mixing and combustion are mainly affected by in-cylinder air flows and fuel sprays. Fuel spray characteristics were determined using Phase Doppler Interferrometry (PDI), which provides information about droplet size distribution and 3D-velocity distributions. To gain visuals of combustion processes in a production engine's combustion chamber at high loads, another optical diagnostic technique "engine endoscopy" was used for spatial combustion visualization, soot distribution and temperature distribution.

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Dr. Chang Sik Lee is currently a Chair Professor of the School of Mechanical Engineering at Hanyang University, Seoul, Korea. His major research areas are combustion and emissions reduction characteristics of automotive engines; alternative fuels (biofuels; biodiesel, DME and alcohol fuels) and their application to automotive vehicles; spray dynamics and liquid atomization, dimethyl ether (DME) fueled engine system. To analyze liquid fuel atomization, the researches focus on the spray characteristics and measurement of fuel atomization process, injection flow visualization, and SI and CI engine sprays. He has authored major books for automotive engineering and thermodynamics, and many international journals papers for the combustion and emission reduction of combustion engines, fuel spray visualization, and atomization characteristics of alternative fuels.

He served on Director of Mechanical Engineering and Technology Research Institute, and the Director of Hybrid Vehicle Education Center at Hanyang University. He served as the President of ILASS-Korea and ILASS-Asia, President of Korean Society of Automotive Engineers and Director of Korea Automobile Environmental Center. He served on Editor-in-Chief for the International Journal of Automotive Technology, Transaction of KSAE, and he serves on Editorial Advisory Board Member of Energy & Fuels, International Editorial Board member FUEL, Energy Conversion and Management, Energies, Journal of Automobile Engineering.

Breakup Regimes of Biodiesel Droplets in a Gas Flow Field

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Abstract

This paper investigated the deformation and breakup regimes of liquid droplets such as water, diesel, and biodiesel fuel droplets in gas flow field. In fuel spray and liquid disintegrating process, fuel droplet atomization phenomena depend on the liquid properties and operating conditions. Fuel density, viscosity, surface tension affect injection characteristics, droplets dispersion and breakup regimes of atomization process of liquid fuels. This work focus on the visualization of deformation and breakup phenomena of liquid and fuel droplet jet in a high-speed gas flow. In order to analyze the breakup process, the deformation of fuel drop and disintegration processes due to liquid breakup regimes were conducted under the various fuel properties and drop jet nozzle geometries. The important influenced factors on the droplet deformation in the primary breakup stage and droplet breakup mechanisms in the secondary breakup stage for the high-speed fuel drops were investigated and compared. The results of visualization of fuel droplet breakup regimes showed that disintegrating behaviors of liquid droplets and breakup mechanism was influenced on the Weber number and liquid properties. In addition, the droplet breakup regimes were investigated that the effects of liquid properties and fuel types investigated under the various injection parameters and flow conditions. To investigate the breakup regimes of diesel and biodiesel fuel, the deformation of biodiesel fuel and breakup regimes were compared to that of conventional diesel fuel droplets.

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Introduction to Improved Methodology for Size Distribution Measurement Using Engine Exhaust Particle Sizer (EEPS)

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Abstract

Particle size distributions measured by the Engine Exhaust Particle Sizer Spectrometer (EEPS) have been reported to disagree with those by scanning mobility particle sizers (SMPS). The discrepancies are larger for the accumulation mode engine exhaust particles than for compact-shape particles. Engine exhaust particles, specifically carbonaceous aggregates, have different charging characteristics compared to nearly spherical particles because aggregates acquire more charges at a given mobility diameter in a unipolar charging environment. Therefore, different instrument matrices, that represent the relationship between particle size and EEPS electrometer current distributions, are needed for compact-shape particles and aggregates. The methodology to improve the EEPS performance has been incorporated by developing a new EEPS instrument matrix for fresh engine exhaust, and its performance was evaluated using a diesel engine, two passenger cars with gasoline direct injection (GDI) engines, one vehicle with a turbo direct injection (TDI) diesel engine, and a diesel generator. The geometric mean diameters by the EEPS new matrix agreed with SMPS within 14% for mono-disperse engine exhaust particles <50 nm while larger particles agreed within 19%. The new matrix also improved the agreement between EEPS and SMPS for poly-disperse exhaust particles from different engines under different operating conditions. Diesel engine tests showed that the total concentration, geometric mean diameter, and geometric standard deviation by the SMPS and EEPS with the new matrix differed less than 16%, 33%, and 9%, respectively, with the greatest differences found for particles <15 nm.

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Gasoline Direct Injection - Challenges

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Abstract

The demand for reduced fuel consumption and low-emission spark ignition engine is rising, in response to concerning energy conservation and preservation of the global environment. Air-fuel mixture formation plays a significant role in controlling exhaust emissions and engine efficiency. The primary purpose of fuel injection system is to provide the engine with correct air-fuel ratio according to engine operating condition. Fuel injection system of spark ignition engine has developed in last thirty years monotonically from the carburetor to throttle-body injection, and then to port fuel injection (PFI). Although, the current port fuel injection technology is highly evolved, but it is difficult to achieve further stringent emission norms and demand for lower fuel economy. Gasoline direct injection (GDI) system is a promising next generation of technology for the automotive engine to improve fuel economy, performance and emissions control. GDI engines are characterized by injecting fuel directly into the combustion chamber at high pressure during the compression stroke. Air-fuel mixture formation takes place inside the combustion chamber as in a diesel engine. GDI engine offers a significant potential for improving the fuel economy and reduction of exhaust emissions from spark ignited engine, while maintaining or improving the high specific power output of current PFI engines. GDI engines has several potential advantages over PFI system, however, it does have a number of inherent problems that need to be address. These constraints are controlling the stratified charge combustion over wide range of engine operation, complexity in injection strategy for seamless load changes, Injector deposits, increased particulate emissions etc. In this paper, several difficulties associated with GDI development and its probable solution will be discussed.

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Dr. Dinesh Kumar is heading Air Purification R&D at Sud Chemie India Pvt. Limited Vadodara. He is responsible for development and evaluation of TWC, DOC, DPF, SCR etc. for purification of automotive exhaust. He has over 35 years of experience in Research and Product Development of internal combustion engines. He possesses in depth knowledge on engine combustion process and emissions and has comprehensive analytical and experimental experience on design and performance optimization of diesel, gasoline engines and use of alternate fuels.

Prior to his current assignment, he has worked with a LML Ltd. two wheeler manufacturer and left in 2010 as Vice President R&D. He has played a key role in development of a strong R&D base and development of efficient, well-engineered, commercially successful products.

He started his carrier with Indian Institute of Petroleum, Dehradun after graduation from University of Roorkee in 1976 and did post-graduation in 1989. He has to his credit 6 patents and 24 research papers in National and International journals.

PM reduction Technology for Locomotive Engines

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Abstract

A Süd-Chemie diesel oxidation catalyst was evaluated on an Electro Motive Diesel (EMD) 12-710 G3 engine. Tests were performed at a US test laboratory on a locomotive test stand installed with a representative EMD 12-710 G3 engine. The DOC was evaluated for both the US EPA "Long Haul" and "Switch" test cycles.

The DOC employed a substrate design that utilized a low cell density with large channel openings to yield low pressure drop. The substrate was coated with a proprietary washcoat and catalyst formulation aiming to reduce PM. Results from testing indicated that on the Line Haul cycle reductions of 92% CO, 45% HC, and 18% PM were achieved, while on the Switch cycle reduction of 79% CO, 22% HC, and 45% PM were achieved. Furthermore, mechanical design changes to the operation of the engine via fuel injection yielded 37% and 34% NOx reduction respectively.

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Dr. Ernst Wintner received his PhD in Physics in 1976 from University of Vienna with a thesis on "Electron Microscopy of Dislocation Structures in CuAl Alloys". Thereafter he changed to the new field of Photonics joining TU. In 1992 he was promoted titular full professor.

His scientific work comprises nonlinear optics, fiber optic sensors, solid-state lasers, ultra-short pulse generation and applications. Together with GE Jenbacher, Austria, he founded the Laser Ignition Research Group in 1998. His external activities comprise visiting scientist at M.I.T. 1982 - 1984, Friedrich-Schiller-University, Jena in 1986, Visiting Professor to Institute of Laser Engineering, Osaka University, 2000-2001, and to Indian Institute of Technology Kanpur. He was in the Editorial Board of journals like "Optical and Quantum Electronics", "Laser Physics Letters" as well as he participated in various program committees of international conferences: "Conference on Lasers and Electro-Optics/Europe", "International Symposium on Modern Problems of Laser Physics"; recently he was Member of Program or Advisory Committee for "The 1st/2nd Laser Ignition Conference 2013/2014", Yokohama, Japan (LIC-13/LIC-14), "Fundamentals of Laser Assisted Micro- & Nanotechnologies Symposium", Saint Petersburg, Russia (FLAMN-13), "International Conference on Advanced Laser Technologies, Budva", Montenegro (ALT'13), "International Conference on Advanced Laser Technologies", Cassis, France (ALT'14). He is (co)author of more than 250 scientific publications including 7 book chapters and member of several professional organisations like the European Physical Society EPS.

The Evolution of Laser Ignition Over More Than Four Decades

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Abstract

After first consideration of laser spark ignition of reactive gases in 1969 it took early one decade until the first engine test was achieved. When analyzing several concepts for an ignition scheme also fiber transport of ns pulses was studied with success. Eventually, most research groups favora laser sparkplug for each individual cylinder. A number of different prototypes, mostly Nd:YAG lasers, transversally or longitudinally, directly or fiber-transmission pumped were developed. Studies have shown that the problem of window failing can be avoided. In order to improve simplicity, reliability and cost, power VCSEL arrays may represent pump sources with perfectly suiting geometry. Thereby direct (non-fiber-coupled) pump arrangement induces a challenge to temperature management for the solid-state as well as the diode lasers representing one of the major problems in laser ignition of car engines to date.

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Dr. Gabriel D. Roy received his B.S. and M.S. degrees in Mechanical Engineering, and Ph.D. in Engineering Science. He served as a faculty member of the mechanical Engineering Department in India and the U.S., and as a major thesis advisor for over a dozen graduate students. His early carrier started as a Senior Research Engineer at the university of Tennessee Space Institute (UTSI), where he developed the MHD Diffuser and heat transfer diagnostic. Later, he joined the industry (TRW, Inc.), where he received the TRW Roll of Honor Award and patents on combustor and atomizer. Dr. Roy served as Associate Director at the office of Naval Research Global (ONRG) Singapore. His responsibilities included global technology awareness, with India and Sri Lanka, and research worldwide related to his area of specialization-propulsion (energy storage, combustion, hypersonics, emission and noise reduction, materials and alternate fuels). Prior to this, he managed the Advanced Propulsion Program for the US Navy at the office of Naval Research (ORN). He managed the Pulse Power Program for the Ballistic Missile Defence Organization. He also managed the Versatile Affordable Advanced Turbine Engines (VAATE) Program, the Advanced Versatile Engine Technology (ADVENT) Program, SBIRs, and STTRs.

Continuous Detonation Wave Engines for the Future

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Abstract

In the search for new and more efficient engines for the future, pulsed detonation engines (PDE), have been investigated and substantial progress has been made. Recently continuous detonation wave engines (CDWE) are getting a lot of attention worldwide. CDWEs can alleviate some of the issues, such as high repetitive rates, and mechanical and thermal fatigue associated with PDEs, and still maintain all the advantages associated with detonation-based propulsion. A simple configuration in which CDW can propagate is that of an annulus around a cylindrical core. In Russia, at the Semenov Institute, a large scale hydrogen CDW combustor has been tested to study the effect of different design elements on its operation and performance. Shaped obstacles have been used at the combustor exit to provide required blockage, which resulted in an increase in the number of CDWs and the thrust performance. At Moscow State University, detonation propagation in a stoichiometric hydrogen/air mixture at supersonic velocity in a channel with constant and varying cross sections is studied. In France, multiagency (CNRS and MBDA) collaborative research is pursued to thoroughly understand the CDW flow process and to refine the design elements. In China (National University of Defense Technology), continuous rotating detonation wave structure has been studied numerically with detailed chemical reaction model using $H_2/O_2/$ Ar mixture. The research in Belgium (Von Karman Institute) is also following a computational approach to solve the multi-dimensional flow characteristics of the CDW. In Poland (Warsaw University of Technology), Rotating Detonation engine (RDE) in the rocket mode has been studied. Continuous rotating detonation was achieved using acetylene/air and hydrogen/air mixtures at various initial conditions. Several configurations were considered. Details of the above-mentioned efforts and other progress made in CDWE R&D worldwide will be discussed.

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Dr. Hukam C. Mongia earned his undergraduate degree at Punjab Engineering College and master's and PhD degrees from the University of Massachusetts. Dr. Mongia came to Purdue from industry having worked at Honeywell Aerospace, Rolls Royce of North America, and GE Aviation. Dr. Mongia joined Purdue in February 2009 to work jointly with his colleagues and students to initiate and grow a Gas Turbine Combustion Research and Technology Innovation Center with the prime objective of creating capability for taking fuel-flexible, energy efficient, clean combustion concepts from conceptual stage in single element test rigs to engine demonstration in collaborative efforts with the national labs and industry.

