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Impact of CNTs on CI Engine Effectiveness and Emission Test Using a Blend of Diesel and Neem-Biodiesel

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Abstract *– Finding an alternative fuel is crucial to combating air pollution, one of the biggest environmental problems facing humanity today, and reducing reliance on foreign sources for conventional fuel. Biodiesel represents one such substitute. For example, carbon nanotubes (CNTs) are added to nanoparticles to enhance their functionality and reduce greenhouse gases. A comparative analysis of different blends was completed using diesel as the baseline. CNTs at concentrations of 25 ppm and 50 ppm were combined with B0, B10, and B20 biodiesel. Graphs comparing the blends' effectiveness, burning, and emissions features were made after measurements were obtained for each blend at different loads. When CNT (25 ppm) was added to B20 biodiesel, improvements in BTE and reduced emissions were noted, as well as enhanced burning when compared to diesel.*

Keywords –CI Engine, Emissions, Performance, Carbon Nanotubes, Biodiesel.

1. INTRODUCTION

An increase in energy demand brought on by the population growth is generating air pollution in the atmosphere. Furthermore evident is the fact that the depletion of fossil fuels has led to a decrease in their use as long-term energy sources[1]. Combustion of fuels produces the majority of energy in various ways. Given that fossil fuels are essential to everyone's livelihood and are used in a variety of activities, their controversial use has made fossil fuel depletion a major concern for people worldwide. In parallel, the widespread use of diesel fuels has led to a sharp increase in lung diseases and cancer invasion [2]. It is imperative that the alternative fuel be well researched.

Under this scenario, study on alternative fuels makes sense because it has the potential to significantly advance the development of alternate carbon life cycles, renewable energy sources, and environmental protection. Plant- and animal fat-based bio-origin alternative fuels can help ease the world's petroleum problems.

Utilizing biomass to prepare biofuel can serve as a substitute fuel. Oil seed is used to obtain vegetable oil. In the current work, biofuel is derived from neem (Azadirachta indica) seed oil. The issue with biofuel is that it contains a higher concentration of free fatty acids, is volatile, has a low pour point, a low calorific value, is dense and viscous, emits more NOx, takes longer to ignite, and has poor combustion characteristics [3, 4].

Trans-esterification drastically reduces the oil's viscosity and mass and removes glycerol from it [5]. However, mixed fuels have drawbacks such as a longer ignition delay. This frequently leads to rough engine performance and increased heat release CN is a crucial CI engine characteristic. It is this that causes the gasoline to ignite [6]. Several gasoline additives are being utilized to overcome these blended fuel disadvantages. Among these are nanoparticles.

In this study, MWCNTs is added to biodiesel to enhance its performance and emission characteristics. A appropriate amount of carbon nanotubes (CNT) can be dispersed into fuels to shorten the evaporation period which shortens the ignition delay and reduces emission [7]. Because CNTs have good stabilities and high heat conductivity, they are used as a catalyst here [8].

1.1 Objective of This Paper

The use of nano-materials in diesel and bio-fuel blends is the subject of this study.Furthermore, the present study offers a comprehensive and perceptive summary of the properties of fuel, engine performance and emissions analysis at different ratios of nanoparticle addition to biodiesel blends.

1.2 Use of Nanoparticles in Mixes of Biofuels.

The attributes of FP, CN, and KV are improved in biodiesel and biodiesel-diesel mixed fuels by the use of metallic-based nanoparticles. SO2, CO2, and CO are reduced by metallic additions such magnesium, manganese, calcium, and copper. CuO and Al2O3 nanoparticles contribute to improved diesel combustion properties. Researchers' interest in Multi Walled Carbon [9]. Nanotubes (MWCNTs) is another metallic addition that has grown recently. The properties of injection and combustion of biodiesel fuels are believed to be significantly impacted by MWCNTs. These nanoadditives raise the fuel's ignition temperature in the combustion zone, lengthen its ignition delay, and enhance heat transmission between fuel droplets[10].

On the other hand, the CNT contribution increased the temperature of the gas after burning, which worsened the NOx emissions.

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1.3.Nanoparticles' Impact on Fuel Properties

The fuel's attributes have a big impact on both the way it burns and the fuel's quality. The addition of nano compounds has emerged as a practical method for improving fuel characteristics in recent years. Different kinds of nano-particles have been used in numbe of studies to analyze fuel properties in various biodiesel-diesel mixtures. The quality of the fuel was also evaluated by air-fuel mixing, which defined the quality of combustion, using physiochemical properties such as KV, CV, FP, density, cetane number, and other metrics.

