Date of publication May 11, 2025, date of current version May 11, 2025.
Digital Object Identifier 10.21608/pesj.2025.370345.1022

Effects of exhaust gas recirculation and manifold pressure on performance and emissions of a Diesel engine fueled with Biodiesel/Diesel Fuel Blends

Medhat Elkelawy*[1], Hagar Alm-Eldin Bastawissi [2], E. A. El Shenawy [3], Moustafa Abd el rahim [4]

[1] Mechanical Power Engineering Departments, Faculty of Engineering, Tanta University, Tanta, Egypt – email: medhatelkelawy@f-eng.tanta.edu.eg
[2] Mechanical Power Engineering Departments, Faculty of Engineering, Tanta University, Tanta, Egypt – email: hagaralmeldin@f-eng.tanta.edu.eg
[3] Mechanical Power Eng. Departments, Faculty of Engineering, Tanta University, Tanta, Egypt – email: el-shinawi.abdulhamid@f-eng.tanta.edu.eg
[4] Mechanical Power Engineering Departments, Faculty of Engineering, Tanta University, Tanta, Egypt – email: moustafa.fz14@gmail.com

Abstract: The enormous volume of petroleum fuel burnt has a direct correlation to both hazardous exhaust emissions for human health and global warming. At first, biodiesel fuels were suggested as a workable substitute fuel to cope with these problems. This viewpoint is supported by the many published studies in the field that study looks at how Exhaust gas recirculation (EGR) is one of the effective methods to control the combustion and emissions of a diesel engine. In EGR method, some portion of exhaust gas was recirculated into the inlet manifold to mix with intake air and then it enters into the cylinder. We deduced the most of the research from it by looking at certain research. The use of Exhaust gas recirculation (EGR) results in increases in carbon dioxide (CO_2), carbon monoxide (CO) and brake specific fuel consumption (BSFC). It lowers the temperature of exhaust gases, NOx concentrations, brake thermal efficiency and the amount of smoke. The current review research concluded categorically that the degraded engine performance, combustion, and emission characteristics of Exhaust gas recirculation (EGR) on diesel engine with diesel fuel**.**

INDEX TERMS: Diesel engine; Emissions control; Biodiesel fuel; Exhaust gas recirculation (EGR)

I. INTRODUCTION

To mitigate climate change and reduce the dependency on fossil fuels, the global community is turning rapidly to energy sources that are more renewable and sustainable [1-8]. In particular, biodiesel has received much interest as a sustainable energy source and an alternative to fossil fuels [9-13]. In terms of the world's energy demands, biodiesel provides a cleaner and more sustainable alternative to fossil fuels while having significantly lower environmental effects [14-23]. Currently, global fossil fuel prices are increasing primarily because of the ongoing conflict between Russia and Ukraine, illustrating the importance of this issue. By May 2022, the average wholesale price of tallow methyl ester had reached [24-28]. USD per metric ton of oil equivalent, representing a remarkable increase of over 133% compared to the levels seen in 2018–2019.3 Also, the conflict between Russia and Ukraine slowed the global economy's recovery from the COVID-19 pandemic, and this conflict related economic limitation increased commodity prices, with disruptions to supply connections causing inflation in many regions worldwide[29-36]. Despite these challenges, the biodiesel market is predicted to increase at a 6.1% compound annual growth rate (CAGR) to 49 [37, 38]. 4 billion USD by 2027 and this growth indicates the biodiesel industry's global demand. The global biodiesel market is expected to expand from 36.55 billion USD in 2022 to 38.93 billion USD in 2023, reflecting a 6.5% CAGR [4, 39]. Furthermore, the world is making enormous strides toward carbon neutrality to minimize carbon emissions, and adopting alternative fuels such as biodiesel is an important part of this change [40-47].

Indonesia, Malaysia, and Thailand are prominent biodiesel producers in Southeast Asia, and they mostly use crude palm oil (CPO) as the primary feedstock for biodiesel production because of its high oil content. Therefore, CPO has become a significant agricultural commodity, especially in Indonesia and Malaysia, which have become key players in the regional production of CPO to date. The International Energy Agency reported that approximately 47.87 billion liters of biodiesel were produced globally in 2022. In 2022, the Food and Agriculture Organization of the United Nations reported that these two nations are global palm oil giants, accounting for more than 20.6% of total world production.

In order to meet the present emissions standards, exhaust gas recirculation (EGR) is one of the most effective means of reducing NOx emissions from the CI engine by reducing the availability of extra oxygen and the temperature during the combustion because of high specific heat of exhaust gas [48-53]. Hot and cooled exhaust gas recirculation (EGR) to increase the fuel-air ratio and found that hot EGR at light loads improved thermal efficiency due to the increase in charge temperature with corresponding reduction in NOx and smoke formation[54-60]. Cooled EGR has been reported to give slightly lower thermal efficiency with greater NOx reduction, when compared to hot EGR [61-67].

II. COMBUSTION OF BIODIESEL

The next paragraphs address the many aspects of combustion biodiesel or diesel fuel with using Exhaust gas recirculation (EGR)[68-75]. In the present study, an attempt has been made to introduce exhaust gas recirculation (EGR) under compressed natural gas (CNG) fueled diesel engine using Jatropha biodiesel (B20) blend as pilot fuel by S.K. Mahla. we discover that CO increase by 8% for the average EGR level at different loads ,We also notice an decrease in the NOX by 19 % and brake thermal efficiency by 5% for the average EGR level [76].

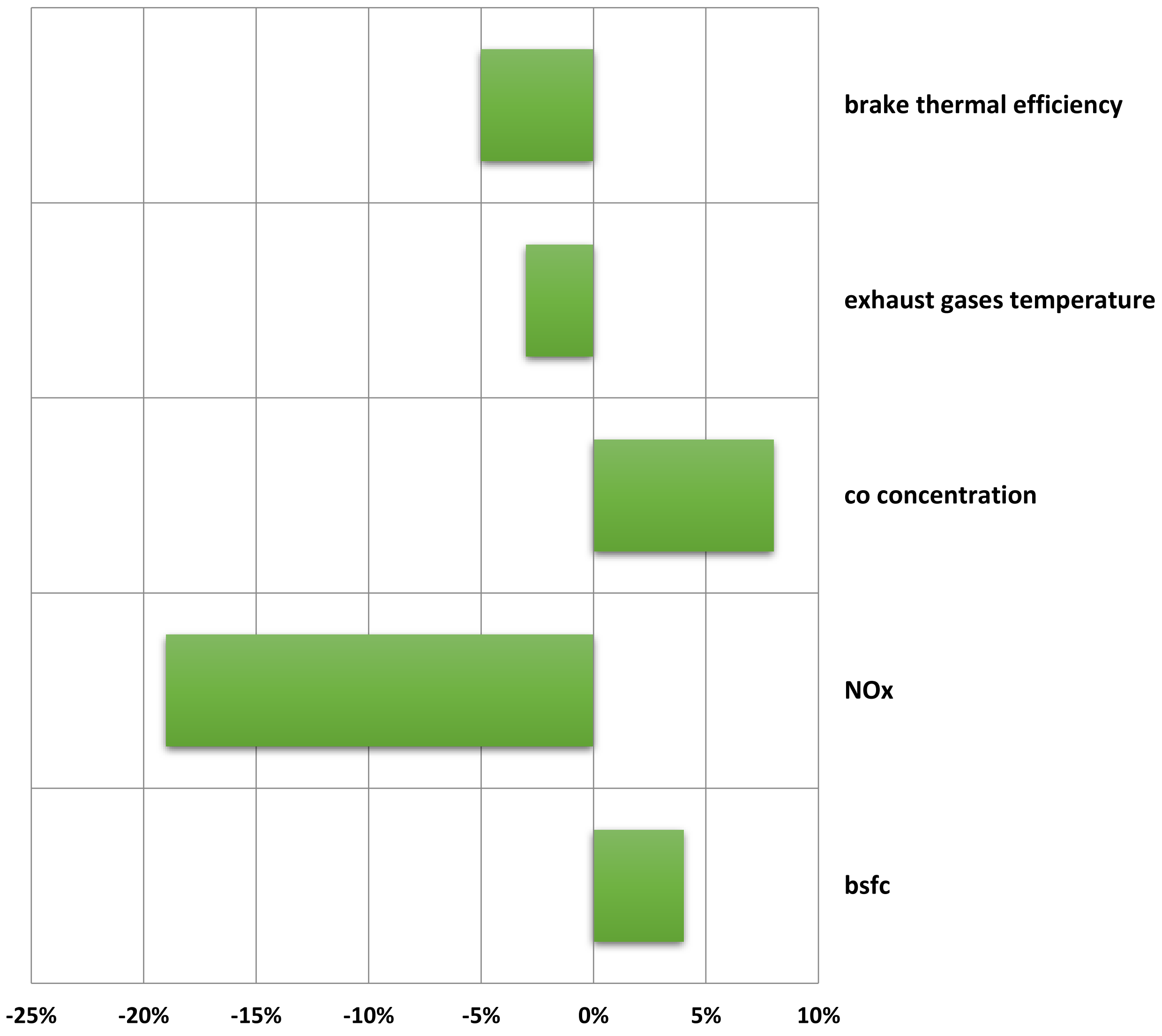

Figure 1. Results of S.K. Mahla experiment of single cylinder direct injection compression ignition engine[77].

Additionally, Pathikrit Bhowmick explores the influence of various fuel injection strategies on the performance, combustion and emission characteristics of the CRDI engine using CIB10 blends and draws a comparison with baseline diesel. we find that CO increase by 7% for the average EGR level at different loads ,We also find an decrease in the NOX by 22 % and brake smoke level by 20% for the average EGR level [76].

