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A Review on Performance and Emission Characteristics of Bio Diesel with Diesel Particulate Filter (DPF)

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ABSTRACT: As fossil fuels are fast diminishing in the atmosphere, the attention has shifted to alternative sources with sustainable development, energy conservation, efficiency, and environmental protection, which has become increasingly important in the current scenario. Biodiesel is an excellent natural source of alternative fuel that also has environmental benefits. Because diesel has become scarce and expensive in recent years, we have turned to biodiesel as a substitute. This research looks into the number of emission characteristics of bio diesel in the proportion 80:20, 70:30, 90:10 at various conditions and compared with diesel fuels. The biodiesels are blended in different ratios and to obtain a perfect blend. Comparatively the biodiesel emissions are lower compared to diesel emissions, to achieve further emission control Diesel Particulate Filter (DPF) is installed. After-treatment devices are required to meet current exhaust pollution rules, and Diesel Particle Filters (DPFs) are necessary to lower particulate emissions from diesel engines. Which reduces the particulate matter (PM) emissions. NO_x levels are higher, whereas HC, CO, and PM levels are lower. The best biodiesel-to-diesel mixture for CRDI engines was discovered to be B20.

KEYWORDS: Biodiesel, Diesel particulate filter (DPF), Emission, Hydro Carbon (HC), particulate matter (PM)

I. INTRODUCTION

Almost every country relies on petroleum fuel to meet their energy needs. The underground has been impacted by the increase in energy demand caused by population growth. Researchers are looking for alternative energy sources. [26] In recent years, indiscriminate mining and usage of fossil fuels has resulted in environmental damage and energy scarcity. Because of rising demand for fossil fuels and rising environmental costs, conventional energy is no longer the only option. Partially replacing fossil fuels is one method that blends with sustainable development and energy consequences. [8]. Every year, we consume the amount of more than 11 billion tonnes of oil in the form of fossil fuels. The world's crude oil reserves are depleting at a rate of 4 billion tonnes per year. If current trends continue, oil reserves will be depleted by 2052. [28] As a result, in the future, that safe option will be explored and exploited. Biofuel would be a primarily viable choice because it can be obtained from renewable resources [17,14]. For the compression ignition (C.I.) engine, blends of varied proportions of jatropha curcas oil and diesel were created, evaluated, and compared to diesel fuel. [29] Because biodiesel contains oxygen, combustion processes are more complete, leading in reduced CO, particle, and visible smoke emissions. [11]

Even though biodiesel has many advantages, because of engine problems its use is restricted to maximum 20% only [27] There are several challenges with using vegetable oils directly and using oil blends. Pyrolysis, It has been studied the splitting of animal fats into smaller molecules by using thermal energy and petroleum catalysts. [12]. Several technologies have been used to control the specific matter emission of diesel engine [15] To meet legal exhaust NO_x and PM emission limits, aftertreatment systems such as diesel oxidation catalysts (DOCs), diesel particulate filters (DPFs), and selective catalytic reduction (SCR) systems have become essential. [6]. Among these, DPF is rated as the best diesel after-treatment technology for meeting increasingly stringent emission standards. [15,13] Catalyst materials coated on DPF flow-wall substrates play an important role in improving soot oxidation activity during passive

regeneration of DPF. There are multiple catalysts for the oxidation of soot are being extensively reported in the literature, such as noble metal catalysts. [3] The research work has revealed that there are various issues related with the use of vegetable oil as a fuel in a diesel engine, [5] Basic or acidic catalysts is being used to carry out the transesterification reaction, however these procedures are time intensive and necessitate a complex extraction of the product and the catalyst. [11] Furthermore, all regeneration methods can only remove combustible constituents of the PM trapped in the DPF and cannot extract incombustible constituents that remains as ash. The DPF still needs to be disassembled after a long cycle of operation to clean out the leftovers in the filter. [2] Rose et al conducted another study. As the load increases, the volume of the soot particles tends to grow. When the exhaust gas recirculation (EGR) system was turned on, higher amounts of soot particles were found. [4] Park et al. (2009) investigated 20% biodiesel blend (BD20) fuel and its exhaust emissions and nanoparticles from diesel engine including warm up catalytic converter. At high loads, the maximum torque of BD20 fuel was determined to be somewhat lower than diesel fuel. BD20, on the other hand, had lower CO and THC emissions and greater NOx emissions than diesel fuel. BD20 was used to lower the total quantity and density of the material.[7] The lower CO, HC, and NOx emissions are encouraging to consider 5C5H as an optimum fuel blend for a compression ignition engine. [21] DPF's process can be split into three steps. The first is the filtering process, which involves soot particles from exhaust being deposited as it travels through a porous wall. The gathered soot particles can raise shear stress because the soot blocked at the conductive wall will obstruct the flow of the exhaust gas. As a result of this phenomena, fuel consumption will rise and engine performance will fall. engine power output is lowered [13]. In the second step, the regeneration process oxidizes the collected soot. The regeneration process will be started if the heat inside the DPF crosses 550°C. [14]. However, under the normal driving conditions, the exhaust gas temperature is only 100-200°C. As a result, the regeneration process can be carried out either effectively by electric heating or gradually through the use of a fuel-borne catalyst. The final step is to rearrange the ashes gathered in order to retain the efficiency of the following filtration process.

