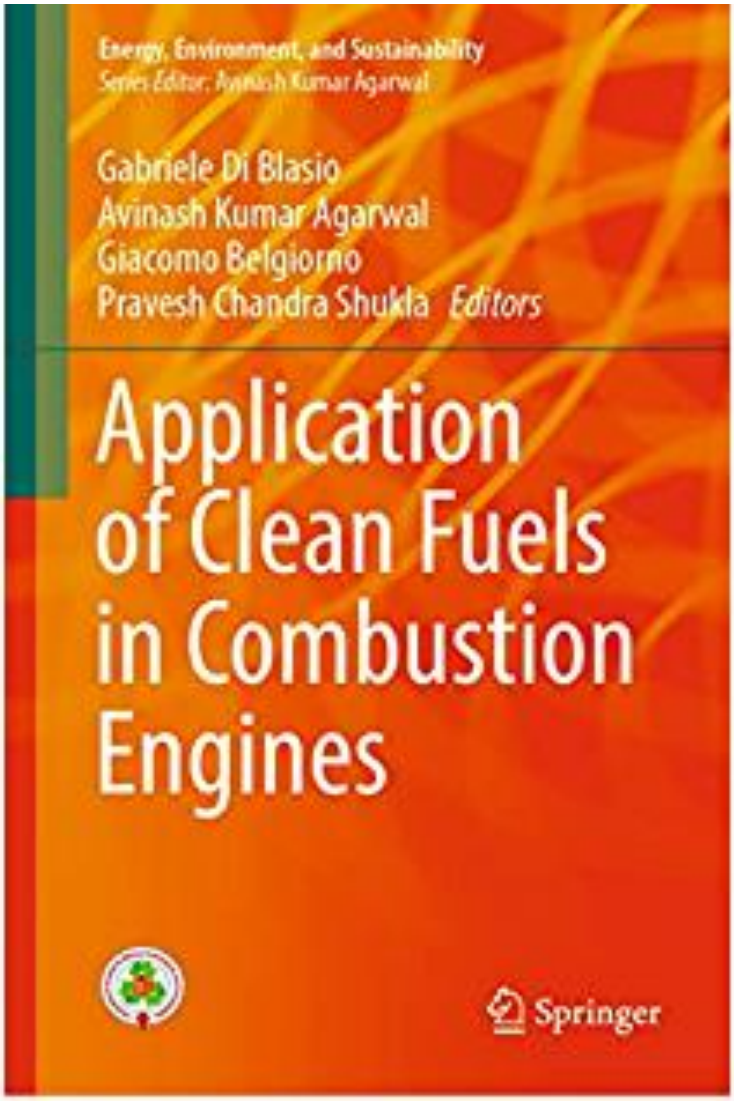

Application of Clean Fuels in Combustion Engines

Editors: Gabriele Di Blasio, Avinash Kumar Agarwal, Giacomo Belgiorno, Pravesh Chandra Shukla

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Springer

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Preface

Energy demand and pollutants growth are the main concerns due to the increasing population and urbanization. Indeed, modern society significantly depends on energy availability. The transport sector plays a crucial role in energy consumption and CO_2 production. In this regard, the application of cleaner fuels provides a practical alternative toward full decarbonization by 2050. The most common renewable fuels are discussed, and their main effects are assessed.

The International Society for Energy, Environment and Sustainability (ISEES) was founded at the Indian Institute of Technology Kanpur (IIT Kanpur), India, in January 2014 to spread knowledge/awareness and catalyze research activities in the fields of Energy, Environment, Sustainability, and Combustion. Society's goal is to contribute to the development of clean, affordable, and secure energy resources and a sustainable environment for society and spread knowledge in the areas mentioned above, and create awareness about the environmental challenges the world is facing today. The unique way adopted by ISEES was to break the conventional silos of specializations (Engineering, science, environment, agriculture, biotechnology, materials, fuels, etc.) to tackle the problems related to energy, environment, and sustainability in a holistic manner. This is quite evident by the participation of experts from all fields to resolve these issues. The ISEES is involved in various activities such as conducting workshops, seminars, and conferences in the domains of its interests. Society also recognizes the outstanding works of young scientists, professionals, and engineers for their contributions in these fields by conferring them awards under various categories.