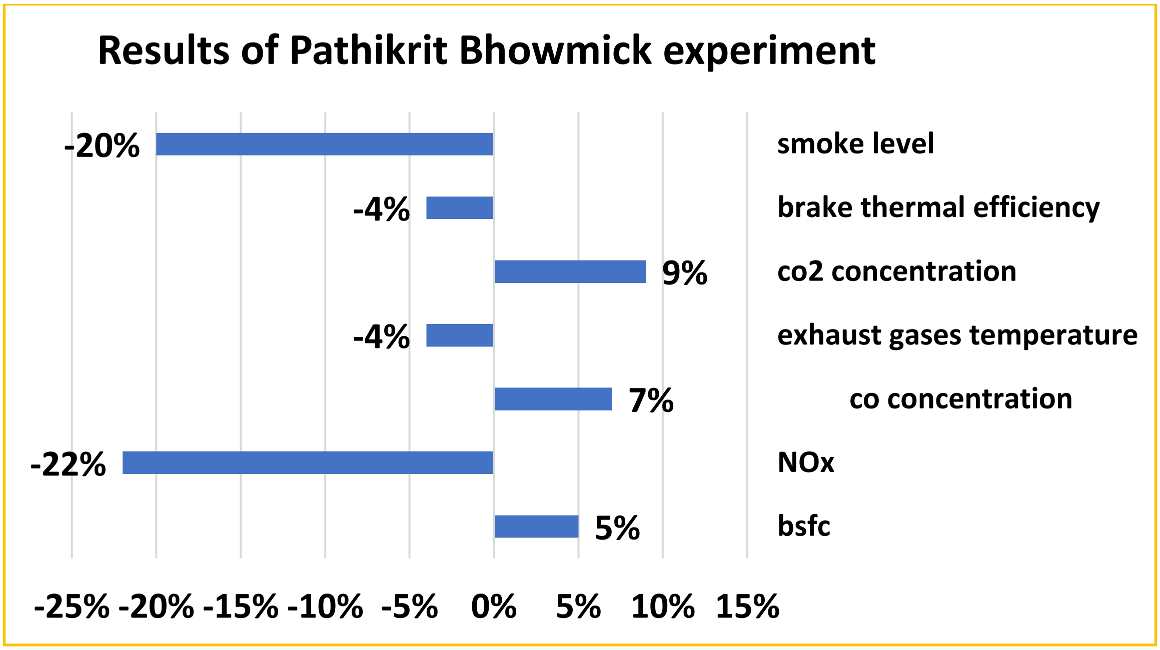

Figure 2. Results of Pathikrit Bhowmick experiment of diesel engine in common- rail direct injection engine [77].

Ashishkumar Jashvantlal Modi evaluated a ceramic-coated twin cylinder water-cooled diesel engine using blends of diesel and Neem biodiesel as fuel for its performance and exhaust emissions. According to studies, we notice a decrease in the smoke level and concentration of NOx by 5%, respectively. We find a increase in carbon monoxide and carbon dioxide by 8% and 20%, respectively [77].

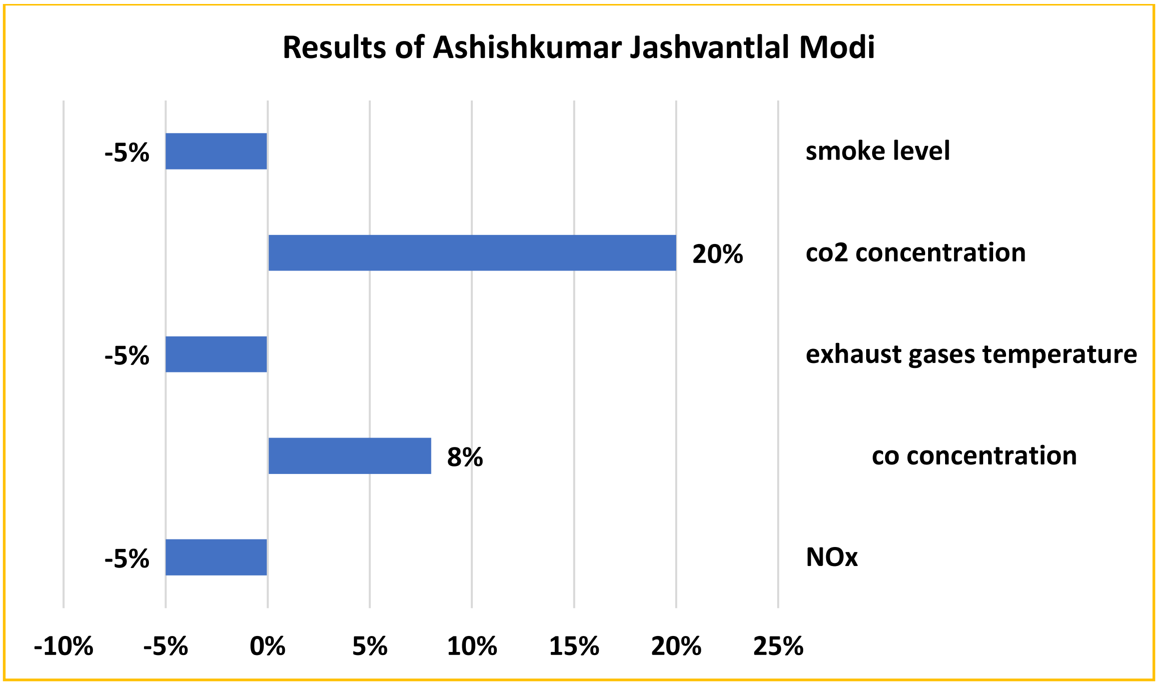

Figure 3. Results of Ashishkumar Jashvantlal Modi experiment of twin cylinder water-cooled diesel engine a constant engine speed (2000 rpm) [78]

Venkatesan Rajasekar tested the combustion of diesel engine using silicon dioxide (SiO_2) nanoparticle additives to methanol in diesel engine. The studies showed that adding Addition of EGR decrease in smoke level, NOx, by 15% respectively. We also find an increase in carbon monoxide CO by 6% [79].

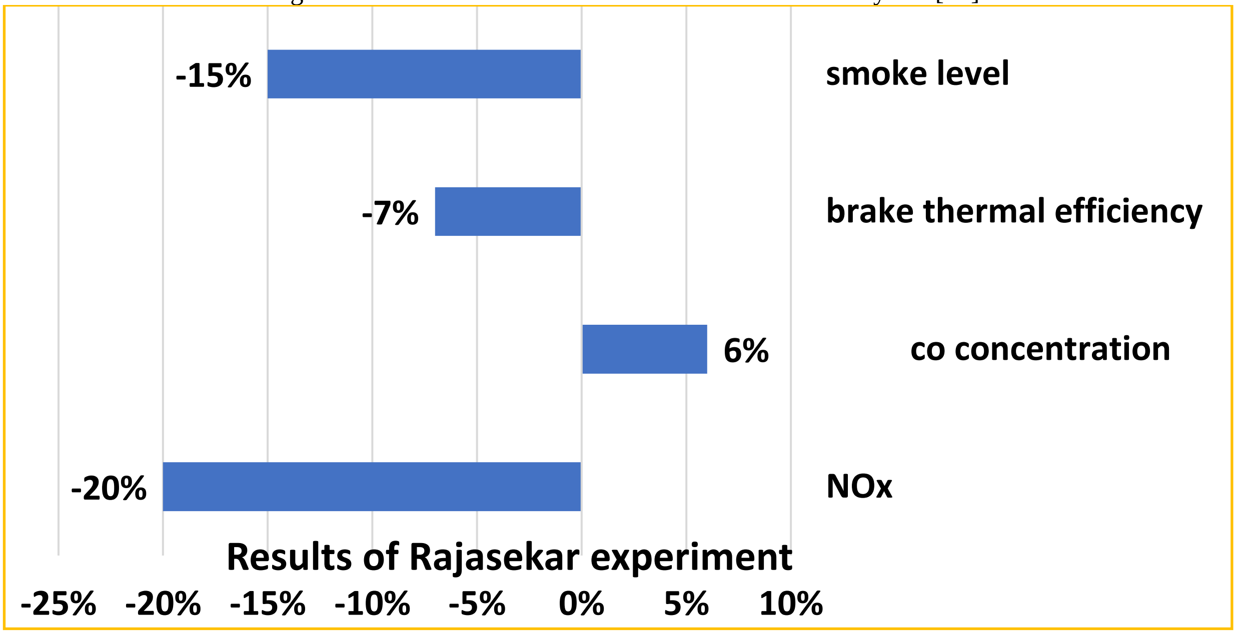

Figure 4. Results of Venkatesan Rajasekar experiment of single cylinder CI engine operating at constant speed. [79].

C. Swaminathan experimented the results of two different types of ethers were selected which were not used in earlier occasions. DGME (Diethylene Glycol Monomethyl Ether) and DGMB (Diethylene Glycol Monobutyl Ether) are the two additives selected from the ether group, used as additives with palm oil methyl ester (POME) biodiesel in various proportions, and tested in a direct injection compression ignition engine, which reduced the emissions. According to studies, we notice a decrease in the concentration of NOx, brake thermal efficiency and by 16%, 6%, respectively. We also find an increase in carbon monoxide concentration(co) and carbon dioxide (co2)by 10% and 7%, respectively [80].

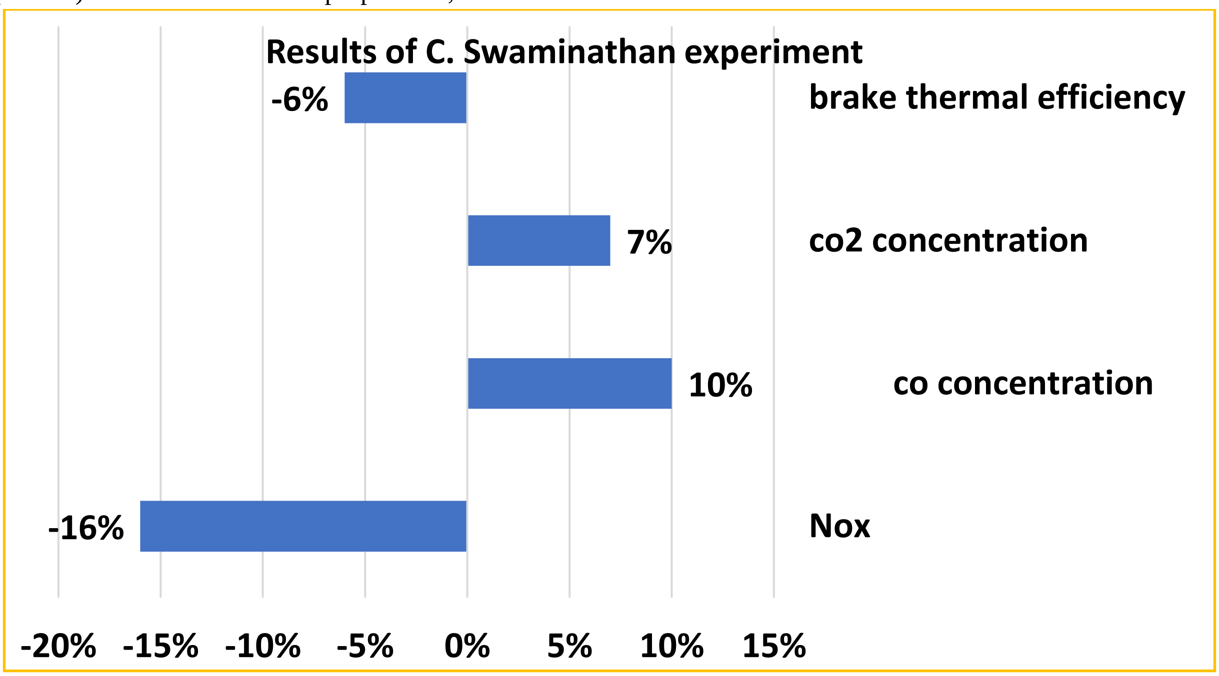

Figure 5. Results of C. Swaminathan experiment of single-cylinder, four-stroke, water-cooled engine with and without exhaust gas recirculation (EGR). [80].

