

Environmental Impact of Waste Plastics and the Use of Waste Plastic-Derived Oil in Diesel Engines: A Literature Review

K. Manikandan¹, S. Devi², G. Neelagandan², C. Manikandan^{3,*}

Abstract

Plastic pollution has become a major global environmental issue, affecting land, water, and living organisms. This review summarizes current research on how waste plastics enter the environment, how they move and break down, and the effects they create in ecosystems and on human health. Special attention is given to the growing problem of microplastics, which continue to accumulate in soil, freshwater bodies, and oceans. The review also discusses recent progress in converting waste plastics into usable oil through processes such as pyrolysis, catalytic cracking, and hydrothermal liquefaction. These methods show strong potential for recovering energy from plastic waste, producing oils that can be refined into fuel. However, challenges remain, including inconsistent oil quality, high energy demand, and the need for improved process control. Each conversion method has specific advantages and limitations, and further research is needed to make them more efficient and environmentally friendly. Another key focus of this review is the use of waste plastic oil (WPO) as an alternative fuel for diesel engines. Studies show that blending WPO with diesel can provide acceptable engine performance, especially at low blend ratios. Combustion characteristics such as ignition delay and fuel atomization influence how these blends behave inside the engine. While WPO blends can reduce certain emissions like particulate matter and carbon monoxide, they may increase nitrogen and sulfur oxides due to fuel composition. Engine modifications and emission-control technologies are therefore important to ensure cleaner operation. Overall, this review highlights both the opportunities and the challenges associated with converting plastic waste into fuel. Continued research is essential to improve conversion technologies, enhance fuel stability, reduce emissions, and support the development of waste plastic oil as a reliable and sustainable alternative energy source.

Keywords: Waste plastics, environmental, diesel engine, emission, performance

*Author for Correspondence

C. Manikandan

E-mail: cpmanikandan07@gmail.com

¹Assistant Professor, Department of Mechanical Engineering, FEAT, Annamalai University, India

²Assistant Professor, Department of Civil Engineering, FEAT, Annamalai University, India

³Research Scholar, Department of Mechanical Engineering, FEAT, Annamalai University, India

Received Date: December 05, 2025

Accepted Date: December 08, 2025

Published Date: December 15, 2025

Citation: K. Manikandan, S. Devi, G. Neelagandan, C. Manikandan. Environmental Impact of Waste Plastics and the Use of Waste Plastic-Derived Oil in Diesel Engines: A Literature Review. International Journal of I.C. Engine and Gas Turbines. 2025; 11(2): 11–17p.

INTRODUCTION

The widespread use of plastics, combined with poor waste management practices, has triggered a severe global plastic pollution crisis. Plastics are valued for their durability and resistance to degradation, yet these very properties cause them to persist in the environment for extended periods, often hundreds of years, resulting in serious ecological and health problems. This literature review consolidates recent research to highlight the environmental consequences of plastic waste. Plastic waste is generated from multiple sectors, including household activities, industrial processes, agriculture, and maritime industries. Among these, single-use plastics, packaging materials, and microplastics have been identified by researchers as

the most significant contributors to environmental pollution. Due to their slow degradation, plastics break down gradually into tiny fragments known as microplastics. These particles have become omnipresent, found even in remote ecosystems such as the Arctic regions and the deep ocean.

The ecological repercussions of plastic waste are considerable, impacting marine, freshwater, and terrestrial environments alike. Plastics not only cause physical harm to wildlife through ingestion and entanglement but also disrupt natural habitats and disturb ecological balance by interfering with food chains. Additionally, the potential effects of plastic pollution on human health have increasingly come under scrutiny. Recent findings indicate that microplastics have infiltrated the human food chain, raising significant concerns regarding their long-term implications for human health. Combating plastic pollution demands integrated strategies encompassing policy interventions, technological innovations, and enhanced public awareness. In regions lacking robust waste management systems, practices like illegal dumping and open burning of plastics are widespread. Such methods pose severe risks to both environmental quality and public health. Consequently, governments and international bodies are recognizing the critical need for comprehensive policies aimed at reducing plastic waste and promoting sustainable disposal methods.