Table I. Worldwide Energy Usage

Sources	2012		2019		2035 (Predicted)	
	Mtoe	Share (%)	Mtoe	Share (%)	Mtoe	Share (%)
Oil	4130	33	4610	33.04	4967.30	28.28
Natural gas	2987	24	3378	24.26	4631.00	4631.00
Coal	3730	30	3770	27.03	4343.00	27.00
Nuclear	2987	24	3378	24.26	4631.00	26.35
Hydro power	831	7	899	6.46	1245.80	7.10
Renewable	237	1	692	4.95	1118.90	6.35
Total	12477	100	13944	100.00	17566.00	100

1.4 Neem Biodiesel

When incorporated into a comprehensive plan, neem tree utilization have a major impact on equitable development. Neem promotes equitable development in a number of ways, including enhanced human health, environmental protection, and improved pest and nutrient management. Pesticides made from neem, which eradicate almost 500 pests worldwide, are far safer and better for the environment than synthetic ones.

Chemical insecticides function by targeting the pest's intestinal and cognitive systems. However, neem components influence the genital system of a caterpillar, preventing the resistance from growing in subsequent generations. Neem's constituents change how organisms develop, therefore it is impossible to nurture, nurture, or change insects. With its plethora of organic uses, such as farming, it practically takes on the role of sustainable agriculture.

It has high concentrations of nitrogen (2 or 3%), phosphorus (1%), and potash (1.5%). Researchers investigated the impacts and economics of using fertilizers made from neem cake, such as superphosphate, urea, etc.

Fig. 1. Neem seeds.

Fig. 2. Neem biodiesel.

1.5 Additive

The newest study results were released, and they relied on optimizing different metallic nano-metals as bio-fuel and diesel fuel additives in order to improve the engine's burning and pollutant properties. This work aims to investigate the effects of using MWCNTs as a catalyst on the effectiveness burning attributes, and pollutant attributes of a gasoline engine operating on clean neem bio-diesel fuel.

The inclusion of CNTs did, however, also quicken the rate of pressure rise.

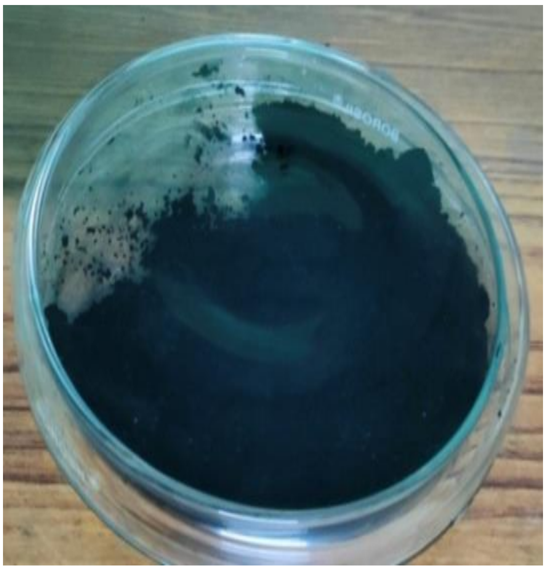

Fig. 3. MWCNTs.

2. FUEL PREPARATION

MWCNTs nanoparticles were added to blends of commercially available biodiesel in different amounts (25 ppm and 50 ppm) for experimental purposes. Eventually, the mixes' engine output and emissions were analyzed and contrasted with those of diesel.

Vegetable oil that is neat lacks the necessary chemical and physical characteristics.Trans-esterification of neem-oil was done in a lab.

Fig. 4. Ultrasonic probe sonicator.

3. TEST SETUP

The following are supported by the design: FP, specified power, BTE, BSFC and IMEP.

Fig. 5. Setup of engine.

4. RESULTS AND DISCUSSION

In the current work, it was generated using a two-stage trans-esterification process with additions of CNT nanoparticles and diesel.

The stochastic diffusion of nano-metals in mixes was confirmed using TEM on HRTEM, JEOL GEM 2100, at IIT Delhi.Fig. displays a TEM image of the distributed MWCNT nanoparticles.