An Art of Using CFD in Combustion Design and Technology Development Process

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Abstract

A historical perspective is provided on the development and application of five combustion technology and product development methodologies: (1) Empirical/analytical design methodology (EADM) that started in the mid 1970's and is still being used in 2015 for developing the 3rd generation of lean direct injection technology (LDI-3). (2) CFD-reactor modeling (CFD-RM) with its first generation formulation and calibration published in 1976 was significantly modified as described in several publications by Rizk and Mongia during 1986 and 1994. (3) Anchored CFD design methodology (ADM) led by Danis in 1994 led to several successful applications for rich dome combustion products starting 1995, and is perhaps the most affordable and reliable approach for rich domes. (4) Comprehensive combustion system modeling (CCSM) effort initiated in 1997 comprised of several elements including laminar flamelet modeling based emissions transport equation; comprehensive analysis of the mixers with both RANS and LES; CFD models calibration with comprehensive benchmark quality data sets; comprehensive combustion system analysis; and comprehensive injector/mixer interaction model. (5) Comprehensive combustion technology modeling (CCTM) effort with focus on the National Combustion Code (NCC) for calibration with the LDI-1 and LDI-2 engineering database was started in 2013 with the goal of providing design guidance for LDI-3 and LDI-4 technology development activities.

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Dr. I. S. Thakur, FNASc., FBRS, FNESA, at present is working as Dean in the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi. After completion of M.Sc. and Ph.D. from Jawaharlal Nehru University, New Delhi, he served as Assistant Professor and Associate Professor in G.B.Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. He has more than 29 years teaching experiences in the field of Environmental Microbiology and Biotechnology, Microbial Ecology, Toxicology and environmental Waste Management, and research experiences on bioremediation, bioconversion and detoxification of natural and organic compounds and metals in industrial effluent-pulp and paper, distillery, electroplating, tannery and municipal solid waste and inorganic compounds (Green House Gases) sequestration and production of biofuel (ethanol, biodiesel and biohydrogen) and value added products. He published more than 115 research papers in peer reviewed journals, 20 chapters in books, two text books, four patents and technologies. He was Visiting Scientist and Visiting Professor in Germany and Japan, and members of the several committees visited USA, Italy, Austria, Netherland, Finland, Sweden etc. He is member of editorial board and reviewing committees of several journals and professional societies. He has completed more than 20 research projects as PI and 18 Ph.D., 2 M.Phil and 14 Post graduate thesis/dissertations are completed under his supervision.

Production of Biodiesel and Bio-Composite Materials from Carbon Dioxide Concentrating Chemolithotrophic Bacteria from Marble Rock

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Abstract

Carbon dioxide concentrating endolithic bacterium, Serratia sp. ISTD104, isolated from marble rock, was enriched by continuous enrichment in the presence of sodium bicarbonate as sole carbon source in the chemostat. Proteomic approach of 2D gel electrophoresis-MALDI/TOF-MS and nanodrop LC-MS and whole genome sequencing was performed for evaluation of carbon-sequestering potentiality of bacterium. The enzyme, carbonic anhydrase, facilitates fixation of carbon dioxide was purified and characterized and recombinant enzyme was produced by isolation, amplification, transformation and characterization of genes produced calcite. Calcite was applied for production of bio-composite materials in presence of silicon dioxide and increasing temperature 60, 200, 600 and 1000 ^{o}C. Bacterium produced fatty acid was optimized for enhanced production by optimization of process parameters by using response surface methodology where the Box-Behnken design matrix and response surface methodology (RSM) was used. The bacterium produced >60% (w/w) fatty acid falls in the range of C13 to C24 by GC-MS analysis that make it a potential source of biofuel after transesterification in presence of methanol and lipid (3:1) and NaOH (1%). Characterization of the lipid and biodiesel was accomplished by 1HNMR and 13CNMR. The total unsaturated fatty acids found in methyl esters amount to 55% and the saturated fatty acids to 45% balanced in composition of biodiesel characterized by GC-MS, FTIR and NMR spectroscopy indicated possible source of biodiesel.

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Dr. Joydeep Dutta is currently a Professor in the Economics Group at the Department of Humanities and Social Sciences at IIT Kanpur. Till June 2014 he was a Professor at the Department of Mathematics and Statistics at IIT Kanpur. Apart from remaining an active researcher in the field of optimization he is also deeply passionate about the Indian Railways and particularly about diesel locomotives. He has written a book titled : The Legend of WDM2 : The Story of Indian ALCO locomotives jointly with S. M. Sharma,(Officer on the Indian Railways) which has been published by the National Railway Museum, Delhi in 2010. He has contributed several articles about railways in books and magazines

Story of Indian ALCO Locomotives

Joydeep Dutta
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Abstract

It was from the late 1950's ALCO locomotives are an important presence on the vast Indian railway network. The coming of the WDM2 in 1962 actually sealed the fate of steam locomotives in the country. In this talk we will discuss this amazing legend of the WDM2 and its consequence on the diesel locomotive development in this country. We will speak on the historical aspects, social aspects and technical aspects of dieselization in India

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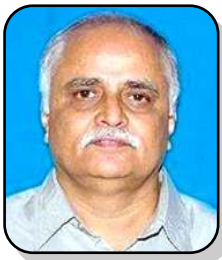

Mr. K B Raja is a Graduate in Mechanical Engg from BVBCET, Hubli and joined the Heavy Power Equipment plant of BHEL at Ramachandra puram, Hyderabad in Sept 1988. BHEL had just entered the Gas Thermal segment of power plants in 1986 under collaboration with General Electric. Since his entry into BHEL, till date, he has been involved with the absorption, diversification and expansion of Gas Turbine Technology in BHEL. He has the unique distinction of starting his career as a mechanical field engineer involved in Installation, commissioning & troubleshooting Gas Turbine based power plants around India & abroad and eventually migrating to Gas Turbine controls with distinction. He is one of the pioneering experts in O&M and troubleshooting on Gas Turbine based power plants in India. He currently heads the Gas Turbine Engineering & Technology Dept and is fully involved in indigenization, customization and design of Gas Turbine based power plants in the Marine, Power & Industrial segments.

6000 HP to 11000HP: Experience to a New Concept

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Abstract

Indian Railways has in service about 550 locos with IGBT based Propulsion Systems. These locos are manufactured at Chittaranjan Locomotive Works, have higher Reliability and many improved features like slip slide controls, redundant VCU, lower losses etc. Energy recovery during braking operations serves to lower costs of operation. BHEL has around 200 IGBT Propulsion systems on locos in service at 10 sheds across the country. The IGBT convertors are manufactured at Electronics Division, Bangalore and under a Business Share Agreement with M/S Strukton, Netherlands.

This Paper presents the Current experience of BHEL in Design, Engineering, Manufacture, Supply and utility of IGBT BASED POWER EQUIPMENT AND CONTROLS for the 6000 HP Electric Locomotives of IR. The initial concepts of Gas based Locomotives as proposed in the Indian Context are introduced and the paper aims to Analyse and build momentum in the Gas based Locomotive Product Ideation. The paper presents the reader with a preview of the deliberations likely in this initiative in the Rail Transportation Sector over the next year.

The initiative of IR is very well thought out and as it rolls out, BHEL offers to bring benefits from its Products and engineering base. Because of its very nature, the initiative is subject to comparisons with very well established Diesel and Electric technologies.

Just as the Sebastian Coe- Steve Ovett duels had enthralled the spectators of 1980s with a raising performance bar, this IR initiative would give the other technologies a close run and has the potential to lead with unlimited Innovations. In India, it would be a significant game changer for the Rail Sector and herald an option of using cheaper fuel.

Mr. Kaushal Patel

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Mr. Kaushal Patel -is the Head of Technical Department for Turbocharging business, for the territory covering India, Sri Lanka, Bangladesh, Maldives & Nepal. He is responsible for Railway Market segments in the territory.

He has Bachelors of Engineering (Mechanical engineering) from L. D. college of Engineering Ahmedabad, Gujarat-India and Post graduate diploma in Management Studies (Marketing) from Symbiosis Institute of Business Management, Pune-India. He is associate member of Institution of Engineers (India).

He started his career in 1997 as Application and Product development engineer for Diesel Engines and reciprocating gas compressors. Since 2007 he joined ABB Turbocharging and has handled various roles in the field of Business Development, Application engineering, Package Engineering, key account manager for India Railways and Technical function. Since 2011 he is exclusively working for Railway Market Segment for New Product development and Technical Services for Turbocharging business based at ABB India Limited, Vadodara.

ABB Turbocharging - Latest Technological Developments in Railway Application

Kaushal Patel,
Head, Technical (Turbocharging), ABB India Limited

Abstract

Greater demands are being placed on railway engine applications as the impact of rising fuel prices underscores the need for more efficient solutions while, simultaneously stricter emission legislation comes into effect. With focus on these two challenging aspects, existing and upcoming engine power-packs still need to cope with the known specifics of Railway applications in terms of high reliability, long durability and operation in an extremely wide range of ambient and load conditions. This paper describes how ABB turbocharging products and related concepts support railway engine builders and operators in ongoing and future engine development as well as in upgrading existing platforms to achieve better fuel efficiency or reduction in emission.

After a brief review of ABB dedicated rail turbocharger platform, TPR, the focus will be on newly developed VTG technology on Indian Railways locomotives and also share experience at CSR-Qishuyan.

Mr. Kishore Raut

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Mr. Kishor Raut graduated with a degree in Mechanical Engineering from Bombay University in the 1980's. He started working at Associated Textile Engineers Ltd. (Assotex Electronics) after graduation, in the field of engine testing, textile equipments and pollution control equipments. At the same time, he completed studying Industrial Electronics from Bombay University. After a short stint in Mumbai, he started with a joint venture named Benz Systems in 1984 in Pune, the then growing automotive hub in India.

Mr. Kishor Raut set on an individual path by establishing Dynomerk Controls, Pune in 1996 as a total solution provider in the field of Engine and Vehicle testing Equipments with Data Acquisition and Control Systems.

Consideration for Test Cell Design for Locomotive Engine Research

Kishore Raut
Dynomerk Controls, Pune

Abstract

We, at Dynomerk Controls based in Pune, design, manufacture & provide services for integrated test bed solutions in the field of Engine & Vehicle Testing for R&D with emission test facility & production performance. The projects executed till date includes engines ranging from 3kW to 4500kW engine capacity in various applications namely automotive, industrial, power generation, marine and locomotives.
Turnkey solutions for -

1. Test Bed Equipments for Engines & Vehicle Testing
2. Data Acquisition & System Integration
3. M & E Services
4. Latest trends for Locomotive Engine Testing

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Dr. L. M. Das is currently Emeritus Professor IIT Delhi. He took his Bachelor's degree in Mechanical Engineering from Regional Engg college, Rourkela in 1970 and M Tech degree from Indian Institute of Technology, Kharagpur and Ph D from IIT, Delhi

His primary areas of research interest include development of alternative-fuelled low emission engines/vehicles. He has supervised 32 PhD theses and 74 M.Tech Projects in this area. Dr Das has published more than 80 research papers in various independently refereed international and national journals in the area of alternative fuels .With an effort to transfer the technology from lab to land, Dr Das has co-ordinated an academia-industry UNIDO-Sponsored project consortium consisting of IIT Delhi, Mahindra and Air products with support UNIDO in which world's first fleet of hydrogen-operated three wheelers were demonstrated during Auto-expo 2012 in New Delhi. Prof Das is also coordinating a Mission-mode project in which IIT Delhi and Mahindra and Mahindra are developing hydrogen-fuelled minibus.

He has been awarded "Rajiv Gandhi Samman" by Government of Odisha in 2005. In 2012 he was awarded Lockheed Martin India Innovation Award. In 2013 International Association of Hydrogen Energy presented him with 'Outstanding Service Award" for his "Altruistic Contribution" to the "cause of Hydrogen Economy". In view of his significant contribution, Hydrogen Association of India has awarded him the T.N.Veziroglu award for the year 2013. He has also been awarded life time achievement award by International Society of Energy, Environment and Sustainability for his stellar scientific and professional contribution in the area of hydrogen engine technology.

Hydrogen Vehicle: Technology Transfer from Lab to Land

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Abstract

This paper highlights the outcome of persistent research efforts carried out in the Engines and Unconventional Fuels Laboratory, Indian Institute of Technology, New Delhi on several configurations of spark ignition engine leading to the development of hydrogen-operated vehicles which are being field-tested right now. Exhaustive tests in the laboratory spanning over a period of close to three decades had provided extremely valuable practical experience in identifying some of the intrinsic properties of hydrogen fuel such wide flammability limits, high burning velocity, antiknock characteristics and nearly zero NOx emissions in the lean zone of engine operation. Several fuel induction techniques starting with carburation were adopted in sequence to evolve conditions of smooth engine operation. It was observed that timed manifold injection, built on the typical combustion properties of hydrogen resulted in high performance and low emission features without any undesirable combustion phenomena such as backfire, pre-ignition and rapid rate of pressure rise.