Technological advancements offer promising solutions to mitigate the environmental impacts associated with plastic waste disposal. Several methods have emerged for converting waste plastics into usable oil products, notably pyrolysis, catalytic cracking, and hydrothermal liquefaction (HTL). Each technology carries distinct strengths and limitations. Pyrolysis involves decomposing plastics thermally in the absence of oxygen, yielding products such as liquid oil, gases, and char. Catalytic cracking employs catalysts to reduce the temperature necessary for plastic decomposition, thereby improving oil quality. Hydrothermal liquefaction converts plastics into oil by using water under high pressure and elevated temperatures. Different plastic types, including polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyethylene terephthalate (PET), exhibit unique properties influencing their conversion efficiency into oil. Key operational parameters – such as temperature control, heating rates, and residence times – significantly impact both the conversion efficiency and the quality of the resulting oil. Economic feasibility for converting plastic waste to oil also depends on factors such as feedstock availability, operational efficiency, and market demand for the resulting fuel.

Waste plastic oil (WPO), primarily produced through pyrolysis, involves heating plastic waste at high temperatures without oxygen. This thermal process breaks down lengthy polymer chains into smaller hydrocarbon molecules, forming liquid fuels comparable to traditional diesel. The physical properties of WPO, including density, calorific value, and viscosity, closely resemble those of conventional diesel, making it a viable alternative fuel. However, WPO often contains higher levels of sulfur and aromatic compounds, which can adversely affect engine performance and emission profiles. To mitigate these issues, WPO is typically blended with diesel fuel, improving combustion characteristics and reducing harmful emissions. Utilizing waste plastic oil in diesel engines can occur either by blending it with standard diesel or using it directly in modified engine setups. Common blend ratios of WPO and diesel generally range between 10% and 30%, adjusted based on specific engine designs, performance requirements, and emission goals.

IMPACT OF WASTE PLASTICS ON THE ENVIRONMENT

Large amounts of plastic waste come from homes, mainly from packaging and everyday disposable items. Studies show that these materials easily end up in landfills and natural areas when not properly managed [1]. Industries also add to the problem through leftover materials from manufacturing processes, while the agricultural sector contributes through plastic sheets, containers, and irrigation tools used in farming [2]. A major global concern is marine plastic pollution. Research estimates that millions of tons of plastic waste reach the oceans every year, carried by rivers and winds [3]. Ocean currents move this waste across long distances, creating large accumulation zones such as the Great Pacific Garbage Patch. Environmental factors such as sunlight, heat, and physical wear slowly break plastics into smaller particles, but complete degradation rarely occurs, resulting in long-lasting microplastics in the environment [4].

Burning plastic waste is another major issue. Incineration releases harmful chemicals, including dioxins and furans, which are linked to breathing problems, cancer, and other health risks [5]. This process also produces high levels of carbon dioxide, adding to global warming. The ash left behind usually contains dangerous toxins, which must be handled carefully to avoid soil and water contamination. Studies warn that poor management of these residues can severely harm the environment [6]. Microplastics have been found in oceans, rivers, lakes, and soils. These tiny particles are easily eaten by fish, birds, and many other organisms, and can accumulate through food chains [7]. Marine life is especially affected; animals often swallow plastic pieces, leading to internal blockages, reduced feeding, or chemical exposure [8]. Plastic waste also causes entanglement, which can injure or kill marine species. In soils, plastics can disturb natural structure, reduce water-holding capacity, and negatively affect plant growth. Their presence in farming areas leads to long-term soil degradation [9]. Microplastics in freshwater ecosystems show similar risks for aquatic species and ecosystem functions. Coastal and wetland habitats also suffer as plastic waste reduces biodiversity and disrupts ecological balance [10, 11].