Date of publication May 11, 2025, date of current version May 11, 2025.
Digital Object Identifier 10.21608/pesj.2025.370345.1022

The following is a summary of previous experiments, in which we show the performance of the engine when using Exhaust gas recirculation (EGR) to diesel or biodiesel fuel over diesel fuel alone without using Exhaust gas recirculation (EGR) **[81-87]**. The results obtained from previous experiments show that the use of Exhaust gas recirculation (EGR) decreases the smoke level [88-92]. As presented in Figure 7, due to Presence of excess oxygen, which leads to oxidation of the carbon particles and hence less smoke in comparison to diesel fuel. However, the exhaust gas temperature, as presented in Figure 9, due to the improved combustion and oxidizing of more fuel because of the availability of oxygen molecules amount in biodiesel blends. The brake thermal efficiency, as shown in Figure 10, were reduced because the exhaust gas recirculation leads to impede the combustion process and reduces the burning rate of the fuel [93-97]. Nitrogen oxides (NOx), which presented in Figure 12, decreased because the oxygen concentration and the flame temperature of the fuel reduce in the EGR method [98-101]. In addition, the increase in carbon monoxide (CO), as shown in Figure 6, is due to the incomplete combustion of fuel with EGR technique. In addition, carbon dioxide (CO2), which shown in Figure 8, was reduced due to Increase in the amount of dilution effect and decrease in the availability of free oxygen due to the increase in EGR rate. Moreover, brake specific fuel consumption (bsfc) in Figure 11 This is due to the lower oxygen content of the intake air leads to improve the fuel consumption [102-107].

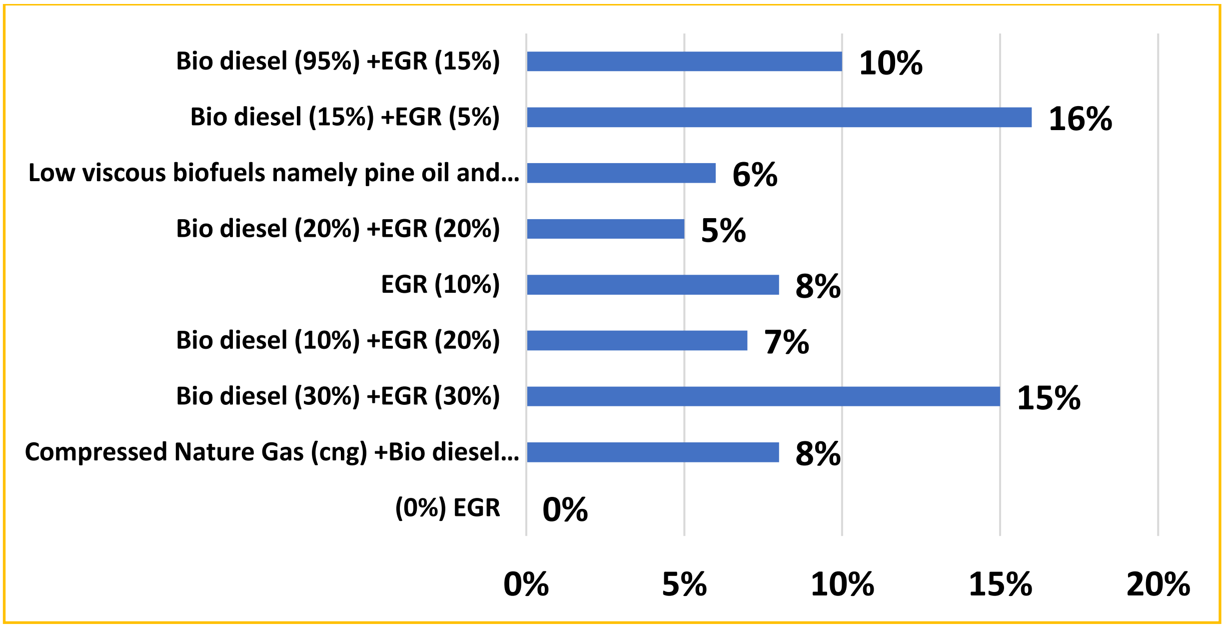

Figure 6. carbon monoxide Results for different EGR fraction at some experiments at optimum conditions [76-79, 84, 93, 108-120].

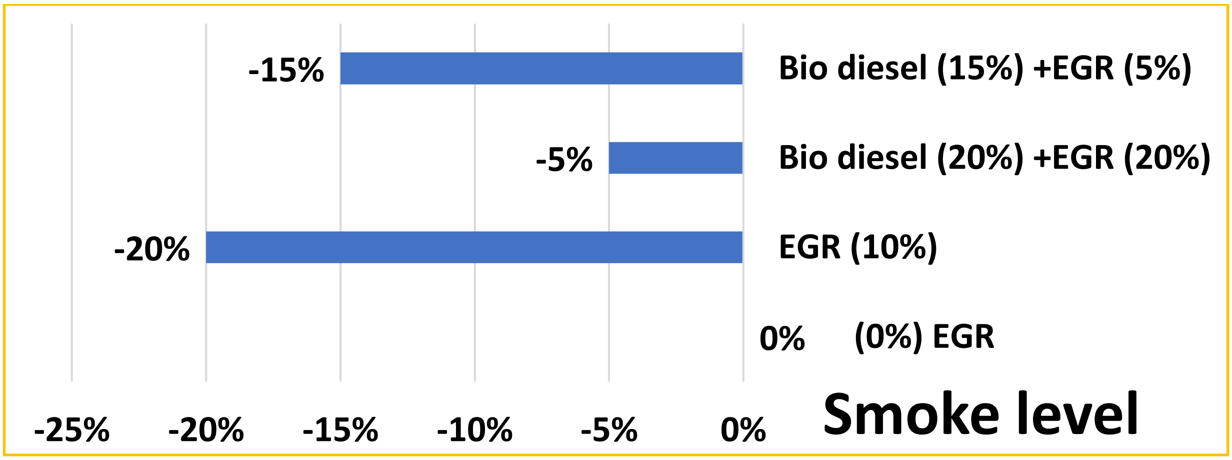

Figure 7. smoke level Results for different EGR fraction at some experiments at optimum conditions[76-79, 84, 93, 108-120].

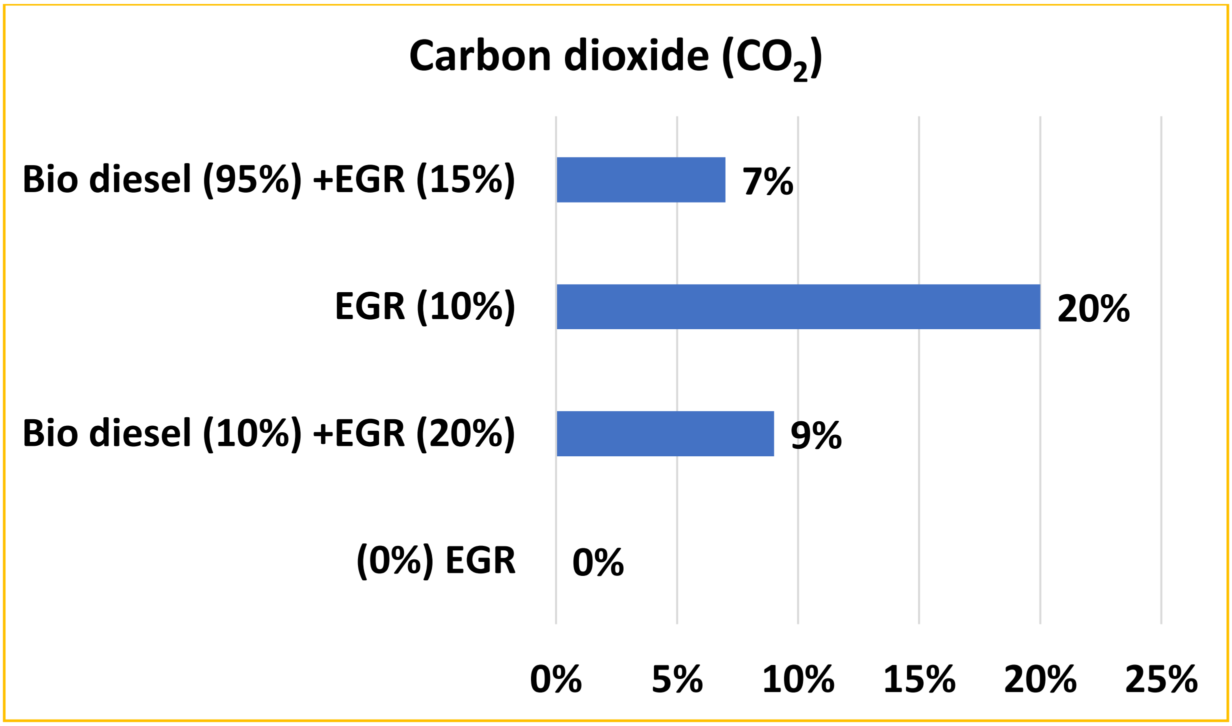

Figure 8. carbon dioxide Results for different EGR fraction at some experiments at optimum conditions [76-79, 84, 93, 108-120].