With an effort to transfer the technology from lab to land, typical engines of Mahindra's three wheelers were installed in the lab in IIT .Tests were conducted for optimum performance and low NOx emission characteristics. Adequate safety steps were adopted to get rid of any abnormal combustion phenomena such as backfire. Such optimised engines were subsequently installed in the vehicles and evaluated for long-term field tests by Mahindra and Mahindra. Successful field trials in Pragati Maidan, Delhi, have been completed for a period of more than three years as part of sponsored projects funded by UNIDO and subsequently by the Ministry of New and Renewable Energy(MNRE).Smooth prolonged operation of these three-wheelers in field have demonstrated the low-emission and fuel economy features of hydrogen vehicles.

In another ongoing mission-mode project sponsored by MNRE to IIT Delhi and Mahindra and Mahindra, laboratory tests in IIT Delhi have been conducted on a 2.5 L. four cylinder spark ignited turbocharged-Intercooled engine built by Mahindra for Mini Bus application. Multipoint fuel injection system has been adopted for intake manifold injection of hydrogen. Tests have also been conducted by Mahindra and the optimised operating conditions have been introduced in the prototype vehicle which has been successfully road-tested for a brief period. Lab tests and field trials related to performance, emission, and combustion aspects for long term application are in progress to ensure an early entry of hydrogen to transportation sector.

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Dr. Nitin Labhsetwar is a Ph.D. in Chemistry with 29 years of research experience in environmental and energy related research. He has worked as STA/JSPS Fellow and Visiting Overseas Researcher at NIMS, Tsukuba, Japan and as a Visiting Professor at Kyushu University, Japan under the Global COE programme. He has also worked at other International Laboratories on development of materials including low cost and nano-materials for control of vehicular emissions, photocatalysis, GHG emissions, methane combustion water treatment, cleaner energy generation, chemical looping combustion etc. He has over 130 research publications with over 2800 citations and 22 international patents in addition to a few contributions in books. He has received 9 awards for excellence in research and also received various fellowships in India and abroad. He is a reviewer for more than ten SCI journals and supervised PhD of 14 students. He is currently involved in more than 12 R&D projects.

Low-Cost, Materials for Cleaner Energy and Environmental Applications

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Abstract

The present and future energy and environmental challenges demand for the development of new functional materials with improved properties. As developing countries are expected to use such materials predominantly in future, their environmental impacts; cost and sustainability of these materials and processes will be of prime importance. Although, noble metal based catalysts have dominated the environmental catalysis area so far, various transition metal oxides, mixed oxides and composite type materials present a potential option, especially considering their low cost, tailoring possibilities, selectivity and thermal stability.

We have recently explored a number of perovskite types and other mixed oxide based low cost catalytic materials for diesel soot oxidation to control PM emissions from different sources. Other mixed oxide based oxygen carriers are also studied for Chemical Looping Combustion process to get sequestration ready CO_2 from combustion of gasified fuels. Such combustion processes present a potential option to utilize carbon/hydrocarbon based fuels, in a sustainable way.

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Dr. P.K. Bose is known as an excellent teacher. He was the chief coordinator and convener of post-graduation in mechanical engineering (automobile) under 'Innovative Programmes - Teaching and Research in Interdisciplinary and Emerging Areas, UGC'. He has extensively travelled abroad to deliver lecture sessions in various international conferences, workshops and symposia. He is the author of more than 125 research papers and three books on diverse aspects of engineering.

Mahua Seed Oil Methyl Ester (MSOME) as a Potential Sustainable Alternative to Diesel: An Experimental Investigation Under Hydrogen Enrichment

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Abstract

In order to meet the challenges of global energy insecurity and the increasing obligations of complying with the environmental legislations, a paradigm shift from the reliance of conventional fossil fuel resources in IC engine domains are being increasingly witnessed. Exhaustive research initiatives to this end are being carried out with non-conventional and alternative fuel resources in the transportation and off-road sector to meet the challenges of exploring a potential alternative to conventional diesel fuel with the additional objectives of meeting the ever increasing stringency of the emission mandates. Among various promising alternative fuels, hydrogen, with its clean and green burning characteristics have proven to be a viable sustainable fuel in IC engine domains with the premium quotient of significantly low emission signature than conventional fuels and reserves a significant importance in the transition to hydrogen based fuel cell economy. Biodiesel, on the other hand presents itself as a ready-to-use sustainable alternative in diesel powertrains in the context of its National agricultural and rural economic development potential. It is to this effect, that the present study attempts to harness the synergy of two sustainable energy resources in the IC engine domain to provide a superior alternative to conventional diesel operation. To this end, a single cylinder diesel engine was made to operate in the duel fuel mode with hydrogen as the main fuel and mahua seed oil methyl ester (MSOME) as pilot fuel. A Timed Manifold injection (TMI) system was adopted to vary the injection strategies and analyze the effect of durations of hydrogen induced; Hydrogen was inducted at four different hydrogen injection strategies, hydrogen injection start from 7000μs to 13000μs with an increment of 2000 at 25%, 50%, 75% and 100%full loads. From the study it was observed that, dual fuel operation with increasing hydrogen energy share with MSOME resulted in higher thermal efficiency at medium and high load, with a slight decrease at lower loads compared to baseline diesel operation. Enhancement in brake thermal efficiency was accompanied with a reduction in brake energy consumption (BSEC),and significant reduction in Filter smoke number (FSN) with slight increase in NOx penalty.

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Mr. R. N. Mishra is currently Senior Executive Director, Engine Development Directorate, RDSO, Lucknow. He obtained 4 year course in Mech. Engg. at Indian Railways Institute of Mechanical & Electrical Engg., Jamalpur. After that he obtained 2 year course in Public Policy & Management at IIM, Bengaluru. His key posting and area of expertise are: Asst. Works Manager, Axle Machine Shop, Rail Wheel Factory, Bengaluru - responsibilities included erection and commissioning of axle machining line including wheel pressing. Director Carriage, RDSO, Lucknow - responsibilities included design and development of Diesel Electric & Diesel Hydraulic Multiple Units. Chief Mechanical Engineer, Diesel Locomotive Works, Varanasi - responsible for production of diesel locomotives for IR. Senior ED, Engine Development Directorate, RDSO, Lucknow - responsible for development of sub systems of diesel engines used in IR locomotives.

Biodiesel as an Alternate Fuel for Diesel Traction on Indian Railway

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Abstract

Indian Railways have a fleet of about 5000 diesel locomotives and this population is growing at a rate of about 200 per year. The diesel fuel expenditure on Indian Railways is about Rs. 20000 Crore per year which is about10% of the turnover of the Indian Railways. There is therefore increasing concern to both reduce this expenditure and/ or replace it with a locally produced alternate fuel. In this direction, Engine Development Directorate of RDSO has carried out engine studies with different indigenously produced biodiesel on two large locomotive engines. This paper discusses these engine studies and their results. Scope for future research is also discussed.

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Dr. Ramesh K. Agarwal is the William Palm Professor of Engineering in the department of Mechanical Engineering and Materials Science at Washington University in St. Louis. From 1994 to 2001, he was the Sam Bloomfield Distinguished Professor and Executive Director of the National Institute for Aviation Research at Wichita State University in Kansas. From 1978 to 1994, he was the Program Director and McDonnell Douglas Fellow at McDonnell Douglas Research Laboratories in St. Louis. Dr. Agarwal received Ph.D in Aeronautical Sciences from Stanford University in 1975, M.S. in Aeronautical Engineering from the University of Minnesota in 1969 and B.S. in Mechanical Engineering from Indian Institute of Technology, Kharagpur, India in 1968. Over a period of 40 years, Professor Agarwal has worked in various areas of Computational Science and Engineering - Computational Fluid Dynamics (CFD), Computational Materials Science and Manufacturing, Computational Electromagnetics (CEM), Neuro-Computing, Control Theory and Systems, Multidisciplinary Design and Optimization. In recent years he has devoted his efforts to Nanotechnology concepts and applications, and the modeling of renewable and clean energy systems including chemical looping combustion and carbon capture, utilization and storage. He is the author and coauthor of over 500 journal and refereed conference publications. He has given many plenary, keynote and invited lectures at various national and international conferences worldwide in over fifty countries. Professor Agarwal continues to serve on many academic, government, and industrial advisory committees. Dr. Agarwal is a Fellow eighteen societies including the Institute of Electrical and Electronics Engineers (IEEE), American Association for Advancement of Science (AAAS), American Institute of Aeronautics and Astronautics (AIAA), American Physical Society (APS), American Society of Mechanical Engineers (ASME), Royal Aeronautical Society, Chinese Society of Aeronautics and Astronautics (CSAA), Society of Manufacturing Engineers (SME) and American Society for Engineering Education (ASEE). He has received many prestigious honors and national/international awards from various professional societies and organizations for his research contributions.

Simulation and Optimization of Enhanced Oil and Gas Recovery and Geothermal System Using CO_2 as a Working Fluid

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Abstract

Because of rising concerns about CO_2 emissions from fossil fueled power plants, in recent years there has been strong emphasis on the development of safe and economical Carbon Capture Utilization and Storage (CCUS) technology. Several technologies that show some promise for CCUS are Enhanced Gas Recovery (EGR), Enhanced Oil Recovery (EOR) and Enhanced Geothermal System (EGS), where CO_2 is used as a working fluid to extract methane, oil, and heat from a geothermal reservoir respectively. Permanent carbon sequestration is also achieved as a byproduct due to subsurface fluid losses throughout the life of the system. In this paper, numerical simulations of subsurface flow in EGR and EGS are conducted using the multi-phase flow solver TOUGH2 (Transport of Unsaturated Groundwater and Heat). For EOR simulations, the code COZSIM is employed. An optimization code based on a multi-objective genetic algorithm is combined with TOUGH2 (designated as GA-TOUGH2) and modified for EGR and EGS applications. Similarly COZSIM is combined with GA. Using GA-TOUGH2 and GA-COZSIM, the CO_2 injection rate is optimized for both constant mass and constant pressure injection scenarios to manage the production of methane or oil or temperature profile and heat extraction for EGR, EOR and EGS respectively to ensure that the output occurs for the entire life of the system thus allowing more efficient use of CO_2. The results of this study show promise of EGR, EOR and EGS technologies for consideration of deployment on a commercial scale.

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Dr. Ryoichi Samuel Amano has an international reputation for energy systems, manufacturing, CFD, experimental fluid dynamics, turbulence research, multi-phase flow analysis, and has worked on research related to power generation, manufacturing material processes, gas/steam turbine performance, aerospace engineering, and mechanical designs of process engineering. Dr. Amano also has contributed to the development of turbulence theories, combustion, heat transfer, propulsion, aerodynamics, and applications to gas turbine and aerospace-related projects.

Dr. Amano has more than 550 publications, including books, refereed journal papers, book chaptersmanuscripts, and conference proceedings. He has conducted numerous experimental and analytical research projectsthrough extramural funding from US governmental agencies and many industries. He published four books, Thermal Aspects of Power Engineering, Computational Fluid Dynamics and Heat Transfer-Emerging Topics, Impingement Jet Cooling in Gas Turbines, Aerodynamics of Wind Turbine Blades--Emerging Topics, all in WIT Press, UK. Dr. Amano is recognized by a number of professional awards including AIAA Sustained Service Award (2007), Outstanding Reviewer Award from Journal of Thermal Science and Engineering Applications in Heat Transfer Div. (2011), AIAA Energy Systems Award (2013), ASME George Westinghouse Gold Medal (2014), three ASME Best Paper awards, more than twelve ASME CIE Review Coordinator Awards, and a number of institutional awards. Dr. Amano is a technical committee member, editorial board member and international advisory committee member for ASME, AIAA, WIT Conferences, ICJWSF, THMT, ISAIF, ICPF conferences and an executive member of ASME International Gas Turbine Institute, AIAA Terrestrial Energy System, and ASMEHeat Transfer Committee. Has is the conference chair of International Conference on Next Generation Wid Energy series. He is a Fellow of ASME and Associate Fellow of AIAA.

Investigation of Liquid Breakup Mechanism for Aluminum Propellant in Propulsion Chamber

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Abstract

In a solid fuel propulsion chamber, the aluminum is oxidized into alumina (Al_2O_3), which tends to agglomerate into molten droplets under the right flow conditions, impinges on the chamber walls, and then flows along the nozzle wall. Such agglomerates cause erosive damages. The lecture covers the flow and breakup mechanism of melt aluminum oxide flowing through the propulsion chamber. The study includes the investigation of characterization the breakup process of a liquid flow that moves along the chamber wall while a high-speed air flows over it. Since we need experimental data to validate our theoretical analyses and numerical simulation results for the two-phase interface flow in a propulsion chamber, we have conducted experiments and got clear images. Through the image-processing technique using Welch method, the detailed information on droplet size and distribution of droplets were systematically identified. In the experiment, water flows were used instead of molten flow as a validation for the simulation studies. The analysis was performed by employing the Smagorinski models with Large Eddy Simulation (LES) code for evaluations of the interacting flow computations. The liquid wave frequency of all three different air velocity cases showed similar levels in all three cases. However, the breakup level increases with the increasing air speed. For the average droplet count for all different size groups, higher air velocity increases the number of droplets separating from the main water body.