Humans are not free from these risks. Microplastics have been identified in seafood, suggesting potential health concerns for consumers [12]. While research is ongoing, possible impacts include inflammation, chemical toxicity, and hormone-related disorders. Plastics can also absorb harmful pollutants from the environment, which may be released into the body when ingested [13]. Many governments and researchers have explored policies for reducing plastic pollution. These include bans on single-use plastics, extended producer responsibility (EPR), recycling rewards, and the use of eco-friendly materials [14]. Advances in recycling technologies and new materials are also crucial. Chemical recycling and biodegradable plastics show strong potential for improving waste management and reducing environmental harm [15]. Public awareness and community participation are equally important for successful recycling and waste-reduction programs [16]. Throughout their entire lifecycle—production, use, and disposal—plastics consume a lot of energy and generate substantial greenhouse gas emissions. Studies estimate that the plastic industry contributes around 3.8% of global emissions, making it a notable factor in climate change [17]. International agreements, such as the Basel Convention's Plastic Waste Amendments, aim to control and manage plastic waste more responsibly across borders [18]. Many countries have also introduced laws promoting recycling, reducing single-use items, and investing in waste-to-energy options. Emerging solutions like chemical recycling and biodegradable materials are seen as promising pathways for the future. Controlled waste-to-energy processes can help reduce landfill use, but they must be closely monitored to prevent toxic emissions and other environmental impacts [19, 20].

CONVERSION OF WASTE PLASTIC INTO OIL

Pyrolysis is one of the most widely studied methods for converting waste plastics into useful oil. In this process, plastic materials are heated between 300°C and 700°C without oxygen, which breaks the long polymer chains into smaller hydrocarbon molecules. Researchers note that the efficiency of pyrolysis depends on several factors, including temperature, heating rate, and the type of plastic used as raw material [21]. The oil produced is a mixture of many hydrocarbons and shares similarities with crude oil. Earlier studies have shown that this oil can be refined further into useful fuels such as petrol, diesel, and kerosene [22]. However, the quality of the oil depends strongly on the type of feedstock and the operating conditions. Some studies point out that pyrolysis oil may contain impurities and therefore needs additional purification before it can be used as fuel. Pyrolysis usually provides conversion rates between 50% and 80%, making it an efficient option for plastic-to-fuel conversion [23]. Compared to burning plastics, pyrolysis produces fewer toxic emissions, making it a relatively safer technology. Still, the high energy demand and potential greenhouse gas emissions remain concerns for large-scale applications.

Catalytic cracking is another promising technique. This method generally works at 350°C–500°C, using catalysts such as zeolites, alumina, and silica to break down the polymers more effectively [24]. The use of catalysts improves both the quality and the amount of oil produced, especially increasing the

yield of lighter hydrocarbons that are more suitable for fuel use. Research shows that catalytic cracking produces oils with lower sulfur levels and higher heating values compared to normal pyrolysis [25]. Studies also report that catalytic cracking offers better conversion efficiency and produces higher-quality fuel than conventional pyrolysis [26]. It generates fewer unwanted by-products like char and heavy oil fractions. However, environmental concerns do exist; some catalysts may be difficult to reuse or may require special handling due to toxicity.

Hydrothermal liquefaction (HTL) is another advanced method for converting plastic waste into oil. This technique uses water at temperatures of 250°C–370°C and high pressures up to 25 MPa. Under these conditions, water acts both as a solvent and as an active medium that helps break down plastic polymers [27]. The oil obtained through HTL usually has fewer impurities, greater stability, and high energy content. It can also be upgraded into transportation fuels [28]. One of the major advantages of HTL is that it produces very small amounts of gas and solid residues, which reduces environmental concerns and makes waste handling easier. Researchers highlight that HTL offers high conversion efficiency while generating fewer by-products [29]. Using water as the main solvent also eliminates the need for organic solvents, lowering environmental risks. However, HTL requires high pressure and significant energy input, which can limit its large-scale application. Overcoming these operational challenges is important to make HTL more practical for widespread use.

FEED STOCKS AND PROCESS CONDITION

Polystyrene (PS) usually produces a high number of aromatic hydrocarbons during the conversion process, which makes it useful for chemical production. However, studies show that the oil obtained from PS often contains several impurities and must be purified before use [30]. Polyethylene terephthalate (PET), because of its aromatic structure and high oxygen content, is more difficult to convert into good-quality oil. Research indicates that PET generally provides lower oil yields and requires more energy for proper conversion [31]. Higher temperatures help improve conversion efficiency and increase the production of lighter hydrocarbons. However, extremely high temperatures can also lead to unwanted by-products, including gases and char [32]. A slower heating rate with longer residence time allows better breakdown of the plastic polymers, which improves oil quality. Still, these parameters must be optimized carefully to avoid excessive degradation or char formation [33]. Waste plastics are cost-effective feedstocks, which adds to the economic advantages of the process. However, differences in plastic types and composition can cause variations in the quantity and quality of the oil produced. This inconsistency remains one of the major challenges when using mixed plastic waste [34].

