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A Literature Review of the Performance and Emission Analysis of Methyl Tert-Butyl Ether Diesel Blended Diesel Engines

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Abstract— The rising energy demand for fast industrialization and residential requirements is putting further strain on current traditional energy sources. These are already emitting more dangerous pollutants into the environment than their permitted limits. So we need some type of energy source that is conveniently accessible, economically effective, and, most importantly, safe. friendly to the environment Many studies have been conducted on this subject, and alternative fuel, biodiesel, which can be generated from waste, have been discovered the different feed stocks. This might be the finest alternative for conventional energy, with practically no environmental impact, as well as a solution to one of the most difficult environmental challenges. This study examines many elements of biodiesel, including performance and emissions. The primary focus of this evaluation is on the elimination of key pollutants. such as carbon monoxide (CO), unburned hydrocarbons (UHC), particulate matter (PM), and the impact of fatty acid content on performance and emission parameters. Biodiesel may be used as fuel in CI engines without modification, which means it can substitute diesel fuel. The varied results demonstrate that the chemical composition of biodiesel varies in performance and emission characteristics depending on the source of origin. The biodiesel produced from saturated feedstock exhibits reduced NOx emissions and great oxidation resistance; nonetheless, additional research and policy concerns are required to enhance atomization. necessary to comprehend the intricate interaction between biodiesel feedstock and its properties and applications.

Keywords— Carbon Monoxide (CO), Unburned Hydro Carbons (UHC), Particulate Matter (PM) and Methyl Tert-Butyl Ether (MTBE)

I. INTRODUCTION

In an internal combustion engine, a high amount of energy is consumed. [1] Petroleum fuels are currently the main source of energy supply for modern civilization. Petroleum-based fuels have a large impact on the global economy through transportation and energy conversion sectors. [7, 8] However in recent years depleting the crude oil reserves and environmental issues have become a major concern for internal combustion engine manufacturers and researchers. As a result, researchers are trying to find alternative fuels. [3-9] They are looking for renewable fuels with similar physicochemical characteristics to petroleum fuels so that they can be used in the existing engine without or with minimum modification to the engine.[7,8] The use of alternative fuels which are renewable and environmentally friendly have the potential to solve or at least ease the petroleum fuel crisis. [4-6] Rodolf diesel is the inventor of the diesel engine. India is getting above 80% of the total requirement of its petroleum products from outside countries which unfavorably distress its economy [11]. Diesel engines are widely used in heavy industrial applications and transportation due to the higher compression ratio and thermal efficiency than spark plug ignition engines. However, NO and smoke emissions of diesel engines threaten to the environment and human health.[8-11] The usage of biodiesel fuel has important potential to solve these problems in a diesel engine. As it is understood biodiesel has a higher cetane number than diesel fuel. [11] A high cetane number increases the standard of combustion by decreasing the ignition time within the compression ignited engines. [10] Biodiesel could also be a fuel that attends indicates the plant seeds or fruits wastage and animal fats. These plant seeds and animal fats are unremarkably shown because of the

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feedstock for biodiesel. [2] Biodiesel typically uses within the engine. [1-9] Biodiesel may be renewable fuel and contributes to the reduction of greenhouse gas emissions. [3] Internal combustion engines the most contributors to the atmospheric pollution problem. At this point, the usage of biodiesel in diesel engines is attractive to the researcher. Biodiesel provides not only reasonable power output but also helps to reduce exhaust emission significantly compared to diesel fuel. [12] So that researcher is intensifying their work on alternate energy sources to decrease the dependency on petroleum-based fuel and the harmful exhaust gases caused by increasing the number of vehicles in the world.

A. Methyl Tert Butyl Ether (MTBE) $(CH_3)_3COCH_3$ is the formula for Methyl Tertiary-Butyl Ether. MTBE is a volatile, flammable, colorless liquid that is only slightly soluble in water. It has a minty odor that is slightly reminiscent of ether, resulting in an unpleasant taste and odor in water. MTBE might be a gasoline additive that acts as an oxygenate to raise the octane rating. Its usage is contentious in the United States, and its use is diminishing, owing in part to its presence in groundwater and laws favoring ethanol. However, global MTBE output has remained stable at around 18 million tonnes per year (2005) mainly to expansion in Asian markets that are less reliant on ethanol subsidies. [19] Since it was originally manufactured 20 years ago, the amount of methyl tertiary butyl ether (MTBE) blended into motor gasoline has risen considerably. MTBE consumption increased in the early 1980s in response to octane demand, which was caused initially by the loss of gasoline's lead and then by growing demand for premium gasoline. Between 1990 and 1994, the vented fuel program stimulated an increase in MTBE production. MTBE consumption increased from 83,000 barrels per day in 1990 to 161,000 barrels per day in 1994.