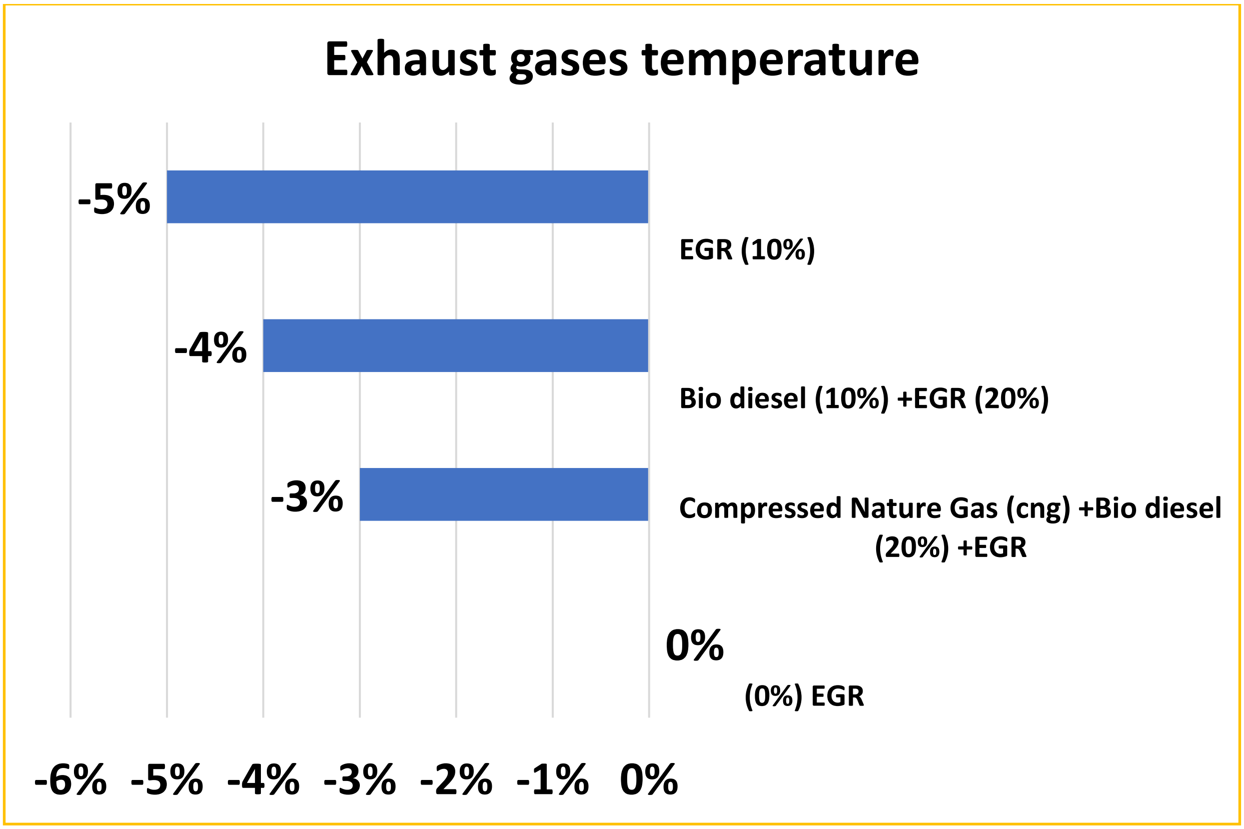

Figure 9. exhaust gas temperature Results for different EGR fraction at some experiments at optimum conditions [76-79, 84, 93, 108-120].

Date of publication May 11, 2025, date of current version May 11, 2025.
Digital Object Identifier 10.21608/pesj.2025.370345.1022

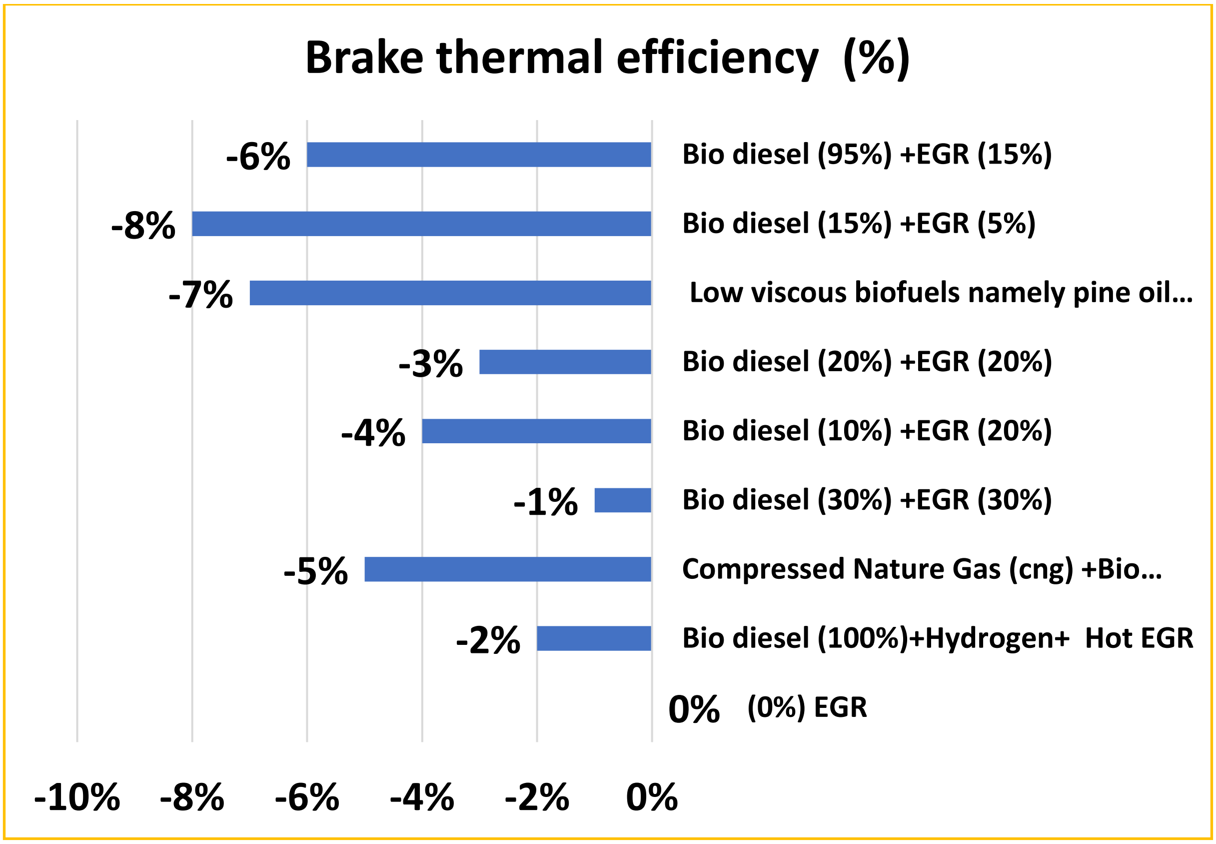

Figure 10. brake thermal efficiency Results for different EGR fraction at some experiments at optimum conditions [76-79, 84, 93, 108-120].

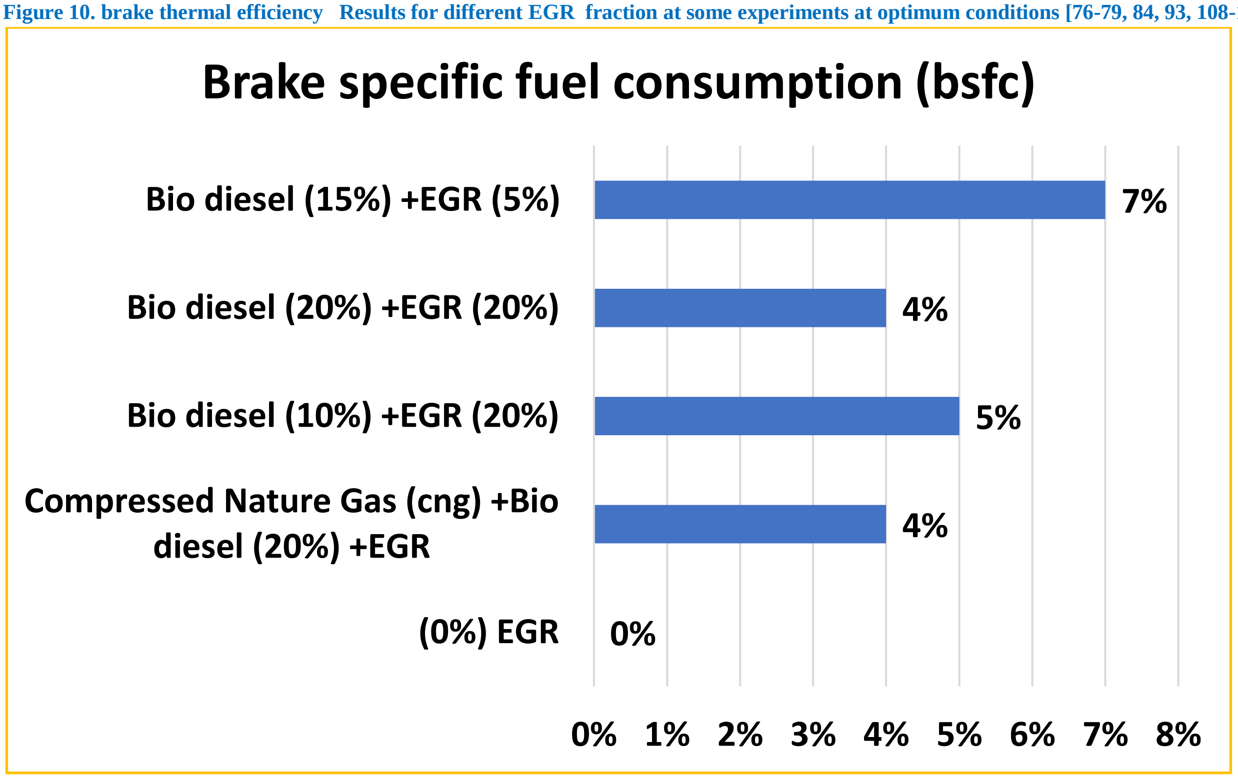

Figure 11. brake specific fuel combustion Results for different EGR fraction at some experiments at optimum conditions[76-79, 84, 93, 108-120].

