CHARACTERIZATION OF NANO-ADDITIVES FOR ENHANCED BIODIESEL PERFORMANCE IN A CI ENGINE

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Abstract

This document is a summary of the results of several studies that looked at how adding nanoparticles to diesel, biodiesel, and water-emulsified fuels affects the way a Diesel engine works and how much pollution it puts out. Two things can be done to cut down on the amount of harmful gases that a diesel engine puts into the air. The first step to reducing emissions is to put in devices that treat exhaust gases, like catalytic converters and diesel particle filters. If you do it this way, you'll get the best results. But the way these gadgets work makes diesel engines less efficient. Using a fuel additive is the second way to improve the efficiency of a CI engine and lower its emissions. Oxides of nitrogen (NOx) and particulate matter (PM) are the main pollutants that come out of diesel engines (PM). But it is hard to keep NOx and PM under control at the same time. Several researchers have found that using nanoparticle additives and fuels that have been mixed with water is the best way to improve engine performance while reducing emissions. This study also talks about biodiesel fuel, which can be made to act like diesel fuel by adding different kinds of nanoparticles. Many studies have compared the effects of diesel and biodiesel fuels on a wide range of factors, both on their own and with the addition of water and nano particles. Most studies show that adding nanoparticles to diesel and biodiesel fuel makes engines run better and reduces the amount of pollution they put out.

Keywords: - Biodiesel, Nano Additives, CI Engine.

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1. Introduction

Diesel engines are used a lot in the transportation and maritime industries, among others. In the last few decades, the availability of petroleum products has gone down due to more people living in cities and relying more on technology. This had a big effect on the pollution of the environment, so people had to look for other ways to get energy. Diesel is quickly becoming one of the best possible replacements for biodiesel because it is similar to biodiesel in so many ways. Biodiesel is mostly made from things that can be used again, like animal fats and oils that can be eaten or not. Biodiesel has been made mostly from vegetable oils like cottonseed oil, sunflower oil, coconut oil, jatropha, and pongamia in the last few decades. The main differences between diesel fuel and vegetable oil are its significantly higher viscosity, lower heating values, higher densities, increased stoichiometric fuel/air ratio due to the presence of molecular oxygen, and the possibility of thermal cracking when the fuel spray in diesel engines reaches high temperatures. Biodiesel is a type of oxygenated fuel that is made from vegetable oils and is refined. It usually has 10-15% oxygen by weight. People also say that the fuel doesn't have any sulphur in it. Because of this, biodiesel burns more completely and puts out less pollution than diesel fuel does. With the right amount of biodiesel to diesel, we could use less fossil fuels without changing CI engines, which would be good for the environment. Moreover today, fuels need a number of additives to work correctly. When you add fuel additives to a blend of biodiesel and diesel in a CI engine, the performance goes up, the combustion efficiency goes up, and the emissions go down. Fuel additives, which improve the quality of fuel, can be used to improve the way the fuel burns.

Publicly available information shows that people are trying to use clean biodiesel and make it more useful and efficient. You can check this out for yourself. In this study, biodiesel was made from oil from pongamia trees. Researchers looked at how well a compression ignition engine works and how much pollution it makes. Also, the results of adding a nano component to biodiesel were looked into. Based on the research in the relevant literature, it was planned to use different amounts of the additive, such as 40 ppm, 80 ppm, and 120 ppm, to see how the additive affected performance. Here, the supplement is ZnO nano fluid.

2. Related work

Gandhi Pullagura et al.(2021) In this essay, we will look at two different ideas about how nanoparticles in blends of biodiesel and diesel affect engine performance, combustion, and pollution. Also, the effects of adding nanoparticles to pure diesel fuel at different ratios of biofuel to diesel have been studied in depth. Several possible ways to make the engine run more efficiently have also been looked into. Nanoparticles can do many things in the process of making biofuels, from cleaning the feedstock to speeding up chemical reactions.

Lv et al.(2022) This report gives an overview of recent research about whether or not nanoparticles could be added to diesel-biodiesel fuel blends. In the first half of the article, the amazing properties of nanoparticles are discussed at length. Then, the methods used to make them are summed up and analysed. In the second part of this study, the effects of the different nanoparticles used in diesel-biodiesel fuel blends are looked at. The presence of these nanoparticles changes the thermal efficiency of combustion, the amount of fuel used by the brakes, and the CO and NOx emissions. Nano-additives will finally be talked about in terms of how they affect internal combustion engines, ecosystems, and human health.

Mukul Tomar et al.(2020) Nanofuel improves the thermal efficiency and specific fuel consumption of diesel engines because it has a better surface-to-volume ratio, better heat and mass transfer properties, and is a catalyst. Based on research that has already been done and published, it has been decided that mixing nanoadditives has a big effect on engine parameters. The paper also says that the amount of nanoparticles affects the injection time, changes in the physical and chemical properties, and cold flow parameters like viscosity, calorific value, flash point, and fire point. Some of the things that were talked about in the review are listed above.