Fig.1 Methyl Tert Butyl Ether

B. Octane Number

The output of an engine is limited by its knocking characteristics. knocking can damage the engine parts. Low engine speed knock is usually easy to hear to the driver but is not damaging to the engine. High engine speed knock, however, is often impossible to hear because of the engine, speed, and wind noise. The most severe knock, which can be very damaging, often occurs at motorway cruising speeds of 4000 to 5000 rpm, and current high compression engines have a higher tendency to knock. Many engines will fail in less than 50 hours under conditions of heavy knock and the damaging effect of knock is cumulative. Laboratory Research and Motor Octane rating procedures such as the American society for testing and material (ASTM) D-2699 and D-2700 are not suitable for use with neat oxygenates such as MTBE. Octane values obtained by these methods are not useful in determining knock-limited compression ratios for vehicles operating on neat oxygenates when blended with gasoline. The same study also concludes that the maximum engine speed associated with knock is greatly reduced with MTBE.

II. LITERATURE REVIEW

Adem Siraj Mohammed et al. [2023], Due to the energy security and environmental pollution from engines working with conventional fuels, various experimental research has been carried out to find alternative, environmentally friendly, renewable, and sustainable fuels. Biodiesel is an eco-friendly and alternative bio-fuel fuel that can substitute partially or fully diesel fuel for a compression ignition engine. This paper provides a comprehensive review of the performance, emission, and combustion characteristics of the diesel-biodiesel blend on diesel engines using ether, antioxidant, and cetane improver additives. The energy and exergy performance of biodiesel on a diesel engine is also discussed. The general impression is that ether especially DEE is the promising one that has a significant effect on improving the physical properties of the biodiesel, increasing the performance, and reducing the exhaust emission characteristics [1].

Marcin Zacharewicz et al. [2023], the results of research on the impact of feeding marine reciprocating internal combustion engines with blends of diesel fuel and n-butanol on their performance parameters. The study includes a research plan and empirical results, in which the engine efficiency and emissions of harmful compounds in the exhaust gases were determined. The research indicates that it is resonable to use fuel blends containing n-butanol. N-butanol positively affect the concentration of NOx has positive impact on reducing the toxicity of exhaust gases. An important aspect of the passive defence of a vessel is the reduction of exhaust gas temperature under nominal loads [2].

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performance, emission, and combustion characteristics of the diesel-biodiesel blend on diesel engines using ether, antioxidant, and cetane improver additives. The other additive reviewed in this paper is a cetane/ignition improver which has been highly applicable in low cetane indexed fuels such as alcohol additives on biodiesel to improve the ignition characteristics. Finally, the energy and energy performance comparison of diesel and biodiesel along with different additives are also explored. Even though there is no agreement among researchers, the dominating conclusion is that the energy and exergy efficiency of biodiesel is higher than diesel fuels [3].

D Dadapeer et al. [2022], MTBE along with gasoline in HCCI mode combustion is a modest try for improving the performance and controlling the emission. This article is focused to analyse the numerical study for the diesel engine which has operated by an optimal gasoline MTBE blend. The deviation between the simulated values and experimental values is minimal. It may be occurred due to unaccounted losses, uncertainties, and limitations in experimentations. Also, the addition of MTBE along with gasoline in HCCI combustion produced better performance and controlled emission than other alternatives [4].

A. Godwin Antony et al. [2021], incomplete combustion in IC engines reduces the efficacy and increases the release of undesired contents to the atmosphere. As an effort to improve the properties of emission and the performance characteristics of the engine, additive MTBE is added to gasoline at different proportions. This work aims at comparison of efficacy and emission characteristics of the plain and MTBE blended gasoline fuel. MTBE was added to the neat fuel in proportions of 5, 10 and 15 ml per 100 ml of gasoline. An upward trend was observed with the BSFC and BTE for blended fuel when compared to the neat fuel. Also, the characteristic of emission of the blended fuel was evaluated with the neat fuel and was observed with downfall in emissions of HC and CO. The emission of CO2 and oxides of nitrogen showed an upward trend with increase in blending ratio [5].