II. RESULTS AND DISCUSSION

The study by (yi guo and richard brown) investigates the impact of the physical characteristics of biodiesel particulate matter on the performance of diesel particulate filters (dpf). On a dpf, the filtration efficiency (fe) and pressure drop (pd) as a function of loading time were tested for a wide range of biodiesel fuels with molecular oxygen levels ranging from 0% (diesel) to 14%. The results showed that the fe is higher for smaller particles in all fuels, they discovered that fe for biodiesel particles was up to 10% lower than for diesel particles at the start of the loading process. [2] The research explored by (Li-Hao Young) analyzed the numerical emission characteristics of nonvolatile particles from a heavy-duty diesel engine operated in steady mode with multiple waste cooking oil biodiesel blends (B2, B10, and B20), engine loads, and waste cooking oil biodiesel blends (B2, B10, and B20) (25 % , 50 % , and 75 %), and a diesel oxidation catalyst plus diesel particulate filter (DOC + DPF). Irrespective of the biodiesel blend and engine load under consideration, the DOC + DPF exhibits exceptional filtering effectiveness for both core and soot particles.[4]

(Hailong Zhang) analyzed the influence of biodiesel impurities (Na, K, and P) on the non-catalytic and catalytic reactivity of diesel soot. TPO experiments revealed that deposits of Na and K in soot or on the catalyst surface improved the oxidative reactivity of soot in both the O₂ and NO_x + O₂ conditions. The addition of Na and K increased the structural flaws of soot and the catalyst's reduction ability, according to the results of this characterization. Additionally, Na/K-doped catalysts had a better ability to convert NO to NO₂. [3] The research by (Pingen Chen) has explored into the behavior of common-rail diesel engines and aftertreatment systems during active DPF regenerations using pure biodiesel and conventional diesel fuels. Engine-out THC emissions are significantly higher at late post injection timings than at early post injection timings for both fuels, while engine-out CO emissions peak in the middle of power strokes and engine-out NO_x emissions can be lowered with late-cycle post injection timings for both fuels.[6] The study conducted by (M. Singh and S.S. Sandhu) focused on the performance, emissions, and combustion characteristics of a four-cylinder turbocharged intercooled engine common rail direct injection engine fueled by argemone biodiesel-diesel blends. The biodiesel blends performed better at half load and high load than at low load. [5] An investigational study was conducted by (Ruban) on a low heat rejection engine using raw Jatropha oil in a 70:30 ratio with diesel. When using raw Jatropha oil and diesel, the experiments conceded for the cylinder pressures. The results have been obtained, and they identify the improved engine performance and emissions characteristics when using Jatropha oil. [1] The outcomes of an experimental study by (Suresh K. Aggarwal) on the oxidation behavior of diesel PM collected from a DPF test system connected to the exhaust stream of a 1.9 L, 4-cylinder, light-duty diesel engine are presented. Surrogate soot's oxidation rate decreases continuously as it oxidizes, whereas diesel soot's oxygen content is nearly constant until about 80% of the sample mass is oxidized, The sample's oxidation rate then lowers as it