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Dr. S. Venkata Mohan has received B.Tech. (1991), M.Tech. (1993) and PhD (1998) with Civil/Environmental Engineering as specialization from Sri Venkatsewara University, Tirupati, India in Environmental Engineering. Currently, he is working as Principal Scientist in CSIR-Indian Institute of Chemical Technology, Hyderabad since 1998. His main research interests are in the domain of Environmental Bioengineering and Biofuels specifically in the field of Biohydrogen, Microbial Fuel Cell, Bio-electrochemical systems, Waste Biorefinery, Advance biological treatment methods and algal based fuels. He has authored about 260 research articles, 30 chapters for books and has 8 patents. His publications have so far received more than 7500 citations, and have an h-index of 48 (Google Scholar). He has guided 18 PhDs., 2 M.Phils and more than 50 M.Tech./ B.Tech./ M.Sc. students. He is recipient of coveted 'Shanti Swarup Bhatnagar (SSB) Prize' for the year 2014 in Engineering Sciences. He also received several awards and honours, such as 'National Bioscience award-2012' by DBT, Government of India, 'Prosper.net-Scopus Young Researcher Award in Sustainable Development -2010' under Energy Category by United Nations University and Elsevier, 'NASI-Scopus Young Scientist Award- 2010' in Earth, Oceanographic & Environmental Sciences by NASI and Elsevier, Nawab ZainYar Jung Bahadur Memorial Prize-1994 by The Institution of Engineers (India), etc.

Dr Mohan is elected fellow of National Academy of Engineering (FNAE), Biotech Research Society of India (FBRSI), Andhra Pradesh/ Telengana Academy of Sciences (FAPASc/ FTASc) and Institution of Engineers (FIEI) and Member of European Academy of Sciences and Arts.

Microbial Electrochemical Technologies; Deciphering potential for Harnessing Energy and Remediating Waste

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Abstract

Microbial electrochemical technologies (METs) have been intensively pursued in both basic and applied research as a futuristic and sustainable platform. During the recent past, METs documented diverse applications specifically in harnessing bio-energy and offering value added bio-products along with waste remediation,opening an avenue towards bioeconomy. Broadly, microbial electrochemical technologies can be classified based on its specific and unique applications viz., microbial fuel cell (MFC) or bio-battery (harnessing bioelectricity), bioelectrochemical treatment (waste remediation), bioelectrochemical systems (microbial electrosynthesis or bio-electrosynthesis of value added products) and microbial electrolysis cell (H_2 production under low applied potential). These bacteria catalyzed electrochemical systems utilize the in situ biopotentialdeveloped through bacterial metabolism for achieving either bioenergy generation/treatment of wastewater or production of value added bioproducts. Among the METs, microbial fuel cell (MFC), primarily intended for bioelectricity generation documented significant interest in the contemporary energy research arena. Bio-electrochemical treatment (BET) which illustrated good waste remediation capability is also being pursued with much interest. Besides, bioelectrochemical systems (BES) which emphasize on sequestering CO_2/waste for synthesizing value added bioproductsis an emergingand blooming area of research aiming towards the development of biobased economy. In this communication, an attempt will be made to address the contemporary progress and recent advances made in the framework of METsencompassing its application towards wastewater and value-added bioproducts production.

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Mr. Sandeep Jain has done M.Tech from Thermal Science & Fluid Mechanics from IIT Kanpur in 2000. He is more than 15 years industrial experience & has worked in past at ICEMCFD (Ansys), and consultant at General Motor and Ford Motor Company Ltd in Europe. He has worked in Aerodynamics, Undrhood Thermal Managemnet, Climate control and Engine application in past.

Currently he is working as Business Development Manager at ESI Group, Pune looking after Gamma business in India.

Emissions and Fuel Consumption Trade-offs of a Turbocharged Diesel Engine Equipped with Electrically Heated Catalyst

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Abstract

In order to meet today's very stringent emissions standards; particular attention has to be provided to ensure quick catalyst light-off. One of the strategies being considered to reduce light-off time is to place an electrically heated catalyst (EHC) upstream of the main catalyst. In present work, to assess the effect of electrical heating on the fuel consumption vs. emissions trade-off an integrated model (engine + vehicle + AT system) was built. Here in this work, the integrated model was ran over the NEDC evaluating several EHC control strategies. A Fast Running Model was derived from an existing GT-POWER detailed model of a 2.0L common rail TC Diesel engine. Emissions were imposed by means of look-up maps where was Multi-catalyst system was modeled including detailed kinetics. Here, for DOC and SCR reaction mechanisms from literature works were directly applied. Simple aqueous urea solution injection strategy was implemented upstream of the SCR, also DPF modeled included deep bed filtration and passive regeneration (via NO2 oxidation. The component models were executed in stand-alone mode in order to assure that the model behavior was in accordance with expected trends. It was concluded that with a threshold temperature for the EHC of 475 K the emissions performance is improved by approximately 50% for CO and HC and more than 100% for NOx. Correspondingly Fuel penalty came out to be 3.2 %, while for back-to-back cycles the fuel penalty came down and reduced to 2.2%.

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Dr Sangeeta Negi is Assistant professor in the Department of Biotechnology at Motilal Nehru National Institute of Technology, Allahabad. Her research interest are in the area of product and process development, enzyme technology, biochemistry, bio-remediation, environmental microbiology and industrial microbiology. She has 20 research articles and three book chapters to her credits.

An Indian Prospect of Alternative Bio-Resources for Lignocellulosic Bioethanol

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Abstract

As the world's population is growing with the capital rate and their energy demand per capita are leading to enormous increase of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), through fossil fuel combustion, are perturbing the Earth's environment. Today's world oil demand is approximately 84 million barrels a day (mb/d) and is predicted to be about 116 million barrels a day by 2030, with transport accounting for some 60% of this rising demand. According to the report of Intergovernmental Panel on Climate Change (IPCC), by 2030, energy utilization and transport emitted carbon are predicted to be 80% more than current levels. Therefore, climate change mitigation, energy security and rising oil prices are working as driving force towards the development of alternative clean biofuel.

A wide range of feedstocks such as sugars, starchy substrates to recent lignocellulosic biomass had been explored towards bio-ethanol production till date. The economy of bio-ethanol production is governed by the cost and availability of feedstock as well as the importance of feedstock towards the human or animal feed or other utilities. As few previously explored feedstocks such as corn, wheat straw etc had caused food scrutiny to the animals. In Indian prospects, selection of non-food crops and lignocellulosic biomasses such as pine fallen foliages, sorghum-stover, corn stover, sugarcane tops, cotton waste, switch grass etc. could provide the economical bioethanol, as the feedstock cost alone represents more than 50% of the total production cost lignocellulosic biomass based biorefinery.

Chirr pine (P. roxburghii) trees are found in Lower Himalayan regions of India at latitudes 26°N to 36°N and longitudes 71°E to 93°E and its foliages are remain as waste in the forest and causes abortion in cattles or sometimes even causes severe forest fire, otherwise it undergoes self-microbial as well as environmental deterioration. Pine wood and wood chips have been already explored for the ethanol production but the pine foliages waste could be a better option as they shows surplus availability throughout the year and other important aspect of utilizing it is, for it there is no need of whole tree sacrifice.

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Dr. Santanu De is an Assistant Professor in the Mechanical Engineering, IIT Kanpur, where he has been since December 2014. He received a Bachelor of Engineering from the North Bengal University in 2002, and an M.Tech from the IIT Kanpur in 2004, both in Mechanical Engineering. He received his Ph.D. in Aerospace Engineering from the Indian Institute of Science, Bangalore in 2012. Prior to his joining at IIT Kanpur, he served two years at the Michigan Technological University as a postdoctoral research associate, and one year at the Institute of Combustion Technology (ITV), University of Stuttgart. He also worked as a scientist at the Liquid Propulsion Systems Center, Indian Space Research Organization between years 2004 and 2005. His primary area of research is modeling of turbulent combustion. During his doctoral and postdoctoral research, he developed RANS and LES based approaches, where different state-of-the-art gas-phase combustion models were extended to turbulent reacting sprays.

Modeling of Turbulent Lifted Jet Diffusion Flames Using Stochastic Multiple Mapping Conditioning Approach

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Abstract

A stochastic implementation of the multiple mapping conditioning (MMC) model has been used for the modelling of turbulence-chemistry interactions in lifted methane-air jet diffusion flames in a vitiated coflow. The objectives of the proposed work are to ascertain the capability of the MMC approach and to capture the flame liftoff height in the RANS context, to develop models for small-scale mixing within the MMC framework which can adequately predict the local extinction/re-ignition phenomena. A single reference variable whose mapping function represents the mixture fraction is used. A separate equation for the evolution of the reference variable is solved that ensures closeness of the cumulative distribution function of the mapping function of the reference variable with mixture fraction. In MMC, major and minor mixing time scales are used. The major mixing time scale controls the turbulent mixing of the characteristic quantity via the modelling of a mapping function while the minor time scale controls all fluctuations of scalars relative to the major fluctuations. In the present work, the modified curl model is used to describe the mixing of scalars. The numerical results are compared with the numerical results from the probability density function (PDF) method as well as with the available experimental measurements.

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Dr. Saptarshi Basu is currently an Associate Professor in the Department of Mechanical Engineering at Indian Institute of Science. He is the receipt of the prestiguous Swarnajayanti Fellowship from Department of science and technology. Prof. Basu leads large scale initiatives in the area of combustion, multi-phase flow and heat transfer. He is a project leader in the National Center for Combustion Research and Development and SERIIUS (Solar Energy Research Institute for India and the United States). Before joining IISc, Dr. Saptarshi Basu was an Assistant Professor in the Department of Mechanical, Materials and Aerospace Engineering at University of Central Florida from August 2007-May 2010. Dr. Saptarshi Basu received his M.S. and Ph. D. degrees in Mechanical Engineering from University of Connecticut in 2004 and 2007 respectively. His current research interests include combustion instability, flame-vortex interaction, sprays, droplet combustion, colloids, droplet/spray vaporization, acoustic levitation of functional droplets, droplet dynamics in high temperature plasmas, water transport characteristics in fuel cells, thermal storage and general areas of heat transfer. He has expertise in optical diagnostics particularly laser induced fluorescence, particle image velocimetry, tunable diode laser absorption spectroscopy, IR-thermography, rayleigh scattering and laser induced incandescence. He has authored over 165 technical publications in journals and conferences. Prof. Basu is a member of ASME, AIAA, ISHMT and Combustion Institute.

Unconfined Non-premixed Swirling Flame: Effect of Swirl Number on Flame Stabilization

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Abstract

The present experimental work reports the first observations of primary and secondary transitions in the time-averaged flame topology in a non-premixed co-airflow swirling flame as the geometric swirl number SG (a non-dimensional number used to quantify the intensity of imparted swirl) is varied from a magnitude of zero till flame blowout. The aim is to systematically study the parametric dependence of flame stabilization modes on swirl intensity, which in turn determines the flame shape. The fuel (99.5% pure research grade Methane) is injected through the central pipe. Three fuel flow rates (Reynolds number-Ref range: 107.52-537.64) are studied in the present work. For each of the fuel flow cases, six different co-airflow settings are considered (Rea range: 2647-5029). For a particular Ref and Rea, SG is varied to build a regime map (SGvsRea) that depicts various regions of flame stabilization modes and study the transition from one mode to another.

The primary transition represents a transformation from yellow straight jet flame (at SG = 0) to lifted flame with blue base and finally to swirling seated (burner attached) yellow flame. For all the fuel flow cases considered, the primary transition is observed at critical Rea and beyond it (super critical Rea). Within the Ref range tested, it is observed that as the swirl number is increased from SG = 0 to SG ~0.8-1.4, the straight jet flame lifts-off from the burner exit to stabilize at a lift-off distance h~0.4R0 (R0 is the radius of the co-annular pipe). The lifted flame is significantly blue in color. Time-averaged streamline plot obtained from 2D PIV in mid-longitudinal plane showed a wake-like recirculation zone (RZ) at the immediate vicinity of burner exit. The lifted flame is stabilized along the vortex core of this RZ. Further, when SG ~1.4-3, the first occurrence of vortex breakdown (VB) induced internal recirculation zone (IRZ) is witnessed. The flame now stabilizes at the upstream stagnation point of the VB-IRZ, which is attached to the burner lip. As a result the flame is burner tip anchored and stabilized around the shear layer separating VB-IRZ and co-annular stream.