Yusof et al.(2020) The main goal of this study is to put together recent information from studies that looked at how nanoparticles affect the quality of fuel and how well it burns in internal combustion engines. We also compare and contrast the effects of different additives that have been put into different kinds of fuel. In the end, the possible uses and benefits of nanofluids as an alternative fuel have been laid out so that more research can be done on them.

Ahmed MM et al.(2022) biodiesel as a way to deal with problems caused by using fossil fuels in I.C. engines (CI engines). In the current study, a compression ignition (CI) engine is powered by waste cooking oil biodiesel (WCME) with nano-added titanium oxide (TiO2). Both how well the engine works and what kind of pollution it puts out are studied in depth. After 50 and 100 ppm of TiO2 were added, the WCME mixtures were stirred with magnets and then shook with ultrasonic waves.

3. Methodology

A nanofluid is what you get when you spread nanoparticles throughout a liquid. When nanotechnology is applied to fluids, it takes on a new meaning, which is what the word "nanofluid" means. The way nanofluids are made is shown in Figure 1. Nanofluids need to be made and characterised because the different nanomaterials have a huge effect on how they spread out and stay stable. In recent years, a lot of research has been done on the possible uses of nanoparticles. They have been able to change the size, shape, and number of holes in nanoparticles while also making their physical and chemical properties better. So, it is very important to choose the right way to make nanofluids. Synthesizing nanofluids has been done in one step, two steps, and more recently, in new ways.

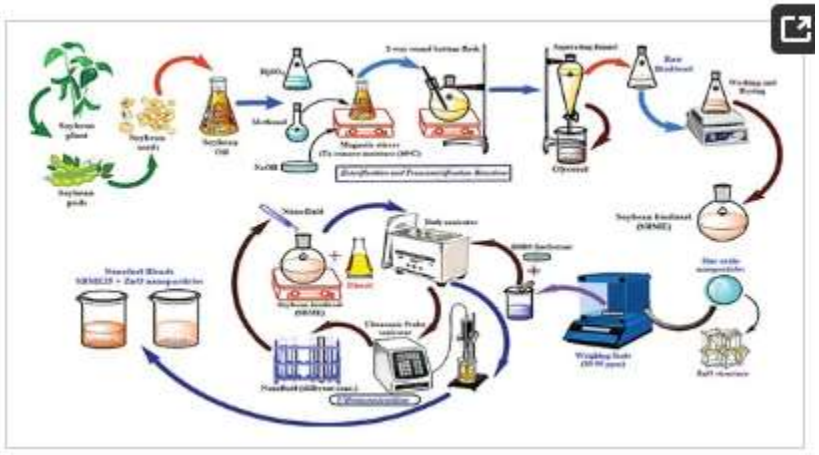

Figure 1. When solid nanoparticles are added to the base fluid, the new NF value is:

3.1 A simple, one-step process for getting ready

For the one-step method, the nanoparticles and the base solution are mixed together at the same time. Here are some of the most important benefits of the streamlined process: (1) It's easy to make and doesn't need to be dried, stored, or spread out, which keeps the cost of making it low compared to other methods. (2) Because nanoparticles don't stick together too much, the one-step method makes nanofluids that stay stable for a long time. Nanofluids are now mostly made using nanoparticle synthesis methods like direct evaporation, vapour deposition, laser ablation, and submerged arc welding instead of the old one-step method. The ferromagnetic metal super-particles with a size of 0.25 nm were made in a single step using vacuum evaporation. Laser ablation, a method that doesn't need dispersants or surface agents, was used to make nanoparticles that were between 9 and 21 nm in size. build a submerged arc nano synthesis system based on gas coalescence. A dielectric liquid made it easier for the system to make copper nanoparticles by making copper aerosols quickly stick together into nanoparticles. After that, when the nanoparticles were mixed with the dielectric liquid, metallic nanofluids were made. Most of the time, this method is used to make nanoparticles of copper, copper oxide, cuprous oxide, and copper phase, which are then dissolved in a dielectric liquid to make metal nanofluid.

3.2 Step-by-step directions on how to cook food

In the two-step method, nanoparticles and the base fluid are made separately and then put together. The first step of a two-step process is to make the nanoparticles. The two-step method is the most common and frequently used way to make nanofluids. This is because the nanofluids it makes are stable and good at spreading out. At the moment, there are mainly two ways to make nanomaterials: from the bottom up and from the top down.