oxidises fully. Furthermore, it is discovered that the oxidation behaviour of surrogate soot is considerably independent of the heat treatment techniques used, but that of diesel soot is heavily influenced by them. [28] An experimental investigation was conducted on the properties of the DPF system's active-passive component regeneration by (Jiachen Li). Several control characteristics of the DPF system, such as temperature distribution, pressure difference, and pollution emissions, are assessed for different reciprocating cycles. From the experimental results concluded that DPF system's operation performance can be influenced by the reciprocating cycles. The temperature profile advances parallel toward the downstream side as the reciprocating cycle lengthens, and the fluctuation range of CO, NO, and NO₂ components expands. [22] The ultimate goal of the paper which was investigated by (D. Buono) was to characterize the regeneration process of the DPF device based on the fuel used, taking into account the various combustion processes and particulate matter types. Overall, the results contribute to significant advantages for using biodiesel in engines with DPFs. [24] To regulate HC, CO, PM, and NO_x emissions from diesel exhaust gas, a prototype catalyst was created and installed into the aftertreatment exhaust system by (K. Theinnoi). With exhaust gas from a diesel engine running on biodiesel - Rapeseed Methyl Ester (RME) - the catalyst activity in eliminating HC and nano particles was investigated. The prototype catalyst's ability to reduce PM from biodiesel combustion was influenced by engine operating conditions and EGR. Increased PM concentration and modified PM composition, on the other hand, resulted in reductions of up to 50% and 30% in total particle number and mass, respectively, and especially total number was decreased to as low as 5%. The results indicated that the using of a prototype catalyst can improve aftertreatment system performance and pollution control. [25] The research done by (Puneet Verma) on the effects of biodiesel on the performance and emission characteristics of diesel engines was reviewed in this study. The main issue with using vegetable oil directly in engines is its higher viscosity, which can be solved by turning it to biodiesel via a transesterification reaction. The performance results showed that the majority of biodiesels provides the higher brake thermal efficiency and lower brake-specific fuel consumption. The results of the emissions showed that in most cases, NO_x emissions increased while HC, CO, and PM emissions decreased. The best biodiesel-to-diesel blend for engines was discovered to be B20. [26] The performance of biodiesel blends in a single-cylinder water-cooled diesel engine was presented in this paper by (Amar Pandhare). All experiments were conducted at a constant speed of 1500 rpm, with biodiesel blends ranging from B10 to B100. The engine had a differential compression ratio (VCR) mechanism. The results of experimental studies on the use of a Jatropha biodiesel blend in a single-cylinder diesel engine, the CO emissions were lower with Jatropha by 15%, 13%, and 13% at 1.5 kW, 2.5 kW, and 3.5 kW load conditions, respectively. The NO_x emissions were higher by 16%, 19%, and 20% at 1.5 kW, 2.5 kW, and 3.5 kW than that of the diesel, respectively. [27] The investigational study conducted by (Mohamad Azzad) examines the impact of Biodiesel impurities (Na, K and P) on the non-catalytic and catalytic reactivity of the Diesel soot was tested under model DPF (Diesel Particulate Filter) regeneration conditions. The addition of Na and K to soot boosted its non-catalytic and catalytic reactivity under both O₂ and NO_x + O₂ conditions, with the Na-doped specimen showed better results. Because of the elevated T50% value, the presence of P in soot or catalyst reduces reactivity. [13]

III. CONCLUSION

This research looks into the number of emission characteristics of bio diesel in the proportion 80:20, 70:30, 90:10 at various conditions and compared with diesel fuels. Biodiesel is a promising alternative fuel generated from various plant and animal materials. Biodiesel is blended with diesel to give diesel equipment many of the benefits of biodiesel while reducing the overall price of fuel. Because biodiesel contains oxygen, it promotes more efficient combustion, resulting in fewer CO, particle, and visual smoke emissions. The effects of biodiesel blend, engine load, and DPF on nonvolatile particle number emission characteristics in exhaust were investigated in this study. Through the usage of vegetable oils directly or in blends has a number of disadvantages, including the thermal cleavage of bigger molecules and the use of vegetable oils instead of petroleum catalysts. Controlling the specific matter emissions of diesel engines has been accomplished using a variety of approaches. DPF is rated as the best diesel after-treatment technology for meeting increasingly stringent emission regulations. From various investigations among the various blend conditions 80:20 is the blend most suitable to reduce the particulate matter and emission.

REFERENCES

- [1] Ruban, M., L. Karikalan, and Soumya Kanti Chakraborty. "Performances and emissions characteristics of diesel engine by using Jatropha oil." *Materials Today: Proceedings* (2020).
- [2] Guo, Yi, et al. "An experimental study of the role of biodiesel on the performance of diesel particulate filters." *Fuel* 247 (2019): 67-76.