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Dr. Somrat Kerdsuwan is a Director of the Waste Incineration Research Center and Associate Professor of Department of Mechanical and Aerospace Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Thailand. His works deal with the research and development for the clean and green energy from waste and biomass by using advance Thermal Technology which includes pyrolysis, gasification, incineration as well as the relevant pollution abatement. He is an inventor, from laboratory scale to commercial scale. The outreach of his work can contribute into the real application and response to the real needed for sustainable development.

Prof. Somrat Kerdsuwan joined King Mongkut's University of Technology North Bangkok, a leader of Thai's University of Technology, since 1994 as lecturer in the department of Mechanical and Aerospace Engineering. He was one of the founders of the Waste Incineration Research Center (WIRC) which is the University's research center from 1998. The research center was the only one waste thermal treatment research center of the country has the mission to provide fundamental and applied research, professional services and consultancyto industry and government in the areas of waste disposal through thermal means, as well as efficient and clean use of green energy.

Continuous Operating and Performance Testing of Dioxin Emission from the 60 Ton per Day Two Chambers Municipal Solid Waste Incineration Plant

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Abstract

Incineration technology is one of the most effective way for Municipal Solid Waste (MSW) disposal. The advantage of incineration technology over other technologies is, it can achieve more than 90% of MSW volume reduction. However, the environmental impact is the most important issue to be concerned, particularly dioxins which are highly toxic and can damage the immune system, interfere with hormones and also cause cancer. This study has an objective to investigate the operating performance and the pollution occurred during the operation of the 60 ton per day two chambers MSW incineration plant in terms of NOx, SO_2, CO, HCl as well as dioxins in exhaust gas. The MSW incineration plant consists of two sets of a 30 ton per day incinerator and gas cleaning devices. The incinerator has two chambers for MSW combustion and flue gas combustion. The gas cleaning devices comprise cyclone, quencher, wet scrubber and bag filter. From the continuous operation and performance test of 7 days consecutively, it can be found that the concentration of NOx, CO and HCl in the exhaust gas based on 7%-vol. O_2 is measured to be 65.98-171 ppmv, 266-578 ppmv and 3.18-7.97 ppmv, respectively, whose values are below the limitation of Thai standards, whereas the concentration of dioxins in exhaust gas ranges between 403.63 and 604.58 ng/Nm3, which is equivalent to 6.74-12.34 TEQ-ng/Nm^3. Regarding to the Thai standard, concentration of dioxins in exhaust gas is considerably greater than the limitation. The dioxin elimination by improving of emission abatement system is still the challenge for MSW incineration plant. The Thailand emission standard from incineration plant is also compared and discussed with the international emission standard.

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Mr. Sourabh Arun Deshpande received BE (Mechanical Engineering) in 2011 from Walchand Institute of Technology &M.Tech (Automotive Engineering) in 2014 from VIT University, Vellore & Automotive Research Association of India, Pune. Sourabh did isdissertation in the field of HCCI combustion with different fuel injection strategies under the guidance of Prof. Sreedhara Sheshadri from Indian Institute of Technology, Bombay and Dr. S.S. Thipse from ARAI, Pune.

Prior to his Master's, Sourabh was working at Faurecia Technology Center India, Pune inthe field of Automotive Interior Designing. Currently, he is working at CEI Software, Pune as an Application Engineer and he is responsible for technical support of a 3D CFD tool - Converge in India and South East Asia.

Numerical Investigation of Late Injection Strategy to Achieve Premixed Charge Compression Ignition Mode of Operation

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Abstract

Premixed charge compression ignition (PCCI) mode of operation simultaneously reduces oxides of nitrogen (NOx) and particulate matter (PM) with improved fuel economy. Late injection is one such strategy to achieve PCCI mode along with the control over the ignition timing. Late injection along with charge dilution retards combustion and prepares homogeneous mixture by providing sufficient ignition delay. The in-cylinder charge distribution dictates mixture formation which affects the performance and emissions characteristics. Experimental results fail to provide an insight of the in-cylinder processes involved. Hence, numerical simulations have been performed to get in-cylinder distributions of scalars, which help in understanding the combustion process. The work consists of late in-cylinder injection of Diesel wherein the heat release rate trace shows only a premixed mode with lower soot and NOx. The absence of diffusion combustion confirms that the engine operates in a PCCI mode. In this work, effects of various injection parameters and swirl ratio on engine in-cylinder processes, performance and exhaust temissions have been studied using 3D model with detailed chemistry by using Converge, a CFD tool. Increasing swirl ratio improved air-fuel mixing causing lower soot emission upto a certain limit beyond which further increase in swirl ratio led to higher soot emission due to increased heat loss. Delayed start of injection resulted in delayed combustion leading to lower soot and NOx emission but partial oxidation resulted in higher carbon monoxide (CO) emissions. Nozzle tilt angle beyond 70° led to formation of fuel-rich mixture at the centre of combustion chamber resulting in higher soot and CO emissions. A narrow spray cone angle improved air-fuel mixing leading to lower soot but produced higher NOx. Medium swirl with late injection timing; wide nozzle tilt angle along with narrower spray cone angle resulted in lower emissions without deteriorating engine performance

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Dr. Suresh K. Aggarwal received his Ph.D. in Aerospace Engineering from Georgia Institute of Technology in 1979. Since then, he has been at Princeton University as a member of the Professional Research Staff, and at Carnegie-Mellon University as a Senior Research Engineer, and since 1984 with The University of Illinois at Chicago, where he joined as Assistant Professor, and was promoted to the rank of Professor of Mechanical Engineering in 1995. His other appointments include being the Director of Graduate Studies, Visiting Scientist at Argonne National Laboratory, USA, Visiting Professor at Ecole Centrale-Paris, France, andGuest Professor at Jiangsu University, China.

Dr. Aggarwal's research and teaching interests include Combustion, Multiphase Reacting Flows, Renewable Fuels, Emissions, Clean Energy, Fire Suppression, and Microgravity Phenomena. He has authored over 330 journal and conference publications, 7 book chapters, and 2 edited books, with over 3700 citations and H-index of 34.His research has been funded by a number of federal agencies and companies, and has resulted in the graduation of 16 Ph.D. and 42 M.S. students. He is an ASME Fellow, AAAS Fellow, and AIAA Associate Fellow. He has serving as an Associate Editor of the AIAA Journal, the Founding Editor of the International Journal of Reacting Systems (now J of Combustion), and on the Editorial Boards of Journal of Green Energy, and Book Series on Sustainable Energy Developments.

Flame Liftoff and Stabilization in Gaseous and Two-Phase Flows

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Abstract

Flame liftoff and stabilization are of fundamental importance in numerous combustion systems, including gas turbine, diesel engine, and fire safety. Extinction of jet diffusion flames is often described in terms of flame liftoff and blowout. In premixed combustion systems, bluff bodies are generally used for flame anchoring or stabilization. Diesel engine combustion involves a lifted flame in a two-phase mixture, and the engine performance and emissions are strongly influenced by the liftoff length and flame structure at the base. Due to such broad range of applications, the flame liftoff and stabilization have been extensively studied, and a number of theories have been proposed. This talk will review computational and experimental studies on lifted laminar flames and their stabilization mechanisms, and discuss their relevance to turbulent flame liftoff. Results pertaining to dilution-induced liftoff and stabilization of non-premixed and partially premixed flames. Various phenomena associated with flame liftoff and stabilization will be discussed. These include local and global extinction, scalar dissipation, edge flame stabilization, triple flame structure and propagation. Heat/mass transport and chemical kinetic processes associated with these phenomena will also be discussed.

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Dr. Sutapat Kwankaomeng is a Professor in the Department of Mechanical Engineering at King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand. She worked in the Fluid Power Laboratory and received her PhD. in the major of mechanical engineering and minor in engineering mechanics and aeronautic from University of Wisconsin-Madison, USA. Dr. Sutapat's areas of interest are heat transfer and thermal system design including green energy engine designs such as Stirling engine and compressed air engine, solar collector, solar power plant, biomass power plant and combined heat and power (CHP) applications. She has published over 50 international journal and conference publications. As a head of Green Energy Engine Research (GEER) Laboratory in KMITL, Dr. Sutapat with her colleagues and students designed and built many prototypes of Stirling engines and compressed air engines with various scales and applications. The free-piston Stirling engine prototype with solar power was awarded the 1st runner up in Alternative Energy Creation of iC-HiEd 2014 by Nation Research Council of Thailand. She was granted a lot of research funding and one of her project was awarded as a good project presentation by Office of the Higher Education Commission, Thailand. Her research prototypes have commercial potential as a small scale distributed generation.

Design of a Solar-Powered Stirling Engine - Generator

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Abstract

Stirling cycle engine, a hot gas engine or an external heat engine, offers potential advantages over conventional engines in fuel choices, noise, and emissions. Multi-fuel such as agricultural by-product, biomass, biodiesel, solar energy and etc. can be employed as the heat source for a Stirling engine. This paper presents a free-piston Stirling engine (FPSE) which utilizes solar energy as the heat source. The FPSE is an engine that operates without a crankshaft and flywheel but instead incorporates only reciprocating motion of the piston. The FPSE, therefore, has advantages such as simplicity, compact, potential self-starting, low noise and long life. A FPSE is coupled with generator in order to convert mechanical power to electricity. The solar collector is designed to provide heat for the hot section of FPSE. In the proof-of-concept device, the engine is heated by a solar simulator and cooled by water.. The performance and dynamic characteristics of the free-piston Stirling engine (FPSE) have been simulated to determine its operating characteristics over a wide range of conditions. A prototype is built and tested to verify stability and the simulation results.

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Dr. Swarnendu Sen is a Professor of Mechanical Engineering at Jadavpur University, Kolkata, India. He obtained his Bachelors, Masters and doctoral degrees from Jadavpur University. Dr. Sen was in visiting positions at University of Illinois at Chicago, Virginia Tech and Technical University of Munich. Dr. Sen is a DAAD fellow. He is a fellow of West Bengal Academy of Science and Technology. Dr. Sen's working areas of interest include heat transfer, reacting and multiphase flows and nanotechnology. His current research activities include atomization, dynamics and control of partially premixed flames, nonlinear dynamics and chaos in combustion systems, flame synthesis of CNT, spray impingement heat transfer and electrokinetic and thermomagnetic microscale flows. Dr. Sen has over 200 research publications and has advised a number of masters and doctoral thesis.

Dynamic Data Driven Prediction of Lean Blow-out in Swirl-Stabilized Dump Combustor

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Abstract

Lean combustion is one of the popular strategies to achieve very low emission levels in confined combustion processes, which are prevalent in landbased and aircraft gas-turbine engines. However, it is extremely susceptible to lean blow-out (LBO). Real time prediction of LBO is a necessity for controlling the combustors sustaining the flame. In the present scheme a swirl-stabilized dump combustor is used as a laboratory-scale model of a generic gas turbine combustor with LPG as fuel. Various time series data of CH chemiluminescence signal are recorded for different flame conditions by varying equivalence ratio, flow rate and level of air-fuel premixing. Here we propose two methods for early prediction of LBO analyzing the time series data. The first one explores a Crosswavelet transform (XWT) aided rule based scheme for early prediction of lean blowout. The extracted features are observed to classify the flame condition into three major classes: near LBO, moderate and healthy. In the second case, dynamic data-driven prediction is tested. The underlying concept is built upon pattern classification and is validated for LBO prediction with experimental time series data.

Prof. Tarun Gupta

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Dr. Tarun Gupta is currently serving as a Professor in the Department of Civil Engineering, Indian Institute of Technology, Kanpur. He earned his Doctoral degreein Environmental Health from Harvard University; School of Public Health, USA inthe year 2004.He received his M.Tech. in Environmental Science and Engineering from the Indian Institute of Technology, Bombay in the year 2000. He has pioneered real-time personal exposure study for a panel of IITK students to various toxic pollutants present in both indoor and outdoor microenvironments using a suite of real time instruments coupled to time-activity recordings. His published work related to changes in critical lung function parameters to acute air pollution is a first of its kind for Indian population. He has also been working towards enhancing the indigenous capabilities within the country to develop inexpensive, portable and readily deployable aerosol measuring instruments. One of his innovative PM1 air sampler has recently been commercialized by a well-known company, Envirotech (Delhi). He has worked on engine exhaust emission physico-chemical characterization including speciation for organic species like PAHs. He is currently working on development and evaluation of non-noble metal based diesel oxidation catalyst (DOC). He has authored more than 65 journal publications and has filed application for 2Indian patents. He has been bestowed upon with salient recognitions like P K Kelkar Research Fellowship (2015), NASI SCOPUS Young Scientist (2015), INSA Medal for Young Scientist (2011), INAE Young Engineer Award (2009)and IEI Young Engineer Award (2008).

Estimating Role of Combustion Sources in the Ambient Air Quality by using Organic Species as Markers

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Abstract

Organic species are one of the major components of both gaseous and particulate emission from various combustion sources. These species after getting in the ambient air gets diluted and transformed. The gas to particulate conversion leads to the formation of secondary organic aerosol (SOA). Combustion generated organics are formed as a result of a complex process. The nature and quantity of Polycyclic aromatic hydrocarbons (PAHs) present in the combustion flue gasesserve as key providing specific source signatures. The PAHs concentration varies significantly in various rural and urban environments and their concentration are mainly influenced by the level of vehicular and domestic emissions. Diagnostic ratio (DR) approaches allow either individual PAHs or their combination to be used for identifying their origin sources. This talk will provide details of the fate and transformation of SOA and PAHs directly emitted from combustion sources. The effect of temperature and relative humidity on the formation of SOA and a brief discussion on its measurement and analysis will be presented.