UTILIZATION OF WASTE PLASTIC OIL (WPO) IN DIESEL ENGINE

The way Waste Plastic Oil (WPO) blends are injected and atomized inside the engine plays a major role in determining combustion efficiency and emissions. Studies show that high-pressure fuel systems, such as Common Rail Direct Injection (CRDI), greatly improve atomization of WPO blends. Better atomization leads to improved air–fuel mixing and more complete combustion [35–37]. Combustion characteristics such as ignition delay and combustion duration are important for understanding how WPO blends behave in diesel engines. Research has reported that WPO–diesel blends often show a slightly longer ignition delay than pure diesel, mainly because WPO has a lower cetane number [38]. Even so, the combustion process remains stable, especially when minor adjustments are made to injection timing. Engine performance using WPO blends has been widely investigated. Studies indicate that lower blend ratios (up to 30%) can provide power output and brake thermal efficiency comparable to standard diesel [39–41]. Higher blend ratios, however, may cause a small drop in performance because of differences in fuel properties such as viscosity, volatility, and energy content.

The effect of WPO on engine emissions is a key focus of ongoing research. Many studies show that WPO blends can reduce particulate matter (PM) and carbon monoxide (CO) emissions due to cleaner combustion. However, nitrogen oxides (NO_x) and sulfur oxides (SO_x) may increase because WPO usually contains more aromatics and sulfur than regular diesel [42]. To control these emissions, advanced after-treatment systems like Selective Catalytic Reduction (SCR) and Diesel Particulate

Filters (DPF) are recommended. Particulate matter – especially soot – remains a major concern in diesel engines. Research findings show that WPO blends generally help lower soot emissions because WPO has a higher hydrogen-to-carbon ratio, which promotes cleaner combustion [43]. Even so, the actual emission levels depend on the blend ratio, engine design, and operating conditions. Another important challenge is the high sulfur content often found in WPO. This can lead to increased SO_x emissions, which is a serious problem in regions with strict emission norms. Studies emphasize the need for effective desulfurization methods and the use of emission-control technologies to manage sulfur emissions when using WPO-diesel blends [44].

CONCLUSION

The reviewed literature clearly shows that plastic waste has a wide and serious impact on the environment. Even though researchers have gained a better understanding of how plastics are produced, how they spread, and how they affect ecosystems, many challenges still remain. Likewise, major progress has been made in converting waste plastics into oil, but several technical and environmental hurdles continue to limit large-scale implementation. Future research should focus on understanding the long-term effects of microplastics on both the environment and human health. It is also important to develop sustainable alternatives to traditional plastics and to design strong policies that promote waste reduction. More studies are needed to improve plastic-to-oil conversion technologies so they become more efficient, require less energy, and produce higher-quality oil. Developing cleaner, more efficient, and environmentally friendly catalysts should be a key research priority. Upcoming work should also aim to improve the consistency of Waste Plastic Oil (WPO), design engines and fuel systems that can operate smoothly with WPO blends, and create better emission-control technologies. These advancements will play a crucial role in making WPO a reliable and sustainable alternative fuel for the future.

REFERENCES

1. Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. *Sci Adv*. 2017;3(7):e1700782.
2. Sharma S, Chatterjee S. Microplastic pollution, a threat to marine ecosystem and human health: a short review. *Environ Sci Pollut Res*. 2017;24:21530–47.
3. Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, Andrady A, et al. Plastic waste inputs from land into the ocean. *Science*. 2015;347(6223):768–71.
4. Andrady AL. Microplastics in the marine environment. *Mar Pollut Bull*. 2011;62(8):1596–605.
5. Verma R, Vinoda KS, Papireddy M, Gowda ANS. Toxic pollutants from plastic waste – a review. *Procedia Environ Sci*. 2016;35:701–8.
6. Qadir W, Ghafor K, Mohammed A. Evaluation of the effect of lime on the plastic and hardened properties of cement mortar and quantified using Vipulanandan model. *Open Eng*. 2019;9(1):468–80.
7. Cole M, Lindeque P, Halsband C, Galloway TS. Microplastics as contaminants in the marine environment: a review. *Mar Pollut Bull*. 2011;62(12):2588–97.
8. Thompson RC, Olsen Y, Mitchell RP, Davis A, Rowland SJ, John AWG, et al. Lost at sea: where is all the plastic? *Science*. 2004;304(5672):838.
9. Rillig MC, Ingraffia R, de Souza Machado AA. Microplastic incorporation into soil in agroecosystems. *Front Plant Sci*. 2017;8:1805.
10. Wagner M, Scherer C, Alvarez-Muñoz D, Brennholt N, Bourrain X, Buchinger S, et al. Microplastics in freshwater ecosystems: what we know and what we need to know. *Environ Sci Eur*. 2014;26(1):1–9.
11. Van Cauwenbergh L, Janssen CR. Microplastics in bivalves cultured for human consumption. *Environ Pollut*. 2014;193:65–70.
12. Teuten EL, Saquing JM, Knappe DRU, Barlaz MA, Jonsson S, Björn A, et al. Transport and release of chemicals from plastics to the environment and to wildlife. *Philos Trans R Soc B Biol Sci*. 2009;364(1526):2027–45.

