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Journal of Energy Research

DIRECTIVE PUBLICATIONS

Editorial

Internal Combustion Engine Fuels Made From Renewable Resources.

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Abstract

The presented Special Issue, "Renewable Fuels for Internal Combustion," is based on the ongoing need to organize and freely share knowledge about renewable fuels meant for internal combustion engines. In the form of original research articles, case studies, or brief reviews, subject-matter experts were invited to present their most recent discoveries. All of the value chain's components, including the generation of liquid and gaseous fuel, upgrading (catalytic and fractional blending), and, finally, valuing combustion engines (traditional and advanced designs), were deemed necessary. Lastly, submissions for this Special Issue of the Energies Journal were cordially invited from techno-economic assessments that sought to evaluate the value chain holistically. This book contains successful entries that, in nine chapters, summarize the most recent research findings in the topic under discussion.

Keywords : *Topics covered include alternative fuels, emission characteristics, engine performance, engine thermodynamics, alternative fuel additives, and new combustion approaches.*

INTRODUCTION

Renewable fuel production has increased by 8% annually over the past decade. However, this expansion only meets half of the global increase in energy consumption. As energy demand rises, combustion engines continue to be the primary mode of transportation for heavy-duty vehicles on land and water. Furthermore, their importance in power generation as fast-response peak-shaving facilities for wind and solar-based renewables is growing.

The 2015 Paris Agreement's CO2 reduction targets highlight the imminent need for high-TRL renewable fuels suitable for combustion engine technology. Extensive combustion research is necessary to fully optimize new fuels for efficiency and emissions. Rapid use of renewable fuels necessitates efficient production and affordable feedstock. To support the fuel market transformation, researchers, investors, lawmakers, and society require easy access to current and important advancements in the aforementioned domains. Nine essays on renewable fuels have been submitted to the Special Issue of Energies for Internal Combustion Engines" [1–9]. All manuscripts present the results of original experiments in complementary sub-areas of this. A short summary of all individual contributions follows in this editorial.

CONTRIBUTIONS IN THIS ISSUE

Three articles submitted examine emission characteristics of several options (2, 3, 7). Kuczy 'nski et al. [2] found that using biofuels derived from waste animal fat significantly reduces unburned hydrocarbons (UHC) and particulate matter (PM) levels compared to diesel fuel. Shepel et al. [3] highlight the benefits of combining Fatty Acid Methyl Esters (FAME) with Hydro-treated Vegetable Oils (HVO) in reducing emissions.

Adding HVO to FAME reduces viscosity and maintains a high cetane number, resulting in decreased CO and UHC emissions from diesel engines. Oxygenated biofuels continue to have elevated nitrogen oxide emissions [2, 3]. Finally, Kryshtopa et al. [7] demonstrates that the use of methanol conversion products might be an economically feasible solution to the issue.

Three papers [3, 5, 6] address engine performance and thermodynamics for biofuels. Shepel et al. [3] found that using animal fat biodiesel additives results in an earlier combustion process. The additives have a negative impact on thermal efficiency and specific fuel consumption.

Cisek et al. [5] investigated how commercial gasoline additives improve kinetic combustion rate and reduce nitrogen oxide generation. Additives that promote diffusion during

***Corresponding Author:** Duda Kamil, National Research Medical University.
Received: 12-Jan-2025, **; Editor Assigned:** 13-Jan-2025 **; Reviewed:** 28-Jan-2025, **; Published:** 02-Feb-2025,
Citation: Duda Kamil. Internal Combustion Engine Fuels Made from Renewable Resources. Journal of Energy Research. 2025 February; 1(1).

combustion may reduce particulate matter production. Pielecha et al. found that utilizing two injectors can significantly affect the combustion process of diesel surrogates [6].

Three studies [1,4,5] validate the use of alternative gasoline additives. Fabi et al. [1] discuss the possibilities of dimethyl ether as a fuel for SI engines.

Paneerselvam et al. [4] evaluated peppermint bio-oil as a cetane improver. Cisek et al. [5] found that combining additives resulted in a larger reduction in nitrogen oxides and particulate matter compared to utilizing them alone.

One publication goes into detail into the qualities of many alternative fuels. Górski et al. [8] investigated the physicochemical parameters of diethyl ether-linseed oil fuel mixes in various concentrations. Diethyl ether enhances the viscosity, density, surface tension, and low-temperature properties of bio-oils.

Karczewski et al. [9] introduce innovative combustion models that leverage alternate fuels. The authors investigate Reactivity Controlled Compression Ignition (RCCI) combustion with a dual fuel supply of HCNG and HVO as a pilot dosage. Low-temperature combustion offers higher efficiency for alternative fuels, but has control concerns and may produce greater N2O emissions. This component has a GHG factor over 100 times higher than CO2 and, combined with methane slip, adds uncertainty to the climate impact of advanced combustion approaches.

CONCLUSION

This special issue highlights that combustion engine fuels are a current research area. FAME and HVO, mature sustainable alternatives derived from biomass/waste, are currently receiving the greatest attention. Research on enhancing existing fuel options is leading to the development of new fuels based on renewable hydrogen. The rapid transition to a hydrogen-based, circular economy presents significant opportunities for engine development, including advanced combustion systems like RCCI. To properly capitalize on this potential, fuel and engine research should be merged rather than pursued separately. New fuel choices from hydrogen synthesis and waste processing can be tuned to specific qualities through instantaneous reforming, fractionation, or blending/addition. The study question is how enhanced fuel characteristics might promote optimal efficiency and ultra-low emissions in future combustion platforms, while being economically and environmentally sustainable. The authors of this editorial believe that tailored fuel and engine co-development enables the development of technology-neutral, optimal renewable powertrain alternatives.

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