DEEPAK KUMAR T
NARAYANASWAMY K M
DHANANJAYA D.A
and
RAMESHA D.K

Performance and emission characteristics of a diesel engine using biodiesel blended with nano additives

Economic uncertainty, price escalation and depletion levels of fossil fuels increases the day-to-day need to look for alternative fuel to meet the world's energy needs. Biodiesel provides the best choice for energy in new world. Biodiesel can be a diesel fuel replacement. In this research, Biodiesel is made with the combination of cottonseed oil and diesel. To stabilize biodiesel and boost its properties, nano particles are added to improve fuel quality. In this study, Silicon oxide is mixed with biodiesel, evaluated and compared to existing diesel with its engine performance, and emission characteristics. Cottonseed oil biodiesel blends improved in properties high calorific value fuel attainment and elimination of toxic exhaust emission forming to the atmosphere by added silicon oxide nano particle promising technique for biodiesel/diesel use.

Keywords: Biodiesel, diesel engine, performance, emissions, silicon oxide nano particles, metal oxide.

1.0 Introduction

In order to meet the demands of vehicle users, fossil fuels are increasingly declining and therefore need a change to alternative energy sources [1]. China, the United States, and India make full use of~23, 17 and 9% of global energy demand, respectively [2]. The only substantial source of increasing energy demand was fossil fuels like coal, oil and gas [3]. Less energy supply availability contributes to the increase prices, which is an economic provocation, especially in the undeveloped countries [4]; the most permanent problem remains the environmental harm due to the use of fossil fuels. The fossil fuel emits hazardous gases as CO_2, CH_4, SO_x, NO_x etc, acid rain, global warming and climate change [5]. Researchers have been strongly committed to implementing effective systems that can meet the demands of energy without negatively influencing the climate [6]. The economic and environmental substitute of expanding energy security is renewable, alternative, energy resources such as hydro, wind, solar and biomass [7]. Biofuel may be sourced from living or organic (biological) organisms [8]. In addition, biodiesel fuel has more O_2. This contributes to better combustion compared to diesel and decreases thereby particle pollution, CO and hydrocarbons [9]. Examination of the diesel engine characteristics for various fractions of Diethyl ether (DEE) in cotton soils as an oxygen additive biodiesel combines leading to BTE reduction at maximum load, increases BSFC and NO_x [10]. The study focuses on advancement in biofuel technology in recent time. A particular emphasis has been put on the role of silicon oxide. Nano additives for the enhancement of engine performance and reduces emission characteristics.

Messrs. Deepak Kumar. T, Research Scholar, Department of Mechanical Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore 560001, Narayanaswamy K M, Associate Professor, Department of Mechanical Engineering, G. Madegowda Institute of Technology Bharathinagara 571422, Dhananjaya. D.A,Vice Principal, Department of Mechanical Engineering, Rajeev Institute of Technology, Hassan 573201 and Ramesha D.K, Professor, Department of Mechanical Engineering, University Visvesvaraya College of Engineering, Bangalore University, Bangalore 560001, India. E-Mail: deepu.doit@gmail.com

2.0 Fuel preparation with silicon oxide

2.1. Characterization of Nano Additives

Several articles were studied based on biodiesel with additives used in diesel engine. To boost performance and reduce the emissions of adding additives in the biodiesel the main problems in the biodiesel are the lower heat value and higher viscosity than the convention in diesel engine. The addition of silicon oxide to diesel substantially reduces the weighted size in number substantially improved distributions and oxidation rate. Silicon oxide is an outstanding earth metal that has an exceptional catalytic activity because of its oxygen defending capability; nano research lab produces silicon oxide particles. Nano particle characteristics as presented in Table 1. The scanning electron microscope detects silicon oxide nano particle composition at magnification of 150.00KX as shown in the Fig.1.

2.2. Preparation of biodiesel blends

The blending of biodiesel in cotton is primarily carried out by the method of sonicisation (Fig.2). The ultrasound mixture enhances mass transfer and kinetic reactions, resulting in quicker transesterification. Higher yield prepared with 50-ppm

Table 1: The characteristics of silicon oxide

	Parameters	Silicon oxide (SiO_2)
1	Manufacturer	Nano research lab
2	Chemical name	Silicon oxide
3	Form colour	Powder white
4	Particle size	25-50 mm
5	Specific surface area	250 m_2/g
6	Molecular weight	60.08 g/mol

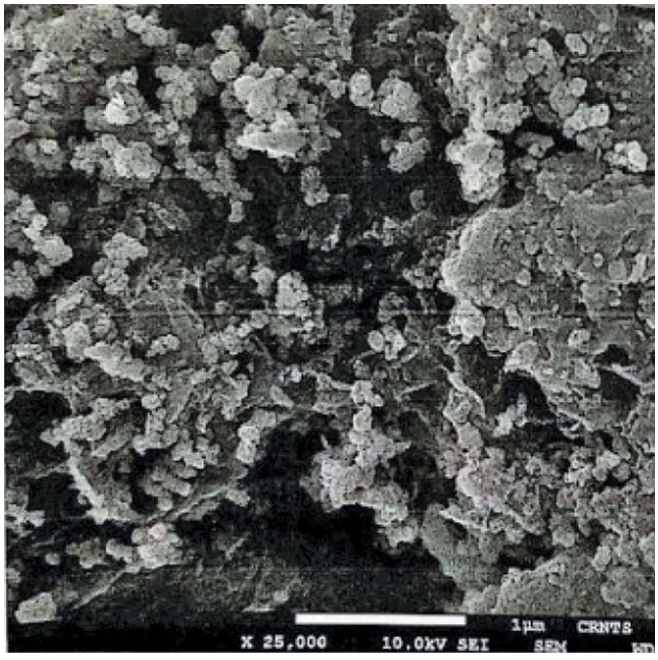

Fig.1: SEM image of SiO_2

addition, with various blending ratios B10, B20, B30, and B40. Nano particles in silicon oxide mixed and investigated via a sonication process. Table 2 shows contains blended biodiesel at various proportions. The parameters of cottonseed bio diesel are presented in Table 3 by use of an ultrasonicator for equal