13. Xanthos D, Walker TR. International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): a review. *Mar Pollut Bull.* 2017;118(1–2):17–26.
14. Hopewell J, Dvorak R, Kosior E. Plastics recycling: challenges and opportunities. *Philos Trans R Soc B Biol Sci.* 2009;364(1526):2115–26.
15. Jambeck J, Moss E, Dubey B, Arifin Z, Godfrey L, Hardesty BD, et al. Leveraging multi-target strategies to address plastic pollution in the context of an already stressed ocean. In: *The Blue Compendium: From Knowledge to Action for a Sustainable Ocean Economy.* Cham: Springer Int Publishing; 2023. p. 141–84.
16. Zheng J, Suh S. Strategies to reduce the global carbon footprint of plastics. *Nat Clim Chang.* 2019;9(5):374–8.
17. Raubenheimer K, McIlgorm A, Oral N. Towards an improved international framework to govern the life cycle of plastics. *Rev Eur Comp Int Environ Law.* 2018;27(3):210–21.
18. Okoffo ED, Donner E, McGrath SP, Tscharke BJ, O'Brien JW, O'Brien S, et al. Plastics in biosolids from 1950 to 2016: a function of global plastic production and consumption. *Water Res.* 2021;201:117367.
19. Astrup T, Riber C, Pedersen AJ. Incinerator performance: effects of changes in waste input and furnace operation on air emissions and residues. *Waste Manag Res.* 2011;29(10 Suppl):S57–68.
20. Sharuddin SD, Abnisa F, Wan Daud WMA, Aroua MK. A review on pyrolysis of plastic wastes. *Energy Convers Manag.* 2016;115:308–26.
21. Ahmed II, Gupta AK. Hydrogen production from polystyrene pyrolysis and gasification: characteristics and kinetics. *Int J Hydrogen Energy.* 2009;34(15):6253–64.
22. Butler E, Devlin G, McDonnell K. Waste polyolefins to liquid fuels via pyrolysis: review of commercial state-of-the-art and recent laboratory research. *Waste Biomass Valorization.* 2011;2:227–55.
23. Aguado J, Serrano DP, Escola JM. Fuels from waste plastics by thermal and catalytic processes: a review. *Ind Eng Chem Res.* 2008;47(21):7982–92.
24. Syamsiro M, Saptoadi H, Norsujianto T, Noviasri P, Cheng S, Alimuddin Z, et al. Fuel oil production from municipal plastic wastes in sequential pyrolysis and catalytic reforming reactors. *Energy Procedia.* 2014;47:180–8.
25. Kadapure SA, Arush K, Sagar C, Shreshtha S, Sangeeta M, Sukanya J, et al. Tertiary recycling of waste plastic using catalytic cracking into crude oil. *Energy Sources Part A Recover Util Environ Eff.* 2016;38(19):2942–8.
26. Anastasakis K, Biller P, Madsen RB, Glasius M, Johannsen I. Continuous hydrothermal liquefaction of biomass in a novel pilot plant with heat recovery and hydraulic oscillation. *Energies.* 2018;11(10):2695.
27. Chaudhary S, Kumari M, Chauhan P, Chaudhary GR. Upcycling of plastic waste into fluorescent carbon dots: an environmentally viable transformation to biocompatible C-dots with potential prospective in analytical applications. *Waste Manag.* 2021;120:675–86.
28. Toor SS, Rosendahl L, Sintamarean I. Recipe-based co-HTL of biomass and organic waste. In: *Direct Thermochemical Liquefaction for Energy Applications.* Woodhead Publishing; 2018. p. 169–89.
29. Miskolczi N, Bartha L, Angyal A. Pyrolysis of polyvinyl chloride (PVC)-containing mixed plastic wastes for recovery of hydrocarbons. *Energy Fuels.* 2009;23(5):2743–9.
30. Panda A, Garg I, Truty MJ, Kline TL, Johnson MP, Ehman EC, et al. Borderline resectable and locally advanced pancreatic cancer: FDG PET/MRI and CT tumor metrics for assessment of pathologic response to neoadjuvant therapy and prediction of survival. *AJR Am J Roentgenol.* 2021;217(3):730–40.
31. Sharuddin SDA, Abnisa F, Wan Daud WMA, Aroua MK. A review on pyrolysis of plastic wastes. *Energy Convers Manag.* 2016;115:308–26.
32. Butler E, Devlin G, McDonnell K. Waste polyolefins to liquid fuels via pyrolysis: review of commercial state-of-the-art and recent laboratory research. *Waste Biomass Valorization.* 2011;2:227–55.

