

# Advanced Research on Internal Combustion Engines and Engine Fuels

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**Abstract:** Internal combustion (IC) engines serve as power devices that are widely applied in the fields of transport, engineering machinery, stationary power generation, etc., and are evolving towards the goal of higher efficiency and lower environmental impacts. In this Editorial, the role of IC engines for future transport and energy systems is discussed, and research directions for advancing IC engine and fuel technologies are recommended. Finally, we introduce the 14 technical papers collected for this Special Issue, which cover a wide range of research topics, including diesel spray characteristics, combustion technologies for low- and zero-carbon fuels, advanced combustion mode, fuel additive effects, engine operation under extreme conditions and advanced materials and manufacturing processes.

**Keywords:** internal combustion engine; fuel; renewable energy; carbon neutral; Special Issue

## 1. Introduction

Internal combustion (IC) engines have driven the development of human civilization and global economic growth, serving as a power device that is widely applied in the fields of transport, engineering machinery, stationary power generation, etc. The current global stock of passenger cars is around 1.19 billion, and the number of commercial vehicles totals 249 million, of which almost 99% are powered by IC engines, accounting for 81.3% of the oil demand in the transport sector [1]. Following that, maritime and aviation vehicles, which are also primarily powered by combustion engines, account for 7.9% and 7.1% of the transport oil demand, respectively [1]. Overall, the transport sector, including road, railway, aviation and shipping vehicles, accounts for 25.5% of global energy consumption [2] and contributes 16.2% of total global greenhouse gas (GHG) emissions as the fourth-largest source of emissions following industry (29.4%), agriculture, forestry and land use (18.4%) and construction (17.5%) [3]. Therefore, IC engines are a leading source of GHG emissions, and significant effort is needed to reduce their carbon footprint.

## 2. Current Status and Trends in IC Engine and Fuel Technologies

### 2.1. Progress in IC Engine Technologies

Since its conception in the late-19th century, the IC engine has undergone a continuous and rapid evolution and is now a complex assembly of numerous advanced technologies. To meet the ever-stringent emission regulations, tremendous effort has been dedicated to research and development aiming at an improvement in combustion efficiency and reduction in pollution emissions. The main harmful emissions generated from IC engine exhaust include particulate matter (PM), nitrogen oxide (NO<sub>x</sub>), carbon monoxide (CO) and unburnt hydrocarbon (UHC). Figure 1 presents the trends in the US federal emission limits on PM, NO<sub>x</sub> and non-methane organic gas (NMOG) emissions for light-duty fleet vehicles [4], which have been tightened significantly since their adoption in 1994. Over the past 40 years, including in the pre-regulation age, the emission levels of these harmful pollutants from IC engines have been effectively reduced by 100–1000 times. Taking the



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# Advanced Internal Combustion Engine Research

**Jessica J Manson**



## **Advanced Internal Combustion Engine Research:**

*Advances in Internal Combustion Engine Research* Dhananjay Kumar Srivastava, Avinash Kumar Agarwal, Amitava Datta, Rakesh Kumar Maurya, 2017-11-29 This book discusses all aspects of advanced engine technologies and describes the role of alternative fuels and solution based modeling studies in meeting the increasingly higher standards of the automotive industry By promoting research into more efficient and environment friendly combustion technologies it helps enable researchers to develop higher power engines with lower fuel consumption emissions and noise levels Over the course of 12 chapters it covers research in areas such as homogeneous charge compression ignition HCCI combustion and control strategies the use of alternative fuels and additives in combination with new combustion technology and novel approaches to recover the pumping loss in the spark ignition engine The book will serve as a valuable resource for academic researchers and professional automotive engineers alike **Advanced Research on Internal Combustion Engines and Engine Fuels** Zongyu Yue, Haifeng Liu, 2024-03-05 Internal combustion IC engines are the power devices most used in the fields of transport engineering machinery stationary power generation etc They have been evolving continuously over the past few decades and still have great potential to further improve to reach the ultimate goal of zero emissions This Special Issue on the subject of Advanced Research on Internal Combustion Engines and Engine Fuels is dedicated to sharing recent progress and findings from the engine research community covering the entirety of the wide scope of engine and fuel related research i e diesel spray characteristics combustion technologies for low and zero carbon fuels advanced combustion modes the additive effects of fuel engine operation under extreme conditions advanced materials and manufacturing **Advanced Internal Combustion Engines** B. Freeman, S. Knoke, EPRI solutions, Energy International, Inc, Electric Power Research Institute, 2001 *Advanced Direct Injection Combustion Engine Technologies and Development* H Zhao, 2014-01-23 Direct injection enables precise control of the fuel air mixture so that engines can be tuned for improved power and fuel economy but ongoing research challenges remain in improving the technology for commercial applications As fuel prices escalate DI engines are expected to gain in popularity for automotive applications This important book in two volumes reviews the science and technology of different types of DI combustion engines and their fuels Volume 1 deals with direct injection gasoline and CNG engines including history and essential principles approaches to improved fuel economy design optimisation optical techniques and their applications Reviews key technologies for enhancing direct injection DI gasoline engines Examines approaches to improved fuel economy and lower emissions Discusses DI compressed natural gas CNG engines and biofuels **Alternative Fuels and Advanced Combustion Techniques as Sustainable Solutions for Internal Combustion Engines** Akhilendra Pratap Singh, Dhananjay Kumar, Avinash Kumar Agarwal, 2021-05-15 This monograph covers different aspects related to utilization of alternative fuels in internal combustion IC engines with a focus on biodiesel dimethyl ether alcohols biogas etc The focal point of this book is to present engine combustion performance and