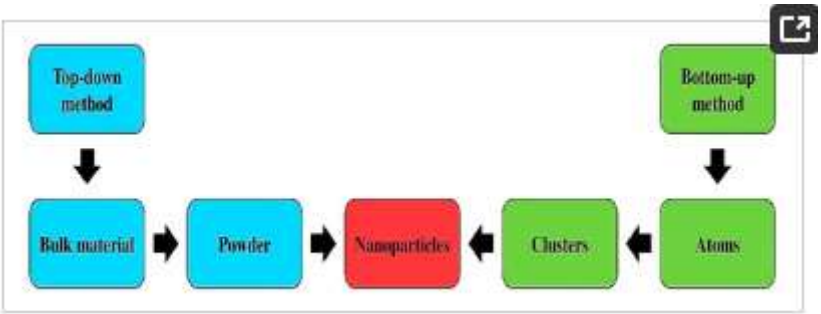

Figure 2. The process of synthesis

A bottom-up method is when you start with atomic building blocks and work your way up to nanoparticles. Pyrolysis, biosynthesis, chemical vapour deposition, and sol-gel are some of the most common ways. Scientists today prefer the sol-gel method because it has many benefits, like being easy to use, scalable, and manageable. When zinc acetate (Zn(CH3COO)22H2O) was used as the starting material, ethanol (CH2COOH) was used as the solvent, and sodium hydroxide and distilled water were used as the media, successful results were found. Using the sol-gel method, ZnO nanoparticles with sizes between 81.28 and 84.98 nm were made. The sol-gel method was also used to make nanoparticles of nickel oxide (NiO). Thermochemical vapour deposition with gold nanoparticles as a catalyst was used to make single-walled carbon nanotubes. By adding microorganisms, plant extracts, fungi, and precursors to biosynthesis, non-toxic, biodegradable nanoparticles can be made that are safe for the environment.

In the top-down method, materials that are bigger than nanoparticles are broken down to nanoparticles. Most of the time, techniques like mechanical grinding, nanolithography, laser ablation, and thermal breakdown are used in this process. One physical way to make nanoparticles is to use a machine to grind up big pieces of material into smaller ones. Plastic deformation is used to reach the goals of the method. Nanolithography is a technology that uses cutting-edge photolithography to shrink the size of large materials from microns to tens of nanometers. Nanolithography is a large group of techniques that includes electron beam, optical, nanoimprinting, multiphoton, and scanning probe lithography. Using laser solution ablation to make nanoparticles of precious metals is usually more reliable than the more common chemical reduction methods. Table 1 has a list of all the different nanoparticles based on performance & Emission

Table 1: Classification of nanoparticles based on performance.

Additives	**Fuel**	**Performance**	**Emission**
Nanosized Zinc Oxide, Diethyl Ether	Mahua Biodiesel-Diesel Blend	Improved Brake Thermal Efficiency, Indicated Mean Effective Pressure, and reduced Specific Fuel Consumption	Reduced CO, UBHC, Smoke, and NOx emissions
Titanium Oxide, Zirconium Oxide, Diethyl Ether	Biodiesel-Ethanol Blend	Improved Brake Thermal Efficiency, Indicated Mean Effective Pressure, and reduced Specific Fuel Consumption	Reduced CO, UBHC, Smoke, and NOx emissions
Various Nano Additives	Diesel-Biodiesel Blend	Improved Engine Performance, Stability, and reduced Emissions	Reduced CO, UBHC, Smoke, and NOx emissions
Nano Additives	Biodiesel-Diesel Blend	Improved Engine Performance and Emission Characteristics	Reduced CO, UBHC, Smoke, and NOx emissions

3.3. Efforts to find a better way to do things

Scientists have also made nanofluids by mixing two or more nanoparticles together, which has led to some amazing results. In recent years, there has been a lot of interest in hybrid nanofluids because they might be able to improve the chemical and thermophysical properties of single-phase nanofluids. Adding cerium oxide nanoparticles and carbon nanotubes to diesel, biodiesel, or ethanol would change how the engine works and how much pollution it puts out. Scientists found that nanoparticles of cerium oxide acted as oxygen supply catalysts, which led to the oxidation of CO and the decrease of NOx. When cerium oxide is turned on, carbon deposits in the cylinder are removed. This causes HC and smoke emissions to go down by a lot. When these nanoparticles are used together, it's possible that they could help create clean combustion, which would lead to less pollution.

4. Conclusion

Biodiesel made from pongamia was used in the experiments, and ZnO was the nano-fluid of choice. There was a focus on how well it worked and how much pollution it made. From the results of the experiment, we can figure out the following:

- The lower heat value of B20 is a side effect of the fact that it is less efficient and uses more energy.
- When nano fuel additives are added to biodiesel, it works much better as a heat source than biodiesel that hasn't been changed.
- The thermal efficiency of the brakes was improved by 2.06% when B20+80ppm was used instead of diesel at full load.
- It has been found that B20+80ppm gives off less CO than diesel. Compared to diesel, the amount of carbon monoxide that went into the air was cut by 25%.
- When compared to diesel and other biodiesel nano-fuel additives, the HC emissions from B20+80ppm are the lowest that can be reached.
- The results show that both B20 and all other biodiesel nano fuel additives produce more NOx than diesel running at full load. The lowest value for emissions was found for B20+80ppm. B20+40ppm and B20+120ppm also had low values, and diesel had the highest value. This is because the temperature of the fire went up.

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