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Investigation of Forward and Reverse Flow CDC Combustors

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Abstract

Colorless distributed combustion (CDC) is characterized by discrete and direct injection for air and fuel at high velocity in the combustor. Injected air mixes with the internally recirculated product gases to form hot and diluted oxidizer. Rapid mixing of the injected fuel with the oxidizer (prior to ignition) results in an overall lean combustion (near the global equivalence ratio) as compared to near stoichiometric combustion found in conventional diffusion flames. Hence, with CDC low pollutant emissions (NOx, CO and UHC) can be achieved even in the non-premixed combustion mode. Different air and fuel injection configurations could be realized for a CDC combustor. In forward flow, air is injected from the opposite end of combustor exit and in reverse flow, air is injected from the same end of combustor exit. In both forward and reverse flow configurations, fuel can be injected from the same end of air injection, opposite end of air injection, or in cross flow with respect to air injection. In this talk, I will discuss the impact of various flow configurations on the overall flow field, gas recirculation, fuel/air mixing and residence time characteristics and combustion and emission behavior of CDC combustors.

Mr. Vikas Singh

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Mr. Vikas Singh is on a mission to help businesses focus on the leaner and greener technologies. As the Power Generation Sales & Marketing Manager for Caterpillar's Gas Turbine subsidiary, Solar Turbines, he is responsible for the Indian Subcontinent business.

Trained as a mechanical engineer, he has a unique decade longback ground in sales & marketing, application engineering and business development. He has experience with various technologies in air conditioning, boilers, vapour absorption chillers and Combined Heating and Power (CHP).

He worked with organizations like Voltas Limited &Thermax Limited prior to joining Caterpillar.

Use of Gas Turbines in Large Locomotives

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Abstract

Reciprocating diesel engines have traditionally been the solution for all transportation applications. This has been supported by the subsidies offered by most countries on diesel and the gas pricing hovering in the 10-15 USD/ mm BTU price range globally. With the US shale gas production rising YoY, more LNG export facilities coming up globally and the crude oil price expected to remain at less than 40 USD/ barrel, the future for use of Natural Gas in transportation looks very bright. Gas Turbines fit into a niche transportation space where countries are looking at having dedicated freight corridors to carry upwards of 10,000 Tonnes of freight.

Mr. Vishal Pawar

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Mr. Vishal Pawar is a Mechanical Engineer who has over 12 years of experience in the field of Structural Mechanics primarily in Virtual Prototyping. He has worked with various OEMs and Suppliers in multiple domains like Safety, Durability and Comfort to name a few. Over the past few years, he has been associated with ESI leveraging the Value-Added Virtual Proposition towards the Structural Industry.

End-to-End Virtual Prototyping Allows Railway Customers to Deliver the Physical Prototype Right the First Time Using ESI Technology

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Abstract

Indian Railways, one of the world's largest mass-transportation and India's Prime Economic movers comprises of over 100,000 kms of tracks and carries over 8 Billion Passengers and 1 billion freight a year. With such a large network, the key challenges would be to maintain a balance between effective operational costs, sustainable profitability and future progression/expansion ensuring passenger safety and comfort. Hence, there is large dependency on the overall design philosophy that includes optimum power requirements, mass-balanced-light-weight designs, passenger safety and comfort to name a few.

A re-look into conventional design process that heavily relies on extensive physical prototyping and testing could be cumbersome in terms of Costs and Time. With the industry norms changing rapidly, this form of process could lead to large design cycles thereby delaying the time to market. Hence Virtual-Prototyping could add immense value towards the entire product-life-cycle and management addressing key issues from concept to manufacturing feasibility to validation and packaging to production. ESI Group established since 1973 has evolved into a Prime Solution Providers on End-to-End Virtual Prototyping today. ESI emphasizes and endeavors in providing Real Time Virtual Solutions in order to mimic the product in an "As Is or As Built" State by accommodating various stages of the product development stages like Casting, Stamping, Welding and other manufacturing stages before validating the Performances like Safety, Durability, Comfort and Acoustics. Some of these key value-added Virtual Solutions towards the Locomotive Industry has been explained here

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Dr. Yun Hin Taufiq-Yap is Professor of Catalysis and Head of the Laboratory for Sustainable Chemicals and Bioenergy, Catalysis Science and Technology Research Centre at Universiti Putra Malaysia. He is the Fellow of Academy of Science Malaysia, Malaysia Institute of Chemistry and Royal Society of Chemistry, UK. He holds a BSc (Hons) and MSc from Universiti Putra Malaysia and a PhD from the University of Manchester Institute of Science and Technology (UMIST) UK and following research attachement at Cardiff Univeristy. He was formely the Visiting Professor for Curtin Sarawak Research Institute at Curtin Univeristy Sarawak, Universiti Teknologi PETRONAS and also at Nagoya University, Japan. His research interests lie on designing heterogeneous catalysts and nano catalyst for sustainable biofuels and chemicals production from biomass and renewable resources.

Current Practice and Problems in Biodiesel Industries

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Abstract

Interest in biodiesel is growing rapidly worldwide due to energy security, diversity, and sustainability as well as for greenhouse gas mitigation. The inadequacy of fossil fuel is the main driving force of the future sustainable energy around the world. The competitive potential of biodiesel is limited by the price of vegetable oils, which strongly influences the final price of this biofuel. Therefore, attention has been placed in this study on the selection of heterogeneous catalyst in biodiesel industry, where the catalyst could be facilitated highly selective towards desired products, easily handled, separated from the reaction medium and subsequently reused. Appropriately planning and designing the whole production process, from the seed to the biodiesel end-product, is essential to contain the influence of energy inefficiencies on the high price of the end-product. This study also focuses on the characteristics of the production processes currently used in the sector, illustrating the technological options and emphasizing the drawbacks of certain practices and the best choices available. The refined vegetable oil can subsequently be converted into biodiesel by means of a great variety of technologies, many of which are still not suitable for applications on an industrial scale. Further, this study reviews on feasible technological improvements that would give rise to oil that is still suitable for use as a source of energy, but at a lower cost.

POSTERS

S. No.	Authors	Poster Title
1.	Dharmendra Kumar Singh, Tarun Gupta, CESE, Indian Institute of Technology Kanpur, India	Combustion and Diesel Engine Emission Containing Polycyclic Aromatic Hydrocarbons (PAHs) Present during Fog Time Collected Submicron Particles in Northern India
2.	Akhilendra Pratap Singh, Avinash Kumar Agarwal, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India	In-Cylinder Air-Flow Characteristics Using Tomographic PIV at Different Engine Speeds, Intake Air Temperatures and Intake Valve Deactivation in a Single Cylinder Optical Research Engine
3.	Chetan Patel, Avinash Kumar Agarwal, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India	Microscopic and Microscopic Spray Investigation of Karanja and Jatropha Biodiesel at Lower Injection Pressure
4.	Jayakrishnan K, L. M. Das Center For Energy Studies, Indian Institute of Technology Delhi, India	Study of Gas to Liquid (GTL) Blends in IC Engine
5.	Omid Askari, Kevin Vein, Hameed Metghalchi, Department of Mechanical and Industrial Engineering, Northeastern University, Boston, USA	Laminar Burning Speed Measurement, Auto-Ignition and Flame Structure Study of Spherically Expanding Flames
6.	Mohamed Saeed Ibrahim Hussein, Ryo S. Amano, University of Wisconsin, Milwaukee, USA	Simultaneous Differential Thermal and Thermo-gravimetric Analysis of Chicken Manure Gasification Using Nitrogen and Carbon Dioxide
7.	Saket Verma, S.C. Kaushik, L.M. Das, Center For Energy Studies, Indian Institute of Technology Delhi, India	Exergy Analysis of Hydrogen-Fuelled IC Engines based on Numerical Investigations
8.	Ayush Jain, Avinash Kumar Agarwal Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India	Optimization of Premixed Charge Compression Ignition Using Fuel Injection Parameters

9.	Ramraj H Sundararaj, S.D.K Juvva, Anup Raut, Chandrashekar T, Vivek Pandey, Abhijit Kushari, John Hu Department of Aerospace Engineering, Indian Institute of Technology Kanpur, India	Effect of Biodiesel Blends on Gas Turbine Emissions
10.	Rajesh Kumar Prasad, Avinash Kumar Agarwal, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India	Laser Ignition and Flame Kernel Characterization of HCNG Mixture at Different C/H Ratios in a Constant Volume Combustion Chamber
11.	S.D.K Juvva, Ramraj H Sundararaj, Sathesh Mariappan, Abhijit Kushari, John Hu Department of Aerospace Engineering, Indian Institute of Technology Kanpur, India	Active and Passive Control of Hooting in Gas Turbine Combustors
12.	Shuchi Singh, Arun Goyal, V.S. Moholkar* Center for Energy, Indian Institute of Technology Guwahati, India	Intensification of Ethanol Production from Parthenium Hysterophorus by Sonication: A Mechanistic Investigation
13.	Nikhil Sharma, Avinash Kumar	An Experimental Study of Microscopic Spray
	Agarwal, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, India	Characteristics of a GDI Injector Using Phase Doppler Interferometry
14.	Rawel Singh, Bhavya B Krishna, Thallada Bhaskar Indian Institute of Petroleum, Dehradun, India	Hydrothermal Liquefaction of Biomass to Fuels/ Chemicals
15.	A Naresh Kumar, S. Venkata Mohan, CSIR-Indian Institute of Chemical Technology (IICT), Hyderabad, India	Bioelectrohydrolysis as a Novel Pre-Treatment Tool for Solid Waste Hydrolysis: Integrated Bioprocess Towards Bio-hydrogen and Carboxylic Acids Production

In-Cylinder Air-Flow Characteristics using Tomographic PIV at different Engine Speeds, Intake Air Temperatures and Intake Valve Deactivation in a Single Cylinder Optical Research Engine

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Abstract

Fuel-air mixing is the main parameter, which affects formation of NOx and PM during CI combustion. Hence better understanding of air-flow characteristics inside the combustion chamber of a diesel engine became very important. In this study, in-cylinder air-flow characteristics of four-valve diesel engine were investigated using time-resolved high-speed tomographic Particle Imaging Velocimetry (PIV). For visualization of air-flow pattern, fine graphite particles were used for flow seeding. To investigate the effect of different operating parameters, experiments were performed at different engine speeds (1200 rpm and 1500 rpm), intake air temperatures (room temperature and 50°C) and intake port configurations (swirl port, tangential port and combined port). Intake air temperature was controlled by a closed loop temperature controller and intake ports were deactivated by using a customized aluminum gasket. Imaging was done by two CCD cameras and timing synchronization was done using external clock pulse synchronizer. Two directional projections of captured flow-field were pre-processed to reconstruct the 3D flow-field by using the MART (multiplicative algebraic reconstruction technique) algorithm. Ensemble average flow pattern was used to investigate the air-flow behavior inside the combustion chamber during the intake and compression strokes of an engine cycle. In-cylinder flow visualization indicated that energy dissipation was the maximum near the end of intake stroke. The non-homogeneous and highly fluctuating flow of intake stroke became uniform during compression stroke. In-cylinder air-flow characteristics were significantly affected by engine speed. Air velocity and turbulence was found to be significantly higher at higher engine speeds. Tangential port configuration showed highest rate of energy dissipation, which resulted in minimum absolute air velocity. Comparison of all operating conditions showed that 50°C and swirl port open configuration provided superior in-cylinder flow condition for better fuel-air mixing, resulting in improved combustion, emissions and performance.

Optimization of Premixed Charge Compression Ignition Using Fuel Injection Parameters

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Abstract

Advancements in engine technology to restrain exhaust emissions in order to meet the emission norms have become the primary incentive of engine research over the past decades. The present study focuses on developing new combustion concepts for CI engines by achieving partially homogeneous fuel-air charge resulting in lean and low temperature combustion. Premixed charge compression ignition (PCCI) is a single-stage combustion process, which shifts combustion towards increasingly premixed combustion phase, resulting in a fuel-lean charge and lower in-cylinder combustion temperatures. Experiments were conducted on a single cylinder research engine (SCRE) with early fuel injection timings and high EGR to reduce NOx and PM emissions simultaneously. In the experiments, a highly advanced and flexible fuel injection system has been employed, which is capable of producing four injections (2 pre-injections, 1 main and 1 post injection) at variable injection timings. Various fuel injection parameters including fuel injection pressure, injection timings, injection duration and number of injections have been optimized in order to tackle the problems of lower volatility and combustion phasing of mineral diesel. The experiments were carried out with mineral diesel using single injection strategy at three different injection pressures (350, 600, and 850 bar) at four different fuel injection timings. In this study, physical characterization of particles has also been carried out using engine exhaust particle sizer (EEPS). Results indicated that early fuel injection led to more homogeneous fuel-air mixing, which improved combustion therefore produced lower soot for all fuel injection timings. PCCI combustion has a significant potential to control emissions without compromising the thermal efficiency.