emission characteristics of IC engines fueled by these alternative fuels A section of this book also covers the potential strategies of utilization of these alternative fuels in an energy efficient manner to reduce the harmful pollutants emitted from IC engines It presents the comparative analysis of different alternative fuels in a variety of engines to show the appropriate alternative fuel for specific types of engines This book will prove useful for both researchers as well as energy experts and policy makers

**Advanced Manufacturing in Biological, Petroleum, and Nanotechnology Processing** Augustine O. Ayeni, Olagoke Oladokun, Oyinkepreye David Orodu, 2022-05-03 This book covers advanced manufacturing in biological petroleum and nanotechnology processing for the development of novel products and systems that incorporate enhanced pollution control and waste management for environmental remediation The book is divided into three parts The first section looks at the design and application of process systems the second section focuses largely on pollution control and management and the final section discusses areas related to process modeling and simulation Coverage highlights the integration of smart tools and solutions and looks at current advances in monitoring industrial and environmental processes that can assist in making significant progress in process design for the effective control of pollution and waste management

**Energy and Water Development Appropriations for 2006** United States. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development, 2005 **Advanced Internal Combustion Engines** K. Sudhakar, Anil Kumar, 2016-02 This book is the outcome of many years of teaching of Advanced IC Engine subject and it is intended to serve as a reference for researchers and engineers The subject matter is arranged sequentially and presented in a very simple and systematic manner A large number of worked out examples are provided in Testing of IC Engine Chapter

Prospectus of Advanced Studies ... University of Manchester, 1919 Artificial Intelligence and Data Driven Optimization of Internal Combustion Engines Jihad Badra, Pinaki Pal, Yuanjiang Pei, Sibendu Som, 2022-01-05 Artificial Intelligence and Data Driven Optimization of Internal Combustion Engines summarizes recent developments in Artificial Intelligence AI Machine Learning ML and data driven optimization and calibration techniques for internal combustion engines The book covers AI ML and data driven methods to optimize fuel formulations and engine combustion systems predict cycle to cycle variations and optimize after treatment systems and experimental engine calibration It contains all the details of the latest optimization techniques along with their application to ICE making it ideal for automotive engineers mechanical engineers OEMs and R D centers involved in engine design Provides AI ML and data driven optimization techniques in combination with Computational Fluid Dynamics CFD to optimize engine combustion systems Features a comprehensive overview of how AI ML techniques are used in conjunction with simulations and experiments Discusses data driven optimization techniques for fuel formulations and vehicle control calibration

Energy and Water Development Appropriations for 2006: Dept. of the Army, Corps of Engineers United States. Congress. House. Committee on Appropriations. Subcommittee on Energy and Water Development, 2005 **Annual Catalogue** Massachusetts Institute of

Technology,1929     *Advanced Design and Manufacturing Technology IV* Jian Zhong Lin,Tian Hong Yan,Xin Sheng Xu,Zheng Yi Jiang,2014-09-19 Selected peer reviewed papers from the 4th International Conference on Advanced Design and Manufacturing Engineering ADME 2014 July 26 27 2014 Hangzhou China     **Horace H. Rackham School of Graduate Studies Announcement** Horace H. Rackham School of Graduate Studies,University of Michigan. Dept. of Literature, Science, and the Arts,1921     **The Lamp** ,2004     **College of Engineering (University of Michigan) Publications** University of Michigan. College of Engineering,1922 Also contains brochures directories manuals and programs from various College of Engineering student organizations such as the Society of Women Engineers and Tau Beta Pi     Announcements University of Nebraska (Lincoln campus). College of Engineering,1924     University of Nebraska-Lincoln, Catalog: GRADUATE. University of Nebraska--Lincoln. Graduate College/Graduate Studies,1917     *General Catalogue* Massachusetts Institute of Technology,1930     General Catalog Georgia Institute of Technology,1921

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