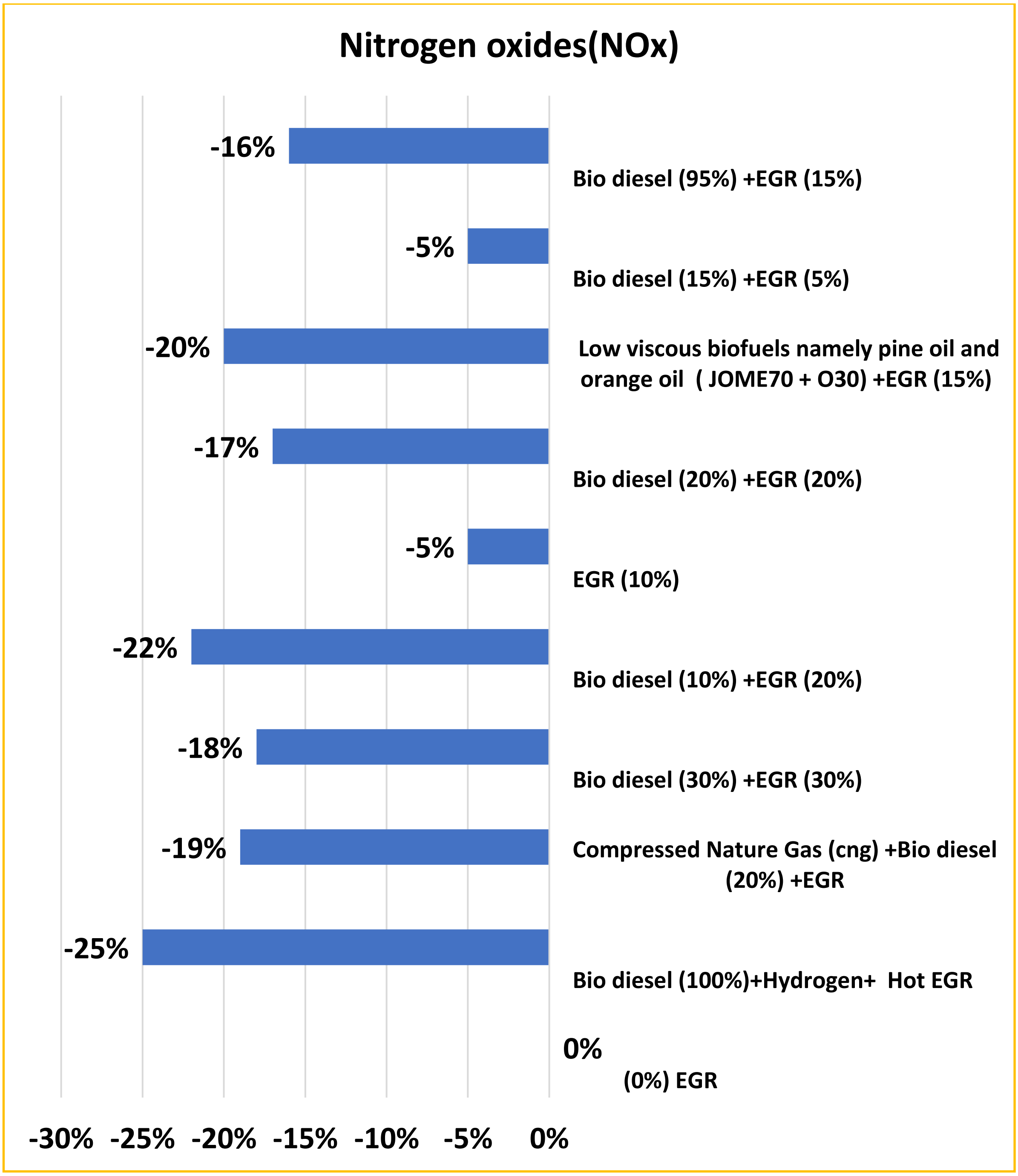

Figure 12. nitrogen oxides Results for different EGR fraction at some experiments at optimum conditions[76-79, 84, 93, 108-120].

III. CONCLUSION

This review concludes that employing Exhaust Gas Recirculation (EGR) in diesel engines compared to operating without EGR using either diesel or biodiesel fuel leads to several key effects observed across the referenced studies. Specifically, EGR increases carbon monoxide (CO) emissions by up to 16% due to incomplete combustion, and carbon dioxide (CO_2) emissions by up to 20% as a result of increased dilution and reduced free oxygen availability from the higher EGR rates. Brake Specific Fuel Consumption (BSFC) increases by up to 7%, primarily due to the lower oxygen content in the intake air, which affects combustion efficiency. Brake Thermal Efficiency (BTE) decreases by up to 8% because EGR impedes the combustion process and reduces the fuel-burning rate. However, nitrogen oxides (NO_x) emissions are reduced by up to 25% and smoke levels by up to 20%, owing to the lower oxygen concentration and reduced flame temperature with EGR. Exhaust gas temperature may increase by up to 5% due to improved combustion and more complete oxidation of fuel in biodiesel blends.

It is important to note that while EGR increases CO, CO_2, and BSFC, its main advantage is the significant reduction of NO_x emissions. Overall, it appears more effective to utilize EGR by increasing the engine's airflow rate rather than reducing the intake air. This approach can further decrease NO_x emissions. Nevertheless, EGR also slows the combustion rate, which can complicate the achievement of stable combustion.

ABBREVIATIONS AND ACRONYMS

PPM	Part Per Million
EGR	Exhaust gas recirculation
BTE	Brake Thermal Efficiency
BSFC	Brake Specific Fuel Consumption
HRR	Heat Release Rate
HP	Horsepower
CO	Carbon Monoxide
CO_2	Dioxide
O_2	Oxygen
UNHC	Unburned Hydrocarbon

Conflicts of Interest:

The authors have no conflict of interest.

REFERENCES

[1] M. Elkelawy, H. A.-E. Bastawissi, A. Abou El-Yazied, and S. El-malla, "Experimental Investigation on Combustion and Emission Characteristics of Co-combustion of Pulverized Biomass with Diesel Fuel in an Industrial Burner," *Journal of Engineering Research*, vol. 8, p. 17, 2024.

[2] M. Elkelawy, E. A. El Shenawy, H. A.-E. Bastawissi, I. A. E. Mousa, and M. M. A.-R. Ibrahim, "Experimental Study on the Impact of Secondary Air Injection and different swirl van angles on Premixed Turbulent Flame Propagation and Emission Behaviors," *Journal of Engineering Research*, vol. 7, p. 10, 2023.

[3] M. Elkelawy, H. A.-E. Bastawissi, and M. Shams, "Influence of Diesel Engine Load, Waste Cooking Oil Biodiesel Blend Percentage, and Nanoparticles Concentrations on Brake Thermal Efficiency and NOx Emissions Using Response Surface Methodology," *Pharos Engineering Science Journal*, vol. 2, pp. 59-74, 2025.

[4] M. H. Aboubakr, M. Elkelawy, H. A.-E. Bastawissi, and A. R. El-Tohamy, "The influence of using HHO with sunflower and soybean oil biodiesel/diesel blend on PCCI engine characteristics," *Journal of Engineering Research*, vol. 7, 2023.

[5] M. lkelawy, H. A.-E. Bastawissi, M. O. Elsamadony, and A. S. and Abdalhadi, "Investigation into the Impact of Ammonia Hydroxide on Performance and Emissions in Compression Ignition Engines Utilizing Diesel/Biodiesel Blends," *Journal of Engineering Research*, vol. 8, p. 21, 2024.

[6] M. Elkelawy, A. E. Mohamed, and H. E. Seleem, "Optimizing Photovoltaic Power Plant Efficiency: A Comprehensive Study on Design, Implementation, and Sustainability," *Pharos Engineering Science Journal*, vol. 2, pp. 12-22, 2025.

[7] M. Elkelawy, A. M. Draz, H. E. Seleem, and M. A. Hamouda, "Performance Characteristics of Diesel Engine Power Plants: Efficiency, Emissions, and Operational Flexibility," *Pharos Engineering Science Journal*, vol. 2, pp. 1-11, 2025.

[8] M. H. Aboubakr, M. Elkelawy, H. A.-E. Bastawissi, and A. R. El-Tohamy, "A technical survey on using oxyhydrogen with biodiesel/diesel blend for homogeneous charge compression ignition engine," *Journal of Engineering Research*, vol. 8, 2024.

[9] S. Chandra Sekhar, K. Karuppasamy, N. Vedaraman, A. E. Kabeel, R. Sathyamurthy, M. Elkelawy, *et al.*, "Biodiesel production process optimization from Pithecellobium dulce seed oil: Performance, combustion, and emission analysis on compression ignition engine fuelled with diesel/biodiesel blends," *Energy Conversion and Management*, vol. 161, pp. 141-154, 2018/04/01/ 2018.

[10] E. A. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, H. Panchal, and M. M. Shams, "Comparative study of the combustion, performance, and emission characteristics of a direct injection diesel engine with a partially premixed lean charge compression ignition diesel engines," *Fuel*, vol. 249, pp. 277-285, 2019/08/01/ 2019.

[11] M. Elkelawy, E. A. El Shenawy, H. Alm-Eldin Bastawissi, M. M. Shams, and H. Panchal, "A comprehensive review on the effects of diesel/biofuel blends with nanofluid additives on compression ignition engine by response surface methodology," *Energy Conversion and Management: X*, vol. 14, p. 100177, 2022/05/01/ 2022.

[12] H. A. E. Mohamad, M. Elkelawy, and M. Ramon, "Computational fluid dynamics study on a solar chimney with different ground materials,," *Journal of Engineering Research*, vol. 7, p. 15, 2023.

[13] M. Elkelawy, S. E.-d. H. Etaiw, H. Alm-Eldin Bastawissi, M. I. Ayad, A. M. Radwan, and M. M. Dawood, "Diesel/ biodiesel /silver thiocyanate nanoparticles/hydrogen peroxide blends as new fuel for enhancement of performance, combustion, and Emission characteristics of a diesel engine," *Energy*, vol. 216, p. 119284, 2021/02/01/ 2021.

[14] M. Elkelawy, E. A. El Shenawy, H. A.-E. Bastawissi, I. A. Mousa, and M. M. A.-R. Ibrahim, "Analyzing the Influence of Design and Operating Conditions on Combustion and Emissions in Premixed Turbulent Flames: A Comprehensive Review," *Journal of Engineering Research*, vol. 8, p. 34, 2024.

[15] M. Elkelawy, M. Bassuoni, H. A.-E. Bastawissi, and S. I. Haiba, "Effect of Dual-fuelled CNG and Gasoline on Spark Ignition engine performance and Emissions behaviors at different loads," *Pharos Engineering Science Journal*, 2025.

[16] M. Elkelawy, H. A.-E. Bastawissi, E. A. El Shenawy, and M. Soliman, "Effect of Organic Compounds Additives for Biodiesel Fuel blends on Diesel Engine Vibrations and Noise Characteristics," *Journal of Engineering Research*, vol. 8, p. 26, 2024.

[17] M. Elkelawy, H. A.-E. Bastawissi, E. A. P. D. El Shenawy, and M. Soliman, "Effect of Organic Compounds Additives for Biodiesel Fuel blends on Diesel Engine Vibrations and Noise Characteristics," *Journal of Engineering Research*, vol. 8, p. 26, 2024.

[18] M. Elkelawy, H. A.-E. Bastawissi, M. O. Elsamadony, and A. S. Abdalhadi, "Engine Performance and Emissions Improvement Study on Direct Injection of Diesel/Ammonia Dual Fuel by Adding CNG as Partially Premixed Charge," *Journal of Engineering Research,* vol. 7, p. 11, 2023.

[19] M. Elkelawy, H. A.-E. Bastawissi, E. A. El Shenawy, and M. Soliman, "Enhancing Biodiesel/Diesel blended Fuel Quality: A Comparative Study of Commercial Additives in Direct Injection Diesel Engine," *Pharos Engineering Science Journal,* vol. 2, pp. 23-36, 2025.