33. Miandad R, Barakat MA, Rehan M, Aburiazaiza AS, Ismail IMI, Nizami AS. Plastic waste to liquid oil through catalytic pyrolysis using natural and synthetic zeolite catalysts. *Waste Manag.* 2017;69:66–78.
34. Manikandan C, Syed Aalam C. Impact of Pine Oil Blend in CRDI Diesel Engine with Different Injection Pressures. *SSRG Int J Mech Eng.* 2024;11(9):83–92.
35. Manikandan C, Syed Aalam C. Extraction and optimization of transesterification process to produce pine biodiesel using nano catalyst. *Int J Eng Trends Technol.* 2024;72(7):111–7.
36. Kumar R, Mishra MK, Singh SK, Kumar A. Experimental evaluation of waste plastic oil and its blends on a single cylinder diesel engine. *J Mech Sci Technol.* 2016;30:4781–9.
37. Panda AK, Murugan S, Singh RK. Performance and emission characteristics of diesel fuel produced from waste plastic oil obtained by catalytic pyrolysis of waste polypropylene. *Energy Sources Part A Recover Util Environ Eff.* 2016;38(4):568–76.
38. Chandrasekaran M, Aalam CS. Recent trends in biodiesel production techniques: a review. *Int J Adv Eng Res Sci.* 2024;11(12):70–83.
39. Manikandan Chandrasekaran, Syed Aalam C. Evaluating the performance, emissions, and combustion characteristics of CRDI diesel engines using pine oil blends as a sustainable fuel alternative. *Int J Mach Syst Manuf Technol.* 2025;3(1):24–33.
40. Gnanasikamani B, Rajamanickam SK, Kasinathan SK, Marimuthu C. Experimental investigation on an EGR based diesel engine fueled with the blend of diesel and plastic oil and an antioxidant additive. *SAE Tech Pap.* 2019;2019-28-0079.
41. Venkatesan H, Sivamani S, Bhutoria K, Vora HH. Assessment of waste plastic oil blends on performance, combustion and emission parameters in direct injection compression ignition engine. *Int J Ambient Energy.* 2019;40(2):170–8.
42. Mangesh VL, Padmanabhan S, Tamizhdurai P, Ramesh A. Experimental investigation to identify the type of waste plastic pyrolysis oil suitable for conversion to diesel engine fuel. *J Clean Prod.* 2020;246:119066.
43. Sharma V, Hossain AK, Griffiths G, Duraisamy G, Krishnasamy A, Ravikrishnan V, et al. Plastic waste to liquid fuel: a review of technologies, applications, and challenges. *Sustain Energy Technol Assess.* 2022;53:102651.
44. Manikandan Chandrasekaran, Syed Aalam C, Devi S, Manikandan K. Analysis of performance, emissions, and combustion in a CRDI diesel engine operating on Soapnut oil as fuel. *Int J Recent Eng Sci.* 2024;11(6):54–62.