Fifth International Conference on 'Sustainable Energy and Environmental Challenges' (V-SEEC) was organized under the auspices of ISEES from December 19–21, 2020, in virtual mode due to restrictions on travel because of the ongoing COVID-19 pandemic situation. This conference provided a platform for discussions between eminent scientists and engineers from various countries, including India, Spain, Austria, Bangladesh, Mexico, USA, Malaysia, China, UK, Netherlands, Germany, Israel, and Saudi Arabia. At this conference, eminent international speakers presented their views on energy, combustion, emissions, and alternative energy resources for

sustainable development and a cleaner environment. The conference presented two high voltage plenary talks by Dr. V. K. Saraswat, Honorable Member, NITI Ayog, on 'Technologies for Energy Security and Sustainability' and Prof. Sandeep Verma, Secretary, SERB, on 'New and Equitable R&D Funding Opportunities at SERB.'

The conference included nine technical sessions on topics related to energy and environmental sustainability. Each session had 6–7 eminent scientists from all over the world, who shared their opinion and discussed the trends for the future. The technical sessions in the conference included Emerging Contaminants: Monitoring and Degradation Challenges; Advanced Engine Technologies and Alternative Transportation Fuels; Future Fuels for Sustainable Transport; Sustainable Bioprocessing for Biofuel/Non-biofuel Production by Carbon Emission Reduction; Future of Solar Energy; Desalination and Wastewater Treatment by Membrane Technology; Biotechnology in Sustainable Development; Emerging Solutions for Environmental Applications' and Challenges and Opportunities for Electric Vehicle Adoption. 500+ participants and speakers from all over the world attended this three days conference.

The conference concluded with a high voltage panel discussion on 'Challenges and Opportunities for Electric Vehicle Adoption,' where the panelists were Prof. Gautam Kalghatgi (University of Oxford), Prof. Ashok Jhunjhunwala (IIT Madras), Dr. Kelly Senecal (Convergent Science), Dr. Amir Abdul Manan (Saudi Aramco) and Dr. Sayan Biswas (University of Minnesota, USA). Prof. Avinash Kumar Agarwal, ISEES, moderated the panel discussion. This conference laid out the roadmap for technology development, opportunities, and challenges in Energy, Environment, and Sustainability domain. All these topics are very relevant for the country and the world in the present context. We acknowledge the support received from various agencies and organizations for the successful conduct of the Fifth ISEES conference V-SEEC, where these books germinated. We want to acknowledge SERB (Special thanks to Dr. Sandeep Verma, Secretary) and our publishing partner Springer (Special thanks to Ms. Swati Meherishi).

The editors would like to express their sincere gratitude to a large number of authors from all over the world for submitting their high-quality work on time and revising it appropriately at short notice. We would like to express our special gratitude to our prolific set of reviewers, Dr. Ayat Gharehghani, Dr. Burak Zincir, Dr. Atul Dhar, Dr. Harsh Goyal, Dr. Prabakaran Balasubramanian, Dr. Jai Gopal Gupta, Dr. Rudrodip Majumdar, Dr. Luis Felipe Mazadiego, Dr. Farzad Jaliliantabar, Dr. Elumalai P. V., Dr. Saket Verma, Michele Pipicelli, Dr. Roberto Ianniello, Dr. Atul Dhar, Dr. Giuseppe Di Luca, who reviewed various chapters of this monograph and provided their valuable suggestions to improve the manuscripts.

This book is based on the description of the impact of fuels characteristics and their effects on the combustion processes in internal combustion engines. This book includes the analysis of a variety of biofuels (alcohol fuels and biodiesel) and biogases (natural gas, hydrogen, etc.), providing valuable information related to consequent effects on performance and emissions. Chapters include recent results and focuse on current trends of fuel utilization in the transport sector. Few chapters of this book are based on the review of the state of the art of clean fuels application. The

book content is oriented to professionals, post-graduate students involved in fuels, IC engines, engine instrumentation, and environmental research.

Naples, Italy — Gabriele Di Blasio
Kanpur, India — Avinash Kumar Agarwal
Turin, Italy — Giacomo Belgiorno
Raipur, India — Pravesh Chandra Shukla

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Biofuel Combustion Generated Particles Analysis