[20] M. Elkelawy, H. A.-E. Bastawissi, M. O. Elsamadony, and A. S. Abdalhadi, "Enhancing Diesel Engine Performance by Directly Injecting Blends of Ammonium Hydroxide and Including Liquid Petroleum Gas as a Partially Premixed Charge," *Journal of Engineering Research,* vol. 8, p. 18, 2024.

[21] M. Elkelawy, M. Aly Farag, and H. E. Seleem, "Enhancing Diesel Engine Power Plant Efficiency and Cutting Emissions with Commercial Fuel Additives in Generator Systems," *Pharos Engineering Science Journal,* vol. 2, pp. 37-46, 2025.

[22] M. Elkelawy, A. M. Draz, A. M. Antar, and H. E. Seleem, "Enhancing Diesel Generator Efficiency and Emissions with CNG and Green Hydrogen: A Sustainable Solution for Power Plants," *Pharos Engineering Science Journal,* vol. 2, pp. 47-57, 2025.

[23] D. S. Flaih, M. F. Al-Dawody, M. Elkelawy, W. Jamshed, A. Abd-Elmonem, N. S. E. Abdalla*, et al.*, "Experimental and numerical study on the characteristics of gasoline engine powered by gasoline blended with water ammonia solution," *Fuel,* vol. 387, p. 134333, 2025.

[24] M. Elkelawy, S. E.-d. H. Etaiw, M. I. Ayad, H. Marie, M. Dawood, H. Panchal*, et al.*, "An enhancement in the diesel engine performance, combustion, and emission attributes fueled by diesel-biodiesel and 3D silver thiocyanate nanoparticles additive fuel blends," *Journal of the Taiwan Institute of Chemical Engineers,* vol. 124, pp. 369-380, 2021/07/01/ 2021.

[25] M. M. El-Sheekh, M. Y. Bedaiwy, A. A. El-Nagar, M. ElKelawy, and H. Alm-Eldin Bastawissi, "Ethanol biofuel production and characteristics optimization from wheat straw hydrolysate: Performance and emission study of DI-diesel engine fueled with diesel/biodiesel/ethanol blends," *Renewable Energy,* vol. 191, pp. 591-607, 2022/05/01/ 2022.

[26] M. Elkelawy, A. E. Kabeel, E. A. El Shenawy, H. Panchal, A. Elbanna, H. A.-E. Bastawissi*, et al.*, "Experimental investigation on the influences of acetone organic compound additives into the diesel/biodiesel mixture in CI engine," *Sustainable Energy Technologies and Assessments,* vol. 37, p. 100614, 2020/02/01/ 2020.

[27] M. Elkelawy, H. Alm-Eldin Bastawissi, K. K. Esmaeil, A. M. Radwan, H. Panchal, K. K. Sadasivuni*, et al.*, "Experimental studies on the biodiesel production parameters optimization of sunflower and soybean oil mixture and DI engine combustion, performance, and emission analysis fueled with diesel/biodiesel blends," *Fuel,* vol. 255, p. 115791, 2019/11/01/ 2019.

[28] M. Elkelawy, E. A. El Shenawy, S. k. A. Almonem, M. H. Nasef, H. Panchal, H. A.-E. Bastawissi*, et al.*, "Experimental study on combustion, performance, and emission behaviours of diesel /WCO biodiesel/Cyclohexane blends in DI-CI engine," *Process Safety and Environmental Protection,* vol. 149, pp. 684-697, 2021/05/01/ 2021.

[29] D. Mevada, H. Panchal, H. A. ElDinBastawissi, M. Elkelawy, K. Sadashivuni, D. Ponnamma*, et al.*, "Applications of evacuated tubes collector to harness the solar energy: a review," *International Journal of Ambient Energy,* vol. 43, pp. 344-361, 2022/12/31 2022.

[30] M. M. El-Sheekh, A. A. El-Nagar, M. ElKelawy, and H. A.-E. Bastawissi, "Bioethanol from wheat straw hydrolysate solubility and stability in waste cooking oil biodiesel/diesel and gasoline fuel at different blends ratio," *Biotechnology for Biofuels and Bioproducts,* vol. 16, p. 15, 2023/02/01 2023.

[31] M. Elkelawy, Z. Yu-Sheng, A. E.-D. Hagar, and J.-z. Yu, "Challenging and Future of Homogeneous Charge Compression Ignition Engines; an Advanced and Novel Concepts Review," *Journal of Power and Energy Systems,* vol. 2, pp. 1108-1119, 2008.

[32] M. Elkelawy, H. A.-E. Bastawissi, A. M. Radwan, M. T. Ismail, and M. El-Sheekh, "Chapter 15 - Biojet fuels production from algae: conversion technologies, characteristics, performance, and process simulation," in *Handbook of Algal Biofuels*, M. El-Sheekh and A. E.-F. Abomohra, Eds., ed: Elsevier, 2022, pp. 331-361.

[33] A. M. Elbanna, C. Xiaobei, Y. Can, M. Elkelawy, and H. A.-E. Bastawissi, "A comparative study for the effect of different premixed charge ratios with conventional diesel engines on the performance, emissions, and vibrations of the engine block," *Environmental Science and Pollution Research,* vol. 30, pp. 106774-106789, 2023/10/01 2023.

[34] M. Elkelawy, Z. Yu-Sheng, H. A. El-Din, and Y. Jing-zhou, "A comprehensive modeling study of natural gas (HCCI) engine combustion enhancement by using hydrogen addition," *SAE Technical Paper,* vol. No. 2008-01-1706, 2008.

[35] E. A. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, M. Taha, H. Panchal, K. k. Sadasivuni*, et al.*, "Effect of cultivation parameters and heat management on the algae species growth conditions and biomass production in a continuous feedstock photobioreactor," *Renewable Energy,* vol. 148, pp. 807-815, 2020/04/01/ 2020.

[36] M. El Kelawy, "Effect of Gasoil-Water Slurry on Atomization in Diesel Engines," M. Sc. Thesis, Tanta University, Egypt, 2004.

[37] M. Elkelawy, E. A. El Shenawy, S. A. Mohamed, M. M. Elarabi, and H. A.-E. Bastawissi, "Impacts of using EGR and different DI-fuels on RCCI engine emissions, performance, and combustion characteristics," *Energy Conversion and Management: X,* vol. 15, p. 100236, 2022/08/01/ 2022.

[38] M. Elkelawy, H. A.-E. Bastawissi, E. A. El Shenawy, M. M. Shams, H. Panchal, K. K. Sadasivuni*, et al.*, "Influence of lean premixed ratio of PCCI-DI engine fueled by diesel/biodiesel blends on combustion, performance, and emission attributes; a comparison study," *Energy Conversion and Management: X,* vol. 10, p. 100066, 2021/06/01/ 2021.

[39] E. A. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, M. M. Shams, H. Panchal, K. Sadasivuni*, et al.*, "Investigation and performance analysis of water-diesel emulsion for improvement of performance and emission characteristics of partially premixed charge compression ignition (PPCCI) diesel engines," *Sustainable Energy Technologies and Assessments,* vol. 36, p. 100546, 2019/12/01/ 2019.

[40] M. Elkelawy, E. A. El Shenawy, H. A. E. Bastawissi, and I. A. El Shennawy, "The effect of using the WCO biodiesel as an alternative fuel in compression ignition diesel engine on performance and emissions characteristics," *Journal of Physics: Conference Series,* vol. 2299, p. 012023, 2022/07/01 2022.

[41] S. C. Sekhar, K. Karuppasamy, R. Sathyamurthy, M. Elkelawy, H. A. E. D. Bastawissi, P. Paramasivan*, et al.*, "Emission analysis on compression ignition engine fueled with lower concentrations of Pithecellobium dulce biodiesel-diesel blends," *Heat Transfer—Asian Research,* vol. 48, pp. 254-269, 2019.

[42] M. Elkelawy, H. A.-E. Bastawissi, M. O. Elsamadony, and A. S. Abdalhadi, "Engine Performance and Emissions Improvement Study on Direct Injection of Diesel/Ammonia Dual Fuel by Adding CNG as Partially Premixed Charg," *Journal of Engineering Research,* vol. 7, p. 11, 2023.

[43] M. Elkelawy, "Experimental Investigation of Intake Diesel Aerosol Fuel Homogeneous Charge Compression Ignition (HCCI) Engine Combustion and Emissions," *Energy and Power Engineering,* vol. Vol.06No.14, p. 14, 2014.

[44] M. ElKelawy, H. A.-E. Bastawissi, E.-S. A. El-Shenawy, H. Panchal, K. Sadashivuni, D. Ponnamma, *et al.*, "Experimental investigations on spray flames and emissions analysis of diesel and diesel/biodiesel blends for combustion in oxy-fuel burner," *Asia-Pacific Journal of Chemical Engineering,* vol. 14, p. e2375, 2019.

[45] J. G. Vaghasia, J. K. Ratnadhariya, H. Panchal, K. K. Sadasivuni, D. Ponnamma, M. Elkelawy, *et al.*, "Experimental performance investigations on various orientations of evacuated double absorber tube for solar parabolic trough concentrator," *International Journal of Ambient Energy,* vol. 43, pp. 492-499, 2022/12/31 2022.

[46] A. Mohammed Elbanna, C. Xiaobei, Y. Can, M. Elkelawy, H. Alm-Eldin Bastawissi, and H. Panchal, "Fuel reactivity controlled compression ignition engine and potential strategies to extend the engine operating range: A comprehensive review," *Energy Conversion and Management: X,* vol. 13, p. 100133, 2022/01/01/ 2022.

[47] H. A. El-Din, M. Elkelawy, and Z. Yu-Sheng, "HCCI engines combustion of CNG fuel with DME and H 2 additives," *SAE Technical Paper,* vol. No. 2010-01-1473, 2010.

[48] M. Elkelawy, E. A. El Shenawy, S. A. Mohamed, M. M. Elarabi, and H. Alm-Eldin Bastawissi, "Impacts of EGR on RCCI engines management: A comprehensive review," *Energy Conversion and Management: X,* vol. 14, p. 100216, 2022/05/01/ 2022.

[49] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, and H. Alm-Eldin Bastawissi, "Investigative research of diesel/ethanol advanced combustion strategies: A comparison of Premixed Charge Compression Ignition (PCCI) and Direct Dual Fuel Stratification (DDFS)," *Fuel,* vol. 345, p. 128143, 2023/08/01/ 2023.

[50] A. M. Elzahaby, M. Elkelawy, H. A.-E. Bastawissi, S. M. El_Malla, and A. M. M. Naceb, "Kinetic modeling and experimental study on the combustion, performance and emission characteristics of a PCCI engine fueled with ethanol-diesel blends," *Egyptian Journal of Petroleum,* vol. 27, pp. 927-937, 2018/12/01/ 2018.