Eshwaraiah Ravula et.al. [2021] -The significant quantity of power is expensive in transportation segment & industrial sector and also a critical command in meeting through CI engine in all over the world due to their greater performance as contrast to the conventional diesel fuels. However, there was a tremendous alarm regarding the crude oil products which are going to be depleted in near future. So, in this connection it is necessary to reach, the suitable fuels other than the fossil fuels and also on the other hand it is mandatory to control the expense of the both fuels. In this work an attempt is to be made to investigate the commercial use of suitable and non-toxic additives in order to improve the performance of an engine without sacrificing the functionality parameters. The main concern of this work is to utilize the maximum effective way to control the asserted parameters like emissions and combustion characteristics. This investigation carried out on a diesel engine fuelled with B100 (jatropha) with two additives, Nitro methane (Nm) and Methyl Tetra Butyl Ether (MTBE) are tested in kirloskar computerized diesel engine. Jatropha bio-diesel is a biodegradable, non-toxic, renewable fuel, environment friendly and do not build on globalwarming. Additives selected are based on the biodiesel characteristics, and economic feasibility. Additive MTBE is used for oxygenated and the other additive Nm is used as cetane booster [6].

Muhammad Ali Ijaz Malik et.al. [2021] -Methanol showed promising results as an alternative to gasoline fuel. However, there exists a research gap for the effect of oxygenated fuel on lubricant oil deterioration along-with engine performance and emissions. This study aims the very topic. The characteristics of SI engine were evaluated for two different loads and nine different engine speeds. The lubricant oil samples were taken out from engine oil sump after 100 h of engine operations using gasoline (G) and M12 sequentially. The brake power of M12 was observed higher in comparison with G. The maximum BTE of 23.69% was observed for M12 on lower load and 2800 rpm. On average, the 6.05% and 6.31% decrease in HC emissions were observed using M12 in comparison with G at lower and higher load respectively. M12 produced 32.52 % higher NOx emissions than that of G at lower load. The reduction in kinematic viscosities at 40C of lubricant oil was found 11.61% and 18.78% for M12 and G respectively. TAN, specific gravity, flash point and ash content of lubricant oil were observed 10.23%, 0.079%, 5.81% and 0.97% higher for M12 respectively. The lubricant oil composition could be developed in future for such fuels which may prolong its life cycle [7].

III. EFFECT OF FREE FATTY ACIDS AND METHYL TERT BUTYL ETHER

Biodiesel is a fatty acid methyl or ethyl ester derived from vegetable oils or animal fats. As a result, we may claim that the fatty acid ester contributes to the fuel's characteristics. The discussion in this section has been focused on the fatty acid content of bio-diesel fuel characteristics. The component's structure Fatty esters and the composition of its minor components have a significant impact on biodiesel characteristics such as ignition quality. oxidative stability of cold flow, viscosity, and lubricity These qualities are present when biodiesel is used as a fuel in a diesel engine. [22] The cetane number of various biodiesels generated from diverse feedstock ranges from 45 to 60. Cetane quantity varies due to chemical structure, oil processing technique, and the environment of the location where oil is gathered Both biodiesel composition and oxidative aging have been studied influencing the cetane number.[16] The calculated cetane number increases with oxidation depending on the state of oxidation. The cetane number of biodiesels increases with chain length and decreases with unsaturation. One long straight chain produces a high cetane number. The cetane number is influenced by alcohol when it is used in biodiesel production Methyl and other straight-chain alkyl esters

