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Ellappan, S.[a] , Rajendran, S.[b m] , Dhairiyasamy, R.[c l] , Al-Mdallal, Q.M.[d] , Khan, S.A.[e] , Asif, M.[f] , Dixit, S.[g h i k] , Ağbulut, Ü.[j]

Experimental investigation of ternary blends on performance, and emission behaviors of a modified low-heat rejection CI engine

(2024) *Case Studies in Thermal Engineering*, 60, art. no. 104673, .

DOI: 10.1016/j.csite.2024.104673

[a] Department of Mechanical Engineering, TJS Engineering College, Gummudipoondi, Tamil Nadu, Chennai, India

[b] Department of Mechanical Engineering, Annapoorna Engineering College, Tamil Nadu, Salem, India

[c] Department of Mechanical Engineering, Aksum University, Ethiopia

[d] Department of Mathematical Sciences, United Arab Emirates University, P.O. Box 15551, Abu Dhabi, Al Ain, United Arab Emirates

[e] Department of Mechanical and Aerospace Engineering, Faculty of Engineering, International Islamic University, Selangor, Kuala Lumpur, 53100, Malaysia

[f] Department of Chemical Engineering, King Saud University, P.O. Box 800, Riyadh, 11421, Saudi Arabia

[g] Division of Research and Innovation, Uttaranchal University, Dehradun, India

[h] Peter the Great St. Petersburg Polytechnic University, Russian Federation, Saint Petersburg, 195251, Russian Federation

[i] Lovely Professional University, Punjab, Phagwara, India

[j] Department of Mechanical Engineering, Faculty of Mechanical Engineering, Yildiz Technical University, Besiktas, Istanbul, 34349, Turkey

[k] Adjunct faculty, Woxsen School of Business, Woxsen University, Telangana, Hyderabad, 502345, India

[l] Department of Electronics and Communication Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Tamilnadu, Chennai, India

[m] Centre of Research Impact and Outcome, Chitkara University, Punjab, Rajpura, 140417, India

Abstract

This study investigated the performance, combustion, and emissions of a modified low heat rejection (LHR) diesel engine fueled with a blend of 90 % coconut waste cooking oil (CWCO) biodiesel and 10 % diethyl ether (DEE). The engine combustion chamber components were coated with 300 μm lanthanum-doped partially stabilized zirconia for thermal insulation. Engine testing was performed at varied loads from 0 to 100 % using an eddy current dynamometer. Exhaust emissions, including hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and smoke were measured. Compared to conventional diesel, the CWCO-DEE blend showed a 3 % higher brake thermal efficiency of 33.4 % and 2.42 % lower brake-specific fuel consumption at full load. HC, CO, and smoke emissions decreased by 18 % (39 ppm), 11 %, and 19 % at higher loads with the blend. However, NOx emissions increased slightly by 21.2 %. The DEE compensated for CWCO's lower cetane number and viscosity, while the LHR coating enhanced combustion by providing thermal insulation, raising exhaust gas temperatures by 13 %. The improved efficiency and reduced emissions demonstrate the potential of optimized biodiesel-additive blends in conjunction with LHR engine modifications to sustainably utilize inexpensive waste cooking oil feedstocks as renewable diesel replacements. However, further optimization of blend compositions, additives, and coatings is needed to balance performance benefits against possible NOx increases. This study highlights a promising combined approach leveraging engine design and fuel advancements. © 2024 The Authors

Author Keywords

Coconut waste cooking oil; Di-ethyl ether; Emission; Lanthanum-doped partially stabilized zirconia

Index Keywords

Additives, Biodiesel, Brakes, Carbon monoxide, Coatings, Esters, Ethers, Machine design, Nitrogen oxides, Smoke, Thermal efficiency, Thermal insulation, Waste incineration, Zirconia; Coconut waste cooking oil, Coconut wastes, Di-ethyl ether, Emission, Ethyl ether, Lanthana doped, Lanthanum-doped partially stabilized zirconium, Low heat rejection, Partially stabilized zirconia, Waste cooking oil; Diesel engines

Funding details

King Saud UniversityKSU

The financial support from the Researchers Supporting Project (RSP2024R42), King Saud University, Riyadh, Saudi Arabia is appreciated.

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Correspondence Address
Agbulut U.; Department of Mechanical Engineering, Besiktas, Turkey; email: umit.agbulut@yildiz.edu.tr
Al-Mdallal Q.M.; Department of Mathematical Sciences, P.O. Box 15551, Abu Dhabi, United Arab Emirates; email: q.almdallal@uaeu.ac.ae

Publisher: Elsevier Ltd

ISSN: 2214157X
Language of Original Document: English
Abbreviated Source Title: Case Stud. Therm. Eng.
2-s2.0-85196963333
Document Type: Article
Publication Stage: Final
Source: Scopus