[51] M. M. El-Sheekh, A. A. El-Nagar, M. ElKelawy, and H. A.-E. Bastawissi, "Maximization of bioethanol productivity from wheat straw, performance and emission analysis of diesel engine running with a triple fuel blend through response surface methodology," *Renewable Energy,* vol. 211, pp. 706-722, 2023/07/01/ 2023.

[52] J.-z. Yu, Z. Yu-Sheng, M. Elkelawy, and Q. Kui, "Spray and combustion characteristics of HCCI engine using DME/diesel blended fuel by port-injection," *SAE Technical Paper,* vol. No. 2010-01-1485, 2010.

[53] H. Panchal, K. Patel, M. Elkelawy, and H. A.-E. Bastawissi, "A use of various phase change materials on the performance of solar still: a review," *International Journal of Ambient Energy,* vol. 42, pp. 1575-1580, 2021/10/03 2021.

[54] M. Elkelawy, H. Alm ElDin Mohamad, A. K. Abdel-Rahman, A. Abou Elyazied, and S. Mostafa El Malla, "Biodiesel as an Alternative Fuel in Terms of Production, Emission, Combustion Characteristics for Industrial Burners: a Review," *Journal of Engineering Research,* vol. 6, pp. 45-52, 2022.

[55] H. Thakkar, K. k. Sadasivuni, P. V. Ramana, H. Panchal, M. Suresh, M. Israr, *et al.*, "Comparative analysis of the use of flash evaporator and solar still with a solar desalination system," *International Journal of Ambient Energy,* vol. 43, pp. 1561-1568, 2022/12/31 2022.

[56] M. Elkelawy, H. Alm ElDin Mohamad, M. Samadony, A. M. Elbanna, and A. M. Safwat, "A Comparative Study on Developing the Hybrid-Electric Vehicle Systems and its Future Expectation over the Conventional Engines Cars," *Journal of Engineering Research,* vol. 6, pp. 21-34, 2022.

[57] H. A. E.-D. Bastawissi and M. Elkelawy, "Computational Evaluation of Nozzle Flow and Cavitation Characteristics in a Diesel Injector," *SAE International Journal of Engines,* vol. 5, pp. 1605-1616, 2012.

[58] H. A. El-Din, Y.-S. Zhang, and M. Elkelawy, "A computational study of cavitation model validity using a new quantitative criterion," *Chinese Physics Letters,* vol. 29, p. 064703, 2012.

[59] H. A. E. M. Medhat Elkelawy, Elshenawy Abd elhamid, Mahmoud A. M. El-Gamal, "A Critical Review of the Performance, Combustion, and Emissions Characteristics of PCCI Engine Controlled by Injection Strategy and Fuel Properties," *Journal of Engineering Research:,* vol. 6, p. 12, 2022.

[60] H. Bastawissi, Z. Yu-Sheng, M. Elkelawy, and A. Bastawissi, "Detailed 3D-CFD/chemistry of CNG-hydrogen blend in HCCI engine," SAE Technical Paper 0148-7191, 2010.

[61] M. Elkelawy, H. Alm ElDin Mohamad, M. Samadony, A. M. Elbanna, and A. M. Safwat, "Effect of Battery Charging Rates for Electric Hybrid Vehicle on Fuel consumption and emissions behaviors in different road conditions: a comparative Study with Conventional Car," *Journal of Engineering Research,* vol. 6, pp. 142-154, 2022.

[62] M. Elkelawy, H. A.-E. Bastawissi, A. K. Abdel-Rahman, A. Abou El-Yazied, and S. Mostafa El malla, "Effect of multifunctional fuel additive in diesel/waste oil biodiesel blends on industrial burner flame performance and emission characteristics," *International Journal of Ambient Energy,* vol. 44, pp. 1382-1395, 2023/12/31 2023.

[63] S. El-din H. Etaiw, M. Elkelawy, I. Elziny, M. Taha, I. Veza, and H. Alm-Eldin Bastawissi, "Effect of nanocomposite SCP1 additive to waste cooking oil biodiesel as fuel enhancer on diesel engine performance and emission characteristics," *Sustainable Energy Technologies and Assessments,* vol. 52, p. 102291, 2022/08/01/ 2022.

[64] A. E. Kabeel, M. Elkelawy, H. A. E. Bastawissi, and A. M. Elbanna, "An experimental and theoretical study on particles-in-air behavior characterization at different particles loading and turbulence modulation," *Alexandria Engineering Journal,* vol. 58, pp. 451-465, 2019/06/01/ 2019.

[65] M. Elkelawy, A. Kamel, A. Abou-elyazied, and S. M. El-malla, "Experimental investigation of the effects of using biofuel blends with conventional diesel on the performance, combustion, and emission characteristics of an industrial burner," *Egyptian Sugar Journal,* vol. 19, pp. 44-59, 2022.

[66] S. F. Abd El Fattah, M. F. Ezzat, M. A. Mourad, M. Elkelawy, and I. M. Youssef, "Experimental Investigation of the Performance and Exhaust Emissions of a Spark-Ignition Engine Operating with Different Proportional Blends of Gasoline and Water Ammonia Solution," *Journal of Engineering Research,* vol. 5, pp. 38-45, 2022.

[67] E. Medhat, B. H. Alm-Eldin, A. E.-Y. Ahmed, and E.-m. Saad, "Experimental Investigation on Combustion and Emission Characteristics of Co-combustion of Pulverized Biomass with Diesel Fuel in an Industrial Burner," *Journal of Engineering Research,* vol. 8, p. 17, 2023.

[68] M. Elkelawy, A. K. Abdel-Rahman, A. Abou-Elyazied, and S. M. El-malla, "Experimental investigation on emission and combustion characteristics of an industrial burner using biogas co-fired with diesel and biodiesel," *Egyptian Sugar Journal,* vol. 19, pp. 29-43, 2022.

[69] M. Elkelawy, Z. Yu-Sheng, H. El-Din, Y. Jing-Zhou, A. El Zahaby, and E. El Shenawy, "Experimental Study on Flash Boiling and Micro-Explosion of Emulsified Diesel Fuel Spray Droplets by Shadowgraph Technology," *Transactions of CSICE,* vol. 27, pp. 306-308, 2009.

[70] E. El-Shenawy, M. Elkelawy, H. Bastawissi, and M. Taha, "Growth conditions of the algae species biomass in a continuous feedstock photo bioreactor by controlling the solar thermal radiation and climate temperature," in *The International Conference on Applied Mechanics and Mechanical Engineering*, 2018, pp. 1-19.

[71] H. Wen, C. Wang, M. Elkelawy, and G. Jiang, "Influence of ambient pressure on gas ingestion in diesel nozzle after end of injection," *Trans. Chin. Soc. Agri. Mach,* vol. 48, pp. 364-369, 2017.

[72] A. E. Kabeel, M. Elkelawy, H. A.-E. Mohamad, A. M. Elbanna, H. Panchal, M. Suresh, *et al.*, "The influences of loading ratios and conveying velocity on gas-solid two phase flow characteristics: a comprehensive experimental CFD-DEM study," *International Journal of Ambient Energy,* vol. 43, pp. 2714-2726, 2022/12/31 2022.

[73] H. A.-E. Bastawissi and M. Elkelawy, "Investigation of the Flow Pattern inside a Diesel Engine Injection Nozzle to Determine the Relationship between Various Flow Parameters and the Occurrence of Cavitation," *Engineering,* vol. Vol.06No.13, p. 13, 2014.

[74] A. Kabeel, E. ElShenawy, M. Elkelawy, H. Alm ElDin Mohamad, and M. M. Elshanshoury, "Numerical Investigation of Combustion in HCCI Diesel Engine Fuelled with Biodiesel Blends," *Journal of Engineering Research,* vol. 3, pp. 1-10, 2019.

[75] H. Alm El-Din, M. Elkelawy, and A. E. Kabeel, "Study of combustion behaviors for dimethyl ether asan alternative fuel using CFD with detailed chemical kinetics," *Alexandria Engineering Journal,* vol. 56, pp. 709-719, 2017/12/01/ 2017.

[76] S. Sarıdemir and Ü. Ağbulut, "Combustion, performance, vibration and noise characteristics of cottonseed methyl ester–diesel blends fuelled engine," *Biofuels,* vol. 13, pp. 201-210, 2022.

[77] S. Manigandan, P. Gunasekar, T. Praveenkumar, J. S. Sabir, T. Mathimani, A. Pugazhendhi, *et al.*, "Performance, noise and emission characteristics of DI engine using canola and Moringa oleifera biodiesel blends using soluble multiwalled carbon nanotubes," *Fuel,* vol. 289, p. 119829, 2021.

[78] O. Antoshkiv and H. P. Berg, "Experimental analysis of the effect of nano-metals and novel organic additives on performance and emissions of a diesel engine," *Fuel Processing Technology,* vol. 196, p. 106166, 2019.

[79] J. Wei, C. He, G. Lv, Y. Zhuang, Y. Qian, and S. Pan, "The combustion, performance and emissions investigation of a dual-fuel diesel engine using silicon dioxide nanoparticle additives to methanol," *Energy,* vol. 230, p. 120734, 2021.

[80] G. Tüccar, "Effect of hydroxy gas enrichment on vibration, noise and combustion characteristics of a diesel engine fueled with Foeniculum vulgare oil biodiesel and diesel fuel," *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects,* vol. 40, pp. 1257-1265, 2018.

[81] H. Alm ElDin Mohamad, M. Elkelawy, and M. Ramon, "Computational fluid dynamics study on a solar chimney with different ground materials," *Journal of Engineering Research,* vol. 7, pp. 176-185, 2023.

[82] M. Elkelawy, H. A. El-Din, A. M. El-Banna, R. Sathyamurthy, and N. Prakash, "Computational study of different turbulence models for air impingement jet into main air cross stream," *International Journal of Fluid Mechanics Research,* vol. 46, 2019.

[83] M. Elkelawy, Z. Yu-Sheng, H. A. El-Din, and Y. Jing-zhou, "Detailed simulation of liquid DME homogenization and combustion behaviors in HCCI engines," SAE Technical Paper 0148-7191, 2008.

[84] M. Elkelawy, E. Abd Elhamid, H. Alm ElDin Mohamad, and I. Abd-Elhay Elshennawy, "Effect of CuO Nanoparticles on Performance and Emissions Behaviors of CI Engine Fueled with Biodiesel-Diesel Fuel Blends," *Journal of Engineering Research,* vol. 6, pp. 230-239, 2022.

[85] M. Elkelawy, H. Bastawissi, E. El Shenawy, and M. El-Gamal, "Effects of using a novel fuel vaporizer on partially premixed charge compression ignition (PPCCI) engine emissions, performance, and combustion characteristics," in *Journal of Physics: Conference Series*, 2023, p. 012017.