Microscoppic And Macroscopic Spray Investigation of Karanja and Jatropha Biodiesel at Lower Injection Pressure

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Indian Institute of Technology Kanpur, Kanpur-208016, India

Abstract

Biodiesel made from vegetable oils such as Karanja and Jatropha oil, by transesterification process, has viscosity comparable to mineral diesel hence can be used as alternate fuel in diesel engines. It is important to investigate the spray characteristics of biodiesel because performance and emissions from the engines are largely dependent on fuel atomization and resulting fuel-air mixing. Spray visualization studies were conducted at higher ambient pressures (1 MPa, and 2 MPa) for different test fuels and it was found that the spray penetration length, and spray cone angle are strongly influenced by ambient pressure for all test fuels. Spray investigations also conducted by using Phase Doppler Interferometry (PDI) for the measurement of various microscopic spray parameters such as arithmetic mean diameter (AMD), Sauter mean diameter (SMD) and spray droplet velocity distribution. Fuel injection pressure during the spray experiments was maintained at 200 bar for all test conditions, which is similar to small horse power engines, and the fuel injection quantity was varied at ambient conditions.

Combustion And Diesel Engine Emission Containing Polycyclic Aromatic Hydrocarbons (PAHs) Present During Fog Time Collected Submicron Particles In Northern India

Dharmendra Kumar Singh, Tarun Gupta*
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Abstract

Submicron particles (PM1) were collected using PM1 sampler during the foggy days (December 2013-January 2014). PM1 values varied between 58.12 ?g/m3 and 198.75 ?g/m3, and average mass concentration was 162.33 ± 38.25 ?g/m3 while total average concentration of particle-associated polycyclic aromatic hydrocarbon (PAHs) determined was (616.31 ± 30.31 ng/m3). This is a signal for an alarming high pollution level at this site situated in the Northern India. PAHs were extracted from filters using toluene and added acetonitrile with ultrasonication method and analysed. High performance liquid chromatography (HPLC) technique was used for quantification of 16 target PAHs including carcinogenic compound benzo(a) pyrene (19.86 ± 38.98 ng/m3). Benzo(a)anthracene, anthracene, fluoranthene and fluorene were the predominant compounds observed in the samples collected during foggy days. In addition to predominated diesel engine emission, wood and coal combustion and biomass burning also significantly contribute to the PAH levels during winter and foggy days.

Keywords: Polycyclic aromatic hydrocarbon; Foggy days; PM1; Benzo(a)pyrene; Fluoranthene

Study of Gas to Liquid (GtL) Blends in IC Engine

Jayakrishnan K, L.M.Das

Abstract

Gas to Liquid (GtL) fuel produced by Fischer Tropsch Process has property very similar to diesel and can be used in diesel engines just like diesel fuel or in blended form with diesel or biodiesel fuel. The fuel is paraffinic in nature with advantages like zero sulphur, low aromatic content and higher cetane number when compared to diesel fuel. GtL has been produced by various industries like Shell Inc. The inherent advantage of GtL being a liquid fuel is that it can be transported easily compared to gaseous fuels by virtue of their higher energy density by volume. In the present study the fuel has been evaluated for its performance, emission and combustion characteristics in an unmodified multicylinder CI engine. The fuels under study, a 20% blend of GtL with diesel, whose performance emission characteristics were compared with base line data generated using diesel. The study indicates that while the performance characteristics of GtL blend closely followed that of diesel fuel and the emission, especially NOx emission was lowered by around 8%.

Laminar Burning Speed Measurement, Auto-Ignition and Flame Structure Study of Spherically Expanding Flames

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Abstract

Laminar burning speed is a thermos-physical property of a combustible mixture. It is a measure of the rate of energy released during combustion in quiescent gas mixtures and incorporates the effects of overall reaction rates, energy (heat) of combustion and energy and mass transport rates. Investigation of spherical flame propagation in constant volume vessels is recognized to be one of the most accurate approaches for laminar burning speed measurement and flame structure study.

In this presentation flame structure, laminar burning speed and onset of auto-ignition are studied for premixed combustible mixtures at high temperatures and pressures over a wide range of fuel-air equivalence ratios. The experimental facilities consist of two spherical and cylindrical vessels. The spherical vessel was used to collect pressure data to measure the burning speed and cylindrical vessel was used to take pictures of flame propagation with a high speed CMOS camera up to 40,000 frame per second located in a shadowgraph system. Flame structures are studied to determine the cell formation conditions. Critical pressures at which the flame becomes cellular are identified and the effects of important parameters on cell formation were studied. Auto-ignition experiments are carried out for fuel-air mixtures with high initial pressures in the spherical chamber.

Simultaneous Differential Thermal and Thermogravimetric Analysis of Chicken Manure Gasification using Nitrogen and Carbon Dioxide

Mohamed Saeed Ibrahim Hussein, R.S. Amano
(Faculty Advisor)
University of Wisconsin-Milwaukee

Abstract

Early gasification history can be dated to the early 1800's where coal was gasified using oxygen and water at high pressure to produce syngas to use it in road lighting. Bio-waste can be treated in a similar manner to generated liquid and gaseous fuels. In livestock farms, manure is considered a burden on the farm economy as it has to be transported away from the farm. The negative economic value of the manure can be converted into a positive saving in the energy bill if the manure is utilized in power production. Manure can be used in heat generation or power production if gasified into Syngas then fired in a diesel engine. In this research, Chicken manure gasification is studied using simultaneous differential thermal analysis (DTA) and thermogravimetric analysis (TGA). The gasification process was studied for Carbon Dioxide, Nitrogen and mixture of these two gases. The main characteristic temperatures were specified, and the different stages of the gasification were defined.

An Experimental Study of Microscopic Spray Characteristics of a GDI Injector Using Phase Doppler Interferometry

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Indian Institute of Technology Kanpur, Kanpur-208016, India

Abstract

Gasoline Direct Injection (GDI) engine is known for its higher power and higher thermal efficiency. Researchers are steadily determining and resolving the problems of fuel injection in a GDI engine. In order to meet the stringent emission norms such as PM and NOx emitted by a GDI engine, it is necessary to investigate the microscopic spray characteristics and fuel-air mixing process. This paper aims to share the fundamental knowledge of the interacting mixture preparation mechanisms at the wide range of fuel injection pressures. The investigations were carried out at five different fuel injection pressures viz: 40, 80, 120, 160, 200 bar, for 24 mg fuel per injection. A high speed CCD camera was used to determine the macroscopic spray characteristics of the GDI injector. It was found that spray penetration length increased with increasing fuel injection pressure. Phase Doppler Interferometry (PDI) was used to determine the droplet size and droplet velocity for different test fuels. In the end, Sauter Mean Diameter (SMD) and Probability Density Function (PDF) and diameter verses velocity curves were plotted, which gave better understanding of the behavior of fuel injection pressures responsible for improved fuel-air mixture. In the PDF, the shifting of the peak towards left was found to be desirable for better fuel-air mixture. It was observed E15 is better fuel for pressure range of 40-160 bar and gasoline for 200 bar pressure. Droplet sizes with different injection pressures in turn helped in minimizing stringent emission norms.

Laser Ignition and Flame Kernel Characterization of HCNG Mixture at Different H/C Ratios in a Constant Volume Combustion Chamber

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Indian Institute of Technology Kanpur, Kanpur-208016, India

Abstract

The study of combustion behavior of H/C ratio in case of gaseous fuels helps to develop an engine which gives less emission, more fuel efficient without loss of power. Laser ignition promote lean burn combustion concept which is mostly used worldwide to reduce environmental problems. In this regards HCNG (mixture of hydrogen and CNG) become more attractive fuel in recent times. The laser ignition of HCNG -air mixture for different H/C ratios were experimentally studied using a nanosecond pulse(6-9 ns) at the fundamental wavelength 1064 nm from a Q-switched Nd:YAG laser in a constant-volume combustion chamber (CVCC). Experiments were conducted at 5 bar, and 10 bar chamber pressures and temperature was kept at 373 K to observe flame kernel development of different H/C ratios. A high speed camera was used for both trigger the laser and record the flame kernel development. These images were further analyzed to get temporal propagation of flame front. It was observed that initially the plasma propagates towards the incoming laser beam. A piezoelectric pressure transducer along with DAQ was used to measure the pressure rise in the combustion chamber. As H/C increases, the peak pressure and laminar flame speed increases and on the other hand lobe formation and combustion duration decreases. With lower H/C, flame kernel of was very prominent lobe formation while for higher side the flame front was almost spherical.

Hydrothermal Liquefaction of Biomass to Fuels/Chemicals

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Abstract

Owing to increased industrialization and urbanization, it is proposed that the future oil production might not be able to meet energy demands. Use of fossils fuels also leads to the generation of green house gases negatively affecting the environment. Alternative energy such as biomass, solar, wind, hydroelectric, (bio) renewable, are attracting considerable global interest to meet our future energy demand. Compared to other forms of renewable energy biomass is the only source of organic carbon. Production of valuable chemicals from highly functional biomass in a single step with high selectivity, economically viable and energy efficient manner is the need of the hour. Hydrothermal liquefaction (HTL) is a process for obtaining fuels/chemicals from biomass in the presence of water at moderate to high temperature (250-350 ?C) and pressure (5-22 MPa). Water associated with aquatic biomass can be advantageously utilized during HTL thereby eliminating the energy intensive drying step. Variety of feedstocks including cellulose, lignin, residues from agriculture, forestry, and microalgae/defatted microalgae, macro algae, water hyacinth etc. has been studied using HTL process for the optimisation of several operating parameters such as reaction temperature, effect of solvent, residence time, biomass: solvent ratio, homogeneous and heterogeneous catalyst etc. Lignin has been converted to various monomeric phenols and aromatic ethers and carbohydrate fraction of biomass was converted to various water soluble oxygenated hydrocarbons viz. hydroxymethyl furfural, lactic acid, levullinic acid, furfural etc. It was also observed that addition of alkali enhances the inherent function of high temperature water, leading to high yields of desired products (bio-oil). Compositional variations in biomass types cause changes in product distribution and nature of products obtained from hydrothermal liquefaction. Agricultural biomass showed higher conversion than forest biomass. Alkali catalysts also showed different activity for agricultural and forest biomass residue. Use of organic solvents significantly increased the bio-oil yield. In order to increase the energy efficiency of the process and product selectivity, non conventional energies like microwave can be utilised. Hydrothermal liquefaction of tamarind seed husk using microwaves have been carried out to obtain high yields of catechol. Use of solid acid/base catalysts during HTL of biomass is highly essential and the challenges with respect to robust (strength and stable) catalyst (solid) have to be addressed.

Exergy Analysis of Hydrogen-Fuelled IC Engines Based on Numerical Investigations.

Saket Verma, S.C. Kaushik & L.M. Das
Centre for Energy Studies, Indian Institute of Technology Delhi, India

Abstract

Hydrogen fuelled IC engines (H2ICEs) have been considered as one of the most promising systems for pollution free transportations. Performance and combustion merits of H2ICEs have been extensively discussed in the literature. But, studies related to these discussions have largely been linked to first law analysis. However, second law of thermodynamics coupled with first law, also known as exergy analysis, can give better insight into the engine performances. Present work deals with second law quantification of hydrogen engine processes and sub-processes, which helps to understand its true potential to deliver the output and simultaneously estimate the losses. As part of this work, a numerical model has been prepared to simulate H2ICE operations and then second law equations have been coupled to ascertain different exergy terms. This study brings out the potential of this technique to quantify different process inefficiencies in terms of irreversibilities thereby identifying the gaps to be addressed for further improvements. In the present study, combustion was found to be the biggest source of irreversibility. It has been found out from this study that the level of irreversibility for a hydrogen-operated engine is substantially lesser as compared to gasoline engines under identical ranges of operating conditions.

Bioelectrohydrolysis as a Novel Pretreatement Tool for Solid Waste Hydrolysis: Integrated Bioprocess towards Biohydrogen and Carboxylic Acids Production

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Abstract

New renewable processes based on solid waste are being developed to generate electricity, biofuels or chemicals to reduce the world's dependency on fossil fuels. One of the attractive avenues to achieve both goals is to harness energy and resources from solid waste (SW) through bioconversion processes Organic fractions of solid waste (municipal solid waste, waste activated sludge, food waste, etc.) contains the complex polysaccharides and proteins, thus needs to convert into simple monomers by using various pretreatement methods (hydrolysis). In the present study, novel bio-electrohydrolysis system (BES) is designed as a pretreatment device to persuade the hydrolysis of SW with simultaneous bioelectricity generation. BES system offers self induced in situ biopotential (self inducing bioelectrogenic activity) facilitates the breakdown of complex SW with simultaneous bioelectricity generation. By considering the above advantage, three different operating modes of BES systems were evaluated to degrade the SW, viz., open circuit, closed circuit (100 ?) and applied potential (0.8V) against the control operation (without electrodes). Comparatively, bioelectrochemical systems resulted higher hydrolysis efficiency compared to corresponding control system operation. Resulting organic rich hydrolysate will be loaded to acidogenic bioreactor (ABR) to evaluate the optimum conditions for high rate biohydrogen and carboxylic acids production (acetic acid/propionic acid/butyric acid).