- [3]. Zhang, Hailong, et al. "Effect of Biodiesel impurities (K, Na, P) on non-catalytic and catalytic activities of Diesel soot in model DPF regeneration conditions." *Fuel Processing Technology* 199 (2020): 106293.
- [4]. Young, Li-Hao, et al. "Effects of biodiesel, engine load and diesel particulate filter on nonvolatile particle number size distributions in heavy-duty diesel engine exhaust." *Journal of hazardous materials* 199 (2012): 282-289.
- [5]. Singh, Mandeep, and Sarbjot Singh Sandhu. "Performance, emission and combustion characteristics of multi-cylinder CRDI engine fueled with argemone biodiesel/diesel blends." *Fuel* 265 (2020): 117024.
- [6]. Chen, Pinggen, Umar Ibrahim, and Junmin Wang. "Experimental investigation of diesel and biodiesel post injections during active diesel particulate filter regenerations." *Fuel* 130 (2014): 286-295.
- [7]. Caliskan, Hakan, and Kazutoshi Mori. "Thermodynamic, environmental and economic effects of diesel and biodiesel fuels on exhaust emissions and nano-particles of a diesel engine." *Transportation Research Part D: Transport and Environment* 56 (2017): 203-221.
- [8]. He, Bang-Quan. "Advances in emission characteristics of diesel engines using different biodiesel fuels." *Renewable and Sustainable Energy Reviews* 60 (2016): 570-586.
- [9]. Barrios, Carmen C., et al. "Effects of animal fat based biodiesel on a TDI diesel engine performance, combustion characteristics and particle number and size distribution emissions." *Fuel* 117 (2014): 618-623.
- [10]. Sudalaiyandi, K., et al. "Performance and emission characteristics of diesel engine fueled with ternary blends of linseed and rubber seed oil biodiesel." *Fuel* 285 (2021): 119255.
- [11]. Dincer, K. "Lower emissions from biodiesel combustion." *Energy Sources, Part A* 30.10 (2008): 963- 968.
- [12]. Demirbas, A., and S. Karlioglu. "Biodiesel production facilities from vegetable oils and animal fats." *Energy Sources, Part A* 29.2 (2007): 133-141.
- [13]. Mokhri, Mohamad Azzad, et al. "Soot filtration recent simulation analysis in diesel particulate filter (DPF)." *Procedia Engineering* 41 (2012): 1750-1755.
- [14]. Czerwinski, Jan, et al. *Diesel emissions with DPF & SCR and toxic potentials with biodiesel (RME) blend fuels*. No. 2013-01-0523. SAE Technical Paper, 2013
- [15]. Li, Jiachen, et al. "Effects of different diesel particulate filter on emission characteristics of in-use diesel vehicles." *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects* 41.24 (2019): 2989- 3000.
- [16]. Hailong Zhang, Jishuang Hec, Shanshan Lid, Eduard Emil "Effect of Biodiesel impurities (K, Na, P) on non-catalytic and catalytic activities of Diesel soot in model DPF regeneration conditions." *Fuel* 285 (2021): 11925
- [17]. D. Buonoa , A. Senatorea, M.V. Pratib "Particulate filter behaviour of a Diesel engine fueled with biodiesel." *Applied Thermal Engineering* 49 (2012) 147e153
- [18]. M.A. Mokhri, N.R. Abdullah, S.A. Abdullah, S. Kasalong, R. Mamat "Soot Filtration Recent Simulation Analysis in Diesel Particulate Filter (DPF)." *Procedia Engineering* 41 (2012): 1750-1755.
- [19]. Jiachen Li, Yunshan Ge, Haohao Wang, Chao Yu, Xindi Yan, Lijun Hao, Jianwei Tan "Effects of different diesel particulate filter on emission characteristics of in-use diesel vehicles." *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects* 41.24 (2019): 2989- 3000.
- [20] [https://www.researchgate.net/publication/289268048 Diesel emissions with DPF SCR and toxic potentials with bio diesel RME blend fuels](https://www.researchgate.net/publication/289268048_Diesel_emissions_with_DPF_SCR_and_toxic_potentials_with_biodiesel_RME_blend_fuels)
- [21] K.V. Suresh , Peter Fernandes a , K. Raju b "Investigation on performance and emission characteristics of diesel engine with cardanol based hybrid bio-diesel blends." <https://doi.org/10.1016/j.matpr.2020.02.691>
- [22] Chong, H. S., Aggarwal, S. K., Lee, K. O., Yang, S. Y., & Seong, H. (2013). *Experimental Investigation on the Oxidation Characteristics of Diesel Particulates Relevant to DPF Regeneration*. *Combustion Science and Technology*, 185(1), 95–121. doi:10.1080/00102202.2012.709563
- [23] Li, J., Ge, Y., Wang, H., Yu, C., Yan, X., Hao, L., & Tan, J. (2019). *Effects of different diesel particulate filter on emission characteristics of in-use diesel vehicles*. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–12. doi:10.1080/15567036.2019.1582738
- [24] Chang, M.-C. O., & Shields, J. E. (2017). *Evaluation of solid particle number and black carbon for very low particulate matter emissions standards in light-duty vehicles*. *Journal of the Air & Waste Management Association*, 67(6), 677–693. doi:10.1080/10962247.2016.1268548
- [25] Theinnoi, K., Rounce, P., Tsolakis, A., Wyszynski, M. L., Xu, H. M., & York, A. P. E. (2008). *Activity of Prototype Catalysts on Exhaust Emissions from Biodiesel Fuelled Engines*. *SAE Technical Paper Series*. doi:10.4271/2008-01-2514
- [26] Verma, Puneet, and M. P. Sharma. "Performance and emission characteristics of biodiesel fuelled diesel engines." *International Journal of Renewable Energy Research* 5.1 (2015): 245-250.
- [27] Pandhare, A., & Padalkar, A. (2013). *Investigations on Performance and Emission Characteristics of Diesel Engine with Biodiesel (Jatropha Oil) and Its Blends*. *Journal of Renewable Energy*, 2013, 1–11. doi:10.1155/2013/163829



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