[86] M. Elkelawy, H. Alm ElDin Mohamad, E. Abd Elhamid, and M. A. El-Gamal, "Experimental Investigation of the Biodiesel Direct Injection and Diesel Fuel as Premixed Charge on CI-Engine Emissions, Performance, and Combustion Characteristics," *Journal of Engineering Research,* vol. 7, pp. 177-187, 2023.

[87] M. Elkelawy, H. Bastawissi, A. Abdel-Rahman, A. Abou-elyazied, and S. El-malla, "Experimental investigation of the effects of diesel-bioethanol blends on combustion and emission characteristics in industrial burner," in *Journal of Physics: Conference Series*, 2023, p. 012018.

[88] M. ElKelawy, A. El-Shenawy, H. A. E. Mohamad, and S. Abd Al Monem, "Experimental investigation on spray characteristics of waste cooking oil biodiesel/diesel blends at different injection parameters," *Journal of Engineering Research,* vol. 3, pp. 29-34, 2019.

[89] E. El Shenawy, M. Elkelawy, H. A.-E. Bastawissi, and M. Shams, "EXPERIMENTAL STUDY ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF PPCCI ENGINE FUELED WITH BIODIESEL/DIESEL BLENDS," *ERJ. Engineering Research Journal,* vol. 41, pp. 119-132, 2018.

[90] M. Elkelawy, E. S. A. El Shenawy, H. A.-E. Bastawissi, and M. M. Shams, "Impact of Carbon Nanotubes and Graphene Oxide Nanomaterials on the Performance and Emissions of Diesel Engine Fueled with Diesel/Biodiesel Blend," *Processes,* vol. 11, p. 3204, 2023.

[91] M. Elkelawy, H. Alm ElDin Mohamad, M. Samadony, and A. S. Abdalhadi, "Impact of Utilizing a Diesel/Ammonia Hydroxide Dual Fuel on Diesel Engines Performance and Emissions Characteristics," *Journal of Engineering Research,* vol. 7, pp. 262-271, 2023.

[92] J. Yu, Y. Zhang, M. Elkelawy, and H. Zhang, "Investigation and numerical simulation of DME flash boiling spray characteristics," *Chinese Internal Combustion Engine Engineering,* vol. 30, pp. 45-50, 2009.

[93] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, and H. A. Elden, "Knock Recognition System in a PCCI Engine Powered by Diesel," *Highlights in Science, Engineering and Technology,* vol. 15, pp. 94-101, 2022.

[94] M. Elkelawy, H. Alm ElDin Mohamad, S. Abo-Samra, and I. Abd-Elhay Elshennawy, "Nanoparticles Additives for Diesel/Biodiesel Fuel Blends as a Performance and Emissions Enhancer in the Applications of Direct Injection Diesel Engines: A comparative Review," *Journal of Engineering Research,* 2023.

[95] M. Elkelawy and H. A.-E. Bastawissi, "Numerical Study on the Hydrogen Fueled SI Engine Combustion Optimization

through a Combined Operation of DI and PFI Strategies," *Energy and Power Engineering,* vol. Vol.05No.08, p. 10, 2013.

[96] M. Elkelawy, H. A.-E. Bastawissi, and A. M. Elbanna, "Solid particles injection in gas turbulent channel flow," *Energy and Power Engineering,* vol. 8, pp. 367-388, 2016.

[97] M. M. El-Sheekh, A. A. El-Nagar, M. ElKelawy, and H. A.-E. Bastawissi, "Solubility and stability enhancement of ethanol in diesel fuel by using tri-n-butyl phosphate as a new surfactant for CI engine," *Scientific Reports,* vol. 13, p. 17954, 2023.

[98] A. M. Elbanna, X. Cheng, C. Yang, M. Elkelawy, H. Alm-Eldin Bastawissi, and H. Xu, "Statistical analysis of ethanol/diesel dual-fuel combustion of compression ignition engines in RCCI mode using multi-injection strategies," *Sustainable Energy & Fuels,* vol. 7, pp. 2749-2763, 2023.

[99] H. Mohamad, E. Medhat, R. Mohamed, and M. Muthu, "Use of Solar Chimney in renewable energy applications–A review," *Renewable Energy Research and Applications,* vol. 2, pp. 117-128, 2021.

[100] M. Elkelawy, H. Alm ElDin Mohamad, M. Samadony, and A. S. Abdalhadi, "Utilization of Ammonia Hydroxide/Diesel Fuel Blends in Partially Premixed Charge Compression Ignition (PPCCI) Engine: A Technical Review," *Journal of Engineering Research,* 2023.

[101] J. Guangjun, Z. Yusheng, and M. Elkelawy, "Visualization experiment of internal flow of nozzle and spray construction for various fuels," *Transactions of the Chinese Society for Agricultural Machinery,* vol. 45, pp. 22-29, 2014.

[102] H. Alm-EldinBastawissi, M. Elkelawy, M. O. Elsamadony, and M. Ghazaly, "Performance and Emissions Characteristics of Multi-Cylinder Direct Injection Diesel Engine Fuelled with Diesel/Biodiesel and Toluene Additives," *Journal of Engineering Research,* vol. 8, pp. 29-37, 2025.

[103] M. Elkelawy, E. El Shenawy, H. A.-E. Bastawissi, M. M. Shams, E. PV, D. Balasubramanian, *et al.*, "Predictive modeling and optimization of a waste cooking oil biodiesel/diesel powered CI engine: an RSM approach with central composite design," *Scientific Reports,* vol. 14, pp. 1-13, 2024.

[104] M. Elkelawy, H. A.-E. Bastawissi, E. El Shenawy, and M. Soliman, "A Quantitative Analysis of the Commercial-Additive Effects on Diesel Engine Combustion and Emissions Characteristics," *Pharos Engineering Science Journal (PES),* vol. 1, p. 25, 2025.

[105] M. Elkelawy, W. M El-Ashmawy, and S. M. Ahmed, "State of the Art in Concentrated Solar Power: Latest Technological Advancements and Innovations in Efficiency and Energy Storage," *Pharos Engineering Science Journal,* vol. 1, pp. 17-28, 2025.

[106] M. Elkelawy, M. Elkomy, and H. E. Seleem, "Strategies for Optimizing Efficiency and Reducing Emissions Footprint in Spark Ignition Engine Power Plants Using Ethanol and CNG," *Pharos Engineering Science Journal,* vol. 2, pp. 107-116, 2025.

[107] M. Elkelawy, H. Bastawissi, E. A. E. Shenawy, and M. M. Ouda, "A Technical Survey on the Impact of Exhaust Gas Recirculation and Multifuel Blends on Diesel Engine Performance and Emission Characteristics," *Journal of Engineering Research,* vol. 8, p. 11, 2024.

[108] M. Elkelawy, H. A.-E. Bastawissi, E. El Shenawy, M. Taha, H. Panchal, and K. K. Sadasivuni, "Study of performance, combustion, and emissions parameters of DI-diesel engine fueled with algae biodiesel/diesel/n-pentane blends," *Energy Conversion and Management: X,* vol. 10, p. 100058, 2021.

[109] M. El-Adawy, "Effects of diesel-biodiesel fuel blends doped with zinc oxide nanoparticles on performance and combustion attributes of a diesel engine," *Alexandria Engineering Journal,* vol. 80, pp. 269-281, 2023.

[110] A. Heidari-Maleni, T. Mesri-Gundoshmian, A. Jahanbakhshi, B. Karimi, and B. Ghobadian, "Novel environmentally friendly fuel: The effect of adding graphene quantum dot (GQD) nanoparticles with ethanol-biodiesel blends on the performance and emission characteristics of a diesel engine," *NanoImpact,* vol. 21, p. 100294, 2021.

[111] S. Jaikumar, V. Srinivas, and M. Rajasekhar, "Influence of dispersant added nanoparticle additives with diesel-biodiesel blend on direct injection compression ignition engine: Combustion, engine performance, and exhaust emissions approach," *Energy,* vol. 224, p. 120197, 2021.

[112] V. Karthickeyan, S. Thiyagarajan, V. E. Geo, B. Ashok, K. Nanthagopal, O. H. Chyuan, *et al.*, "Simultaneous reduction of NOx and smoke emissions with low viscous biofuel in low heat rejection engine using selective catalytic reduction technique," *Fuel,* vol. 255, p. 115854, 2019.

[113] M. E. M. Soudagar, N.-N. Nik-Ghazali, M. A. Kalam, I. A. Badruddin, N. Banapurmath, T. Y. Khan, *et al.*, "The effects of graphene oxide nanoparticle additive stably dispersed in dairy scum oil biodiesel-diesel fuel blend on CI engine: performance, emission and combustion characteristics," *Fuel,* vol. 257, p. 116015, 2019.

[114] A. Taghizadeh-Alisaraei and A. Rezaei-Asl, "The effect of added ethanol to diesel fuel on performance, vibration, combustion and knocking of a CI engine," *Fuel,* vol. 185, pp. 718-733, 2016.

[115] M. Elkelawy, H. A.-E. Bastawissi, K. K. Esmaeil, A. M. Radwan, H. Panchal, K. K. Sadasivuni, *et al.*, "Experimental studies on the biodiesel production parameters optimization of sunflower and soybean oil mixture and DI engine combustion, performance, and emission analysis fueled with diesel/biodiesel blends," *Fuel,* vol. 255, p. 115791, 2019.

[116] J. Wei, Z. Yin, C. Wang, G. Lv, Y. Zhuang, X. Li, *et al.*, "Impact of aluminium oxide nanoparticles as an additive in diesel-methanol blends on a modern DI diesel engine," *Applied Thermal Engineering,* vol. 185, p. 116372, 2021.

[117] E. A. E. Elshenawy, M. A. Elkelawy, M. K. El-fakharany, H. A.-E. Bastawissi, and M. M. Shafey, "STUDY OF THE PERFORMANCE AND EMISSION CHARACTERISTICS OF DI DIESEL ENGINE FUELLED WITH BIODIESEL-DIESEL BLENDS."

[118] B. Heidary, S. Hassan-Beygi, B. Ghobadian, and A. Taghizadeh, "Vibration analysis of a small diesel engine using diesel-biodiesel fuel blends," *Agricultural Engineering International: CIGR Journal,* vol. 15, pp. 117-126, 2013.

[119] A. M. S. Varadappan and A. G. Sundaram, "Effect of Diesterol blends on the noise vibration and harshness of a Genset engine," *Materials Today: Proceedings,* 2023.

[120] S. Peddinti, P. S. Reddy, and P. Timothy, "Noise and Vibration Analysis of Diesel Engine fueled using Diesel and Neem Biodiesel with Inclusion of MoO3 Nano Particles."