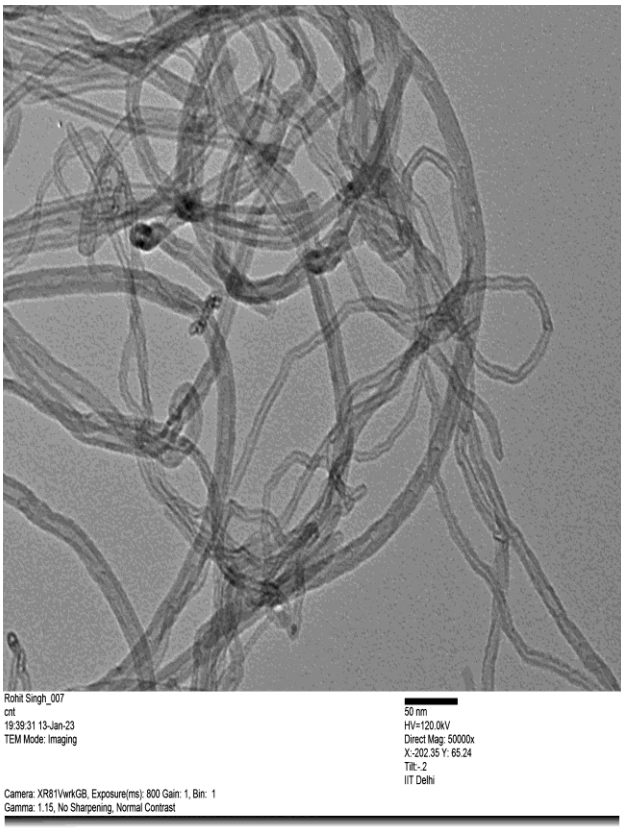

Fig. 6. TEM image.

4.1 Properties of Different Blends

a). CalorificValue: How much heat energy is released when a fuel unit mass is completely burned

Table 2. CV of different mixture.

S.N.	Samples	CV (KJ/KG)
1	B-0	42698
2	B-10	41685
3	B-20	41553
4	B0-C25	41757
5	B10-C25	42956
6	B20-C25	43872

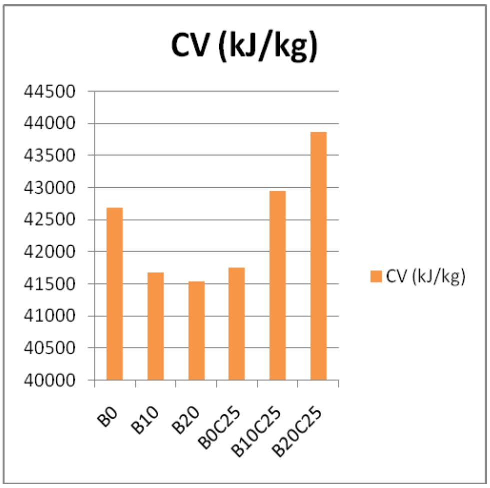

Fig. 7. CV of different blends.

The graph above shows that the CV of diesel is 42698 kJ/kg, but that number gradually rises with the addition of nanoparticles.

b). Kinematic Viscosity: In this example, kinetic viscosity is used to determine the different diesel and biodiesel formulations. A fluid assesses its intrinsic flow resistance when it is only subjected to gravity.

Table 3. KV of different blends.

S.N.	Samples	Result (CST)
1	B-0	3
2	B-10	2.9
3	B-20	2.8
4	B0-C25	3.2
5	B10-C25	3.3
6	B20-C25	3.5

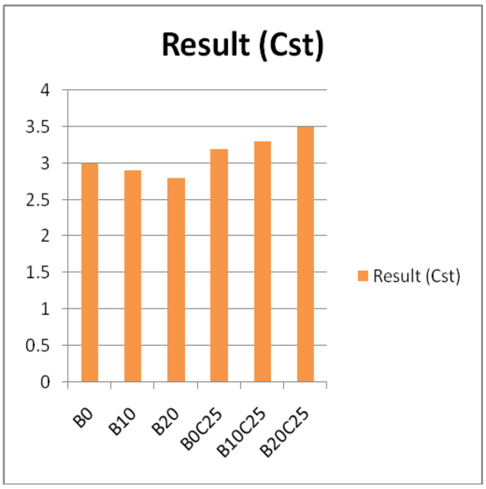

Fig. 8. KV of different blends.

The displayed curve for mixing biodiesel shows that the addition of nanoparticles raises the KV of the mixes. Combining nanoparticles always results in an increase in KV, while it occasionally decreases.

4.2 Effectiveness Test

a). BTE: BTE=BP/(fluid-mass*CV).

Table 4. BTE of distinctive blends.

CR 16	0 PPM			25 PPM		
	8 -kg	10- kg	12- kg	8- kg	10 -kg	12-kg
B0	26.2	27.87	28.32	26.84	28.614	29.098
B10	24.35	25.9	26.77	24.983	26.612	27.538
B20	24.27	25.23	25.88	24.844	25.959	26.638

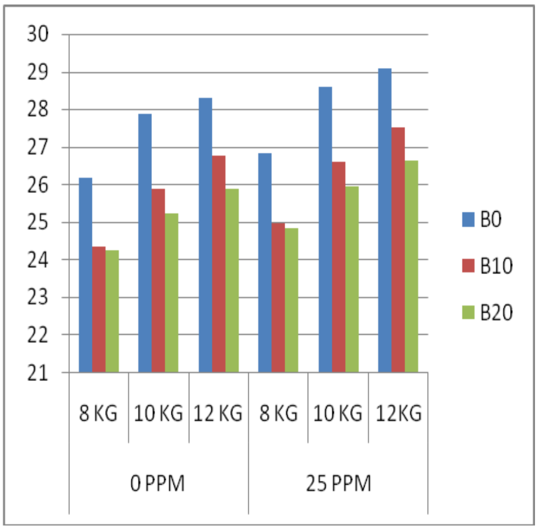

Fig. 9. BTE vs loads.