have a competitive cetane number with branched-chain alkyl esters. [21] ester revealed that saturated substances (stearic acid, palmitic acid, and oleic acid) Myristic acid, for example, has a high cetane number. Furthermore, owing to temperature variations, they tend to crystallize indefensibly. Some fatty compounds (particularly highly unsaturated esters) have lower cetane numbers due to the production of low cetane number molecules during pre-combustion. The manufacture of biodiesel from saturated oils with a higher cetane number (tallow and frying oil). The degree of unsaturation determines the carbon/hydrogen ratio of biodiesel from different sources will change somewhat. Approximately 10–12% (by weight) of Biodiesel includes oxygen, which is responsible for lower combustion heat and lower particle emissions. in comparison to diesel The calorific value, often known as the heat of combustion, is an essential fuel characteristic that indicates the quantity of energy used. the amount of heat released by the fuel inside the engine. Furthermore, the energy in chemical signals. The calorific value of a fuel, which defines its energy value, is an essential characteristic [9]. In general, as chain length rises, so does the heat of combustion. Cold flow characteristics such as cloud points and pour points are a key issue when using biodiesel as a fuel for engines. The change in feedstock affects the cold flow characteristics of biodiesel and is mainly influenced by the amount of fat saturation [19]. Because of their extremely low melting points, unsaturated esters function as solvents, whereas saturated esters dissolve in them. As a result, with decreasing temperature, unsaturated fatty compounds in a crystallization mixture crystallize at a lower temperature than saturated fatty compounds [15]. As a result, biodiesels with a notable quantity of saturated fatty components have a greater pour point and cloud point. Oil with a high saturation level Higher cetane number, higher cloud point fats includes coconut, palm, and animal fats. Flow, viscosity, and volatility The existence of crystalline crystals in biodiesel affectability and filterability. Furthermore, branching chain The addition of alcohol ester enhances the cold flow characteristics. The two primary fuel quality criteria are viscosity and density of biodiesel and diesel fuel. reachers investigated the viscosities and densities of eight methyl esters and seven ethyl esters at atmospheric pressure and temperatures ranging from 0oC to 90oC.[23] The results show that the viscosity For any ester decreases with unsaturation level and rises with ester chain length. In terms of fatty acid equivalents, The viscosity of methyl ester is lower than that of ethyl esters. The form and quantity of double bonds profoundly influenced the kinematic viscosity of unsaturated fatty molecules, even though the effect of double bonds is minor. Compounds with hydroxyl groups or free fatty acids have much greater viscosity [22]. Biodiesel has a greater energy density. fuel in terms of viscosity and spray penetration The greater viscosity of biodiesel prevents it from breaking. As a result of the spray jet, the size of the spray droplets grows. Because of the increased size of the spray droplets As velocity rises, resistance diminishes, preventing penetration [14]. Because fuel density has amazing features, the injection system, the pump, and the nozzles must be correctly set to deliver the proper amount of fuel for combustion [3]. Despite its higher density, biodiesel has a lower energy content than diesel. Consequently, that more fuel is injected, resulting in higher fuel consumption for biodiesel to get the same power. The iodine number of fuel is used to calculate the amount of unsaturation.

IV. CONCLUSION

Many experiments were conducted by researchers from many nations utilizing vegetable oils as I.C. engine fuel replacements. These findings demonstrated that, when utilizing vegetable oils, thermal efficiency was equivalent to diesel, with only minor power loss. The particle emissions of vegetable oils exceed those of diesel fuel. with a decrease in NOx The performance and emission parameters of vegetable oil methyl esters were equivalent to those of diesel, for example As a result, they may be called diesel fuel replacements. Raw vegetable oil may be used as a fuel in engines. diesel engines with a few minor tweaks The usage of vegetable oils as I.C. engine fuels can be quite beneficial. assisting the developed nations in lessening the environmental effect of fossil fuels Because biodiesel has the most promising characteristics, such as renewability, sustainability, and a lower environmental effect, it has the potential to play an important role in the transportation industry in the next years. It has all of the qualities of diesel but with some extra benefits. The performance and emission characteristics of biodiesel derived from various feedstocks influence the performance of The CI engine. A link has been found between the type of feedstock, the performance, and the emission characteristics of biodiesel. make it possible for us to manufacture more efficient gasoline Aside from this, another element that impacts biodiesel characteristics is, For example, the free fatty acid content of vegetable oils and fats. In comparison to unsaturated esters, greater saturated esters have a higher cetane number, a lower density, and a lower iodine number. Low carbon chain compounds have a greater density, while high carbon chain compounds have a lower density. The viscosity and cold flow characteristics of Unsaturated biodiesel are superior to saturated biodiesel, although it has poor oxidation stability. Biodiesel derived from Saturated feedstock emits less NOx while simultaneously being more resistant to oxidation. Because it is very viscous, it should be shown atomization is lacking. NOx levels are greater in lower carbon saturated esters than in higher carbon saturated esters. As a result, although slightly sacrificing the performance features of biodiesel, animal fat may be a superior alternative to minimize NOx emissions

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