Farzad Jaliliantabar, Abdul Adam Abdullah, Paolo Carlucci & Sudhakar Kumarasamy

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Abstract

Soot emission or carbon black is considered as a major challenge recently. Generally, internal combustion engines have been introduced as the main source of these materials specially in urban areas. Different methods are proposed to control soot emission of diesel engine such as DPF (Diesel Particulate Filter) which is attached to the engine exhaust line and the microstructure and size of NPs were introduced as important parameters on its efficiency. In addition, biodiesel has become widely accepted as an appropriate substitution for diesel fuel, however, the using of biodiesel fuel may change the structural characteristics of soot emission. It is observed that biofuel has higher soot oxidative reactivity, and it is more reactive than diesel fuel, which is an advantage for DPF regeneration. Smaller size of particles in biodiesel fuel soot compared to diesel fuel is mentioned as a reason for this phenomenon. For instance, it is reported that the fractal dimension of micro algae, cotton seed, waste cooking oil, eucalyptus oil, tea tree oil and diesel fuel is 2.02, 1.97, 1.85, 1.75, 1.80, 1.73, 1.69 (nm) respectively. Filtration efficiency which is a crucial characteristic of the DPFs for biodiesel fuel and diesel fuel was found to be much different. These differences are attributed to the morphology of the produced soot of the fuel burning. The source of the biodiesel fuel is introduced as an impactful parameter on engine NPs morphology and size. For example, the primary diameter of the soot emission from the above fuels is 20.1, 14.8, 14.8, 15.5, 14.5, 15, 17.5 and 20.75 nm, respectively. The result of these study reveals that structure and morphology of soot emission come from biofuel combustion is different from diesel fuel and these properties should be investigated for any unique biofuel resource individually. However, the smaller size of the biofuel combustion generated soot is an advantage of these fuels to enhance their oxidation reactivity.

Keywords

Biofuel | Engine | Soot microstructure | Particulate matter

References

Baldelli A, Trivanovic U, Sipkens TA, Rogak SN (2020) On determining soot maturity: a review of the role of microscopy-and spectroscopy-based techniques. Chemosphere 252:126532

Google Scholar

Bassiony MA, Ibrahim A, El-Kassaby MM (2016) An experimental study on the effect of using gas-to-liquid (GTL) fuel on diesel engine performance and emissions. Alex Eng J 55(3):2115–2124. https://doi.org/10.1016/j.aej.2016.06.026

CrossRef **Google Scholar**

Bhardwaj OP, Luers B, Heuser B, Holderbaum B, Pischinger S (2017) Fuel formulation effects on the soot morphology and diesel particulate filter regeneration in a future optimized high-efficiency combustion system. Int J Engine Res 18(5–6):591–605. https://doi.org/10.1177/1468087416675059

CrossRef **Google Scholar**

Chacko N, Jeyaseelan T (2020) Comparative evaluation of graphene oxide and graphene nanoplatelets as fuel additives on the combustion and emission characteristics of a diesel engine fuelled with diesel and biodiesel blend. Fuel Process Technol 204:106406. https://doi.org/10.1016/j.fuproc.2020.106406

Chandran D (2020) Compatibility of diesel engine materials with biodiesel fuel. Renew Energy 147:89–99. https://doi.org/10.1016/j.renene.2019.08.040

CrossRef **Google Scholar**

Chen X, Sun Y, Zhao Q, Song X, Huang W, Han Y, Shang J, Zhu T, Wu A, Luan S (2016) Design and characterization of human exposure to generated sulfate and soot particles in a pilot chamber study. J Air Waste Manag Assoc 66(4):366–376. https://doi.org/10.1080/10962247.2015.1136712

CrossRef **Google Scholar**

Distaso E, Amirante R, Tamburrano P, Reitz RD (2019) Understanding the role of soot oxidation in gasoline combustion: a numerical study on the effects of oxygen enrichment on particulate mass and number emissions in a spark-ignition engine. Energy Convers Manage 184:24–39. https://doi.org/10.1016/j.enconman.2019.01.022

CrossRef **Google Scholar**

Fayad MA, Tsolakis A, Martos FJ (2020) Influence of alternative fuels on combustion and characteristics of particulate matter morphology in a compression ignition diesel engine. Renew Energy 149:962–969. https://doi.org/10.1016/j.renene.2019.10.079

CrossRef **Google Scholar**

Guan JF, Fang J, Xue Y, Wang JW, Wang JJ, Zhang YM (2016) Morphology and concentration of smoke from fluorinated ethylene propylene wire insulation in microgravity under forced airflow. J Hazard Mater 320:602–611. https://doi.org/10.1016/j.jhazmat.2016.07.056

CrossRef **Google Scholar**

Huang DM, Guo CN, Shi L (2017) Experimental investigation on the morphology of soot aggregates from the burning of typical solid and liquid fuels. J Nanoparticle Res 19(3). https://doi.org/10.1007/s11051-017-3786-x

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