When CNT nanoparticles are introduced to different blends under high loads, BTE keeps getting better.

b).BSFC:

BSFC = BP/ (FC*CV)

Table 5. BSFC of different blends.

CR 16	0 PPM			25 PPM		
	8 -kg	10- kg	12- kg	8- kg	10 -kg	12-kg
B0	0.26	0.252	0.245	0.2486	0.240	0.233
B10	0.29	0.282	0.275	0.278	0.270	0.263
B20	0.32	0.314	0.307	0.308	0.301	0.294

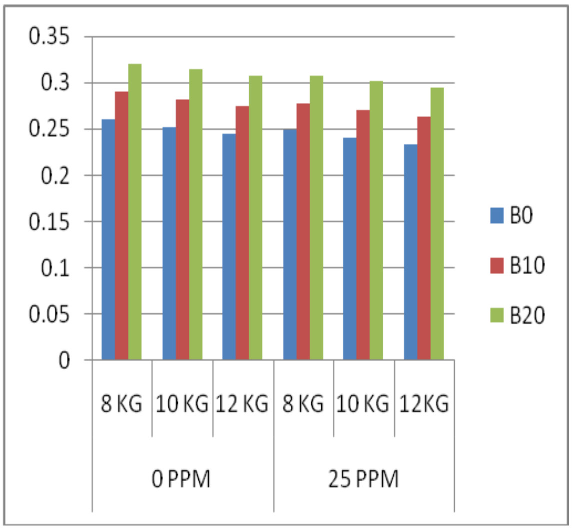

Fig. 10. BSFC vs loads.

When fuel is mixed with nanomaterials, the peak load-based fuel economy (BSFC) value gradually decreases.

4.3 Emission Test

a. Carbon Monooxide Emission[mg/nm^3]: It influences the quantity of greenhouse gases, which are connected to both global warming and climate change.

Table 6. CO emission of different mixture.

CR 14	0 PPM			25 PPM		
	8 -kg	10- kg	12- kg	8- kg	10 -kg	12-kg
B0	0.38	0.37	0.355	0.345	0.339	0.324
B10	0.33	0.31	0.3	0.295	0.283	0.273
B20	0.29	0.275	0.267	0.258	0.251	0.243

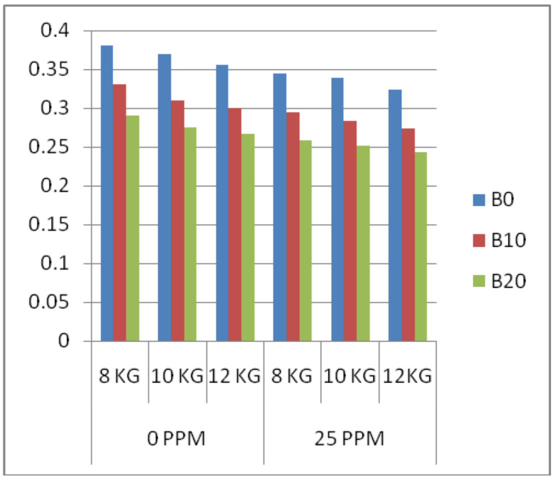

Fig. 11. CO vs loads.

5. CONCLUSION

A. The maximum CV for 20-B with CNTs at 25 ppm is 43872 kj/kg weight; the maximum CV for diesel is 42698 kj/kg.

B. Diesel has a KV of 3Cst, while the blend 20-B with 25 -ppm MWCNTs has its greatest KV at 3.5Cst.

C. When comparing blend 0-B containing CNT nanoparticles at a 25 -ppm dosage to diesel at a 12 kg load, the greatest BTE is 29.098%.

D. The B-0 mix with C-25 ppm has a lesser BSFC of 0.233 kg than regular diesel when using a 12-kilogram load.

E. The CO emission that is lowest when comparing 20-B with 25-Cppm to 0-B at 12 kg load is.243 mg/nm3.

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NOMENCLATURE

CNT: Carbon Nano Tubes
BTE: Break Thermal Efficiency
IC Engine: Internal Combustion Engines
KV: Kinematic Viscosity
CV: Calorific Vlaue
CO: Carbon Monooxide
BP: Break Power
FC: Fuel Consumption
MWCNT: Multi Walled Carbon Nano Tubes
TEM: Transmission Electron Microscope
BSFC: Break Specific Fuel Consumption
FP: Flash Point
CN: Ceten Number

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