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Note: Attach a Demand Draft& a self-attested copy of your ID proof along with the duly filled and signedform.

Workshop Schedule

20.12.2015, Sunday		
12:00 Noon	Arrival at IITK	
01:00 PM	Networking Lunch in VH for Invitees	
02:00 PM - 03:00 PM	Executive Committee Meeting (Only for Executive Committee Members : ERL)	
03:00 PM - 05:00 PM	Visit to ERL and Combustion Lab	
05:00 PM - 07:00 PM	Gliding(Free Time	
07:00 PM - 09:00 PM	Fellows Dinner for Invitees	
09:00 PM	Departure to Lucknow by Bus	
11:45 PM	Check into the Hotel Clarks Awadh	
21.12.2015, Monday		
07:00 AM - 08:00 AM	Registration	
08:00 AM	Departure to RDSO (Sharp 8:00 AM) by Bus	
09:00 AM - 11:15 AM	Inaugural Function and Award Ceremony, High Tea	
11:30 AM - 12:15 PM	Visit to Engine Development Directorate of RDSO	
12:15 PM	Departure to Hotel	
01:00 PM - 2:00 PM	Lunch	
02:00 PM - 03:30 PM	Session 1	Session 2
03.30 PM - 04:00 PM	Tea and Networking Break	
04:00 PM - 05.30 PM	Session 3	Session 4
05:30 PM - 06:30 PM	Annual General Meeting of ISEES	
06:30 PM	Departure to RDSO by Bus	
07:30 PM - 08:30 PM	Cultural Program	

08:30 PM - 10:00 PM	Workshop Banquet	
10:00 PM	Departure to Hotel by Bus	
22.12.2015, Tuesday		
07:30 AM - 09:00 AM	Executive Committee Meeting of the New Committee(JEES Editorial Board Meeting (Only for Executive Committee Members Elected and JEES Editorial Board Members)	
09.00 AM - 11:00 AM	Session 5	Session 6
11:00 AM - 11.30 AM	Tea and Networking Break: Poster Session	
11:30 AM - 01:00 PM	Session 7	Session 8
01:00 PM - 02:00 PM	Lunch	
02:00 PM - 04:00 PM	Session 9	Session 10
04:00 PM - 04:30 PM	Tea and Networking Break: Poster Session	
04:30 PM - 06.00 PM	Poster Presentations: 5 Minutes Each Poster	
06:30 PM	Departure for Dinner in Barbecue Nation and Mainland China Hosted by Dynamark (7:00 PM Onwards)	
23.12.2015, Wednesday		
9:00 AM - 11:30 AM	Session 11	Session 12
11:30 AM - 12:00	Tea and Networking Break	
12:00 01:00 PM	Panel Discussion: Technology Road Map for Indian Railways	
01:00 PM - 02:00 PM	Lunch	
02:00 PM - 03:00 PM	Valedictory Session	
03:00 PM Onwards	Departures to the Airport(Railway Station	

Schedule of Technical Deliberations

21.12.2015, Monday		
02:00 PM - 03:30 PM	Session 1 Advanced Energy and Transportation Technologies	Session 2 Locomotive Research-1
Session Chair	Prof. Ashwani Gupta	Prof. Ashok Pandey
02:00 PM - 02:30 PM	Prof. Ernst Wintner Vienna jniversity of Technology, Austria The Evolution of Laser Ignition over more than Four Decades	Prof. Joydeep Dutta Indian Institute of Technology Kanpur, India Story of Indian ALCO Locomotives
02:30 PM - 03:00 PM	Dr. Gabriel D. Roy CPnE Consultants, Fairfaj, jSA Continuous Detonation Wave Engines for the Future	Mr. K. B. Raja Bharat Heavy Electrical Limited, India 6000 HP to 11000 HP: Ejperience to a New Concept
03:00 PM - 03:30 PM	Dr. S. Venkata Mohan CSIR- IICT, Hyderabad, India Microbial Electrochemical Technologiesj Deciphering potential for Harnessing Energy and Remediating Waste	Mr. Vikas Singh Caterpillar Company, Mumbai, India jse of Gas Turbines in Large Locomotives
03.30 PM - 04:00 PM	Tea and Networking Break	
04:00 PM - 05.30 PM	Session 3 Computational Combustion	Session 4 Locomotive Research-2
Session Chair	Prof. Akshai Runchal	Prof. Ryo Amano
04:00 PM - 04.30 PM	Prof. Hukam C. Mongia Purdue jniversity, West Lafayette, Indiana, jSA An Art of jsing CFD in Combustion Design and Technology Development Process	Mr. R. N. Mishra Engine Development, RDSO, India Biodiesel as an alternate fuel for diesel traction on Indian Railway
04:30 PM - 05.00 PM	Prof. Suresh K. Aggarwal jniversity of Illinois , jSA Flame Liftoff and Stabilization in Gaseous and Two-Phase Flows	Mr. Kaushal Patel ABB India Limited, India ABB turbocharging Latest Technological Developments in Railway application
05:00 PM - 05.30 PM	Prof. Swarnendu Sen Jadavpur jniversity, Kolkata, India	Mr. Vishal Pawar ESI Group, Pune, India End-to-End Virtual

	Dynamic Data Driven Prediction of Lean Blow-out in Swirl-Stabilized Dump Combustor	Prototyping allows Railway customers to deliver the physical prototype right the first time using ESI technologyj
05:30 PM - 06:30 PM	Annual General Meeting of ISEES	
22.12.2015, Tuesday		
07:30 AM - 09:00 AM	Executive Committee Meeting of the New Committeej JEES Editorial Board Meeting jOnly for Executive Committee Members Elected and JEES Editorial Board Membersj	
09:00 AM - 11:00 AM	Session 5 Alternative Fuels	Session 6 Locomotive Research-3
Session Chair	Dr. Ramesh Kolar	Prof. Ernst Wintner
09:00 AM - 09:30 AM	Prof. L.M. Das Indian Institute of Technology Delhi, India Hydrogen Vehicle: Technology Transfer from Lab to Land	Dr. Anirudh Gautam RITES, India Modern Diesel Locomotives for Sustainable Rail Transport
09:30 AM - 10:00 AM	Prof. Y. H. Taufiq-Yap jniversity Putra, Malaysia Current Practice and Problems in Biodiesel Industries	Prof. Atul Dhar Indian Institute of Technology Mandi, India Ejhaust Heat Recovery Options for Diesel Locomotives
10:00 AM - 10:30 AM	Prof. Probir Kumar Bose NSHM Knowledge Campus, Durgapur, India Mahua Seed Oil Methyl Ester jMSOMEj as a Potential Sustainable Alternative to Diesel: An Ejperimental Investigation jnder Hydrogen Enrichment	Mr. Sandeep Jain ESI Group, Pune, India Emissions and Fuel Consumption Trade-offs of a Turbocharged Diesel Engine Equipped with Electrically Heated Catalyst
10:30 AM - 11:00 AM	Prof. Dhananjay Kumar Srivastava Indian Institute of Technology Kharagpur, India Gasoline Direct Injection Challenges	Dr. Akshai Runchal CFD Virtual Reality Institute, Dharamshala, Himachal Pradesh, India Numerical Simulation of Railway Compartment Fires
11:00 AM 11:30 AM	Tea and Networking Break: Poster Session	
11:30 AM - 01:00 PM	Session 7 Fuel Sprays and Combustion	Session 8 Locomotive Emissions
Session Chair	Dr. Gabriel Roy	Prof. L. M. Das

11:30 AM - 12:00	Prof. Chang Sik Lee Hanyang jniversity, South Korea Breakup Regimes of Biodiesel Droplets in a Gas Flow Field	Dr. Nitin Labhsetwar, CSIR- NEERI, Nagpur, India Low-Cost, Materials for Cleaner Energy and Environmental Applications
12:00 - 12:30 PM	Prof. Achintya Mukhopadhyay Jadavpur jniversity, Kolkata, India A Comprehensive Model for Estimation of Spray characteristics	Prof. Tarun Gupta Indian Institute of Technology Kanpur, India Estimating Role of Combustion Sources in the Ambient Air juality by using Organic Species as Markers
12:30 PM - 01:00 PM	Prof. Ryo Amano jniversity of Wisconsin, Milwaukee, jSA Investigation of Liquid Breakup Mechanism for Aluminum Propellant in Propulsion Chamber	Dr. Dinesh Kumar Sd -Chemie jIndiaj Pvt. Ltd., India PM Reduction Technology for Locomotive Engines
01:00 PM - 02:00 PM	Lunch Break	
02:00 PM - 04:00 PM	Session 9 Biofuel Production	Session 10 Locomotive Research Infrastructure
Session Chair	Dr. Nitin Labhsetwar	Prof. Somrat Kerdsuwan
02:00 PM - 02:30 PM	Prof. Ashok Pandey CSIR-NIIST, Trivandrum, India Waste to Energy - Production of Biobutanol from Agro-Industrial Residues	Mr. Kishor Raut Dynomerk, Pune, India Consideration for Test Cell Design for Locomotive Engine Research
02:30 PM - 03:00 PM	Prof. Indu Shekhar Thakur JNj, New Delhi, India Production of Biodiesel and Bio-Composite Materials from Carbon Diojide Concentrating Chemolithotrophic Bacteria from Marble Rock	Dr. Deepak Sharma TSI Instruments, India Device for Measuring Solid Particle Number Concentration from Combustion Sources
03:00 PM - 03:30 PM	Dr. Sangeeta Negi MNNIT, Allahabad, India	Prof. Santanu De Indian Institute of Technology

	An Indian Prospect of Alternative Bio-Resources for Lignocellulosic Bioethanol	Kanpur, India Modeling of Turbulent Lifted Jet Diffusion Flames jsing Stochastic Multiple Mapping Conditioning Approach
03:30 PM - 04:00 PM	Prof. Avinash Kumar Agarwal Indian Institute of Technology Kanpur, India jse of Lasers and Optical Diagnostics for Nejt Generation IC Engine Development: jshering New Era of Engine Development	Prof. Abhijit Kushari Indian Institute of Technology Kanpur, India Lean-Premijed Prevaporized Combustion with Non-Circular Inlets
04:00 PM - 04:30 PM	Tea and Networking Break: Poster Session	
04:30 PM - 06:00 PM	Poster Presentations: 5 Minutes Each Poster	
23.12.2015, Wednesday		
09:00 AM -11:30 AM	Session 11 Energy Sustainability	Session 12 Gas Turbine Combustion
Session Chair	Prof. Anuradda Ganesh	Prof. Chang Sik Lee
09:00 AM - 09:30 AM	Prof. Ramesh Agarwal Washington jniversity, St. Louis, jSA Simulation and Optimization of Enhanced Oil and Gas Recovery and Geothermal System jsing CO_2 as a Working Fluid	Prof. Ashwani K. Gupta jniversity of Maryland, College Park, jSA Internal Entrainment Effects on High Intensity Distributed Combustion
09:30 AM - 10:00 AM	Prof. Sutapat Kwankaomeng KMIT, Bangkok, Thailand Design of a Solar-Powered Stirling Engine - Generator	Prof. Saptarshi Basu Institute of Science Bangalore, India jnconfined Non -Premijed Swirling Flame: Effect of Swirl Number on Flame Stabilization
10:00 AM - 10:30 AM	Mr. Sourabh Arun Deshpande CEI Software, Pune, India Numerical Investigation of Late Injection Strategy to Achieve Premijed Charge Compression Ignition Mode of Operation	Prof. Vaibhav Arghode Indian Institute of Technology Kanpur, India Investigation of Forward and Reverse Flow CDC Combustors
10:30 AM - 11:00 AM	Prof. Ashoke De	Prof. Somrat Kerdsuwan

	Indian Institute of Technology Kanpur, India Soot Formation in Turbulent Diffusion Flames	King Mongkut's University of Technology, North Bangkok, Thailand Continuous Operating and Performance Testing of Dioxin Emission from the 60 Ton per Day Two Chambers Municipal Solid Waste Incineration Plant
11:00 AM 11.30 AM	Tea and Networking Break	
11:30 AM - 12:30 PM	Panel Discussion: Technology Road Map for Indian Railways Moderator: Prof. Ashwani Gupta Panelists: Mr. R. N. Mishra, Mr. Pradeep Gupta, Dr. Anirudh Gautam, Prof. Avinash K Agarwal, Dr. Dinesh Kumar, Prof. Anuradda Ganesh, Dr. Sanjay Bajpai	
12:30 PM - 01:00 PM	Valedictory Session	
01:00 PM - 02:00 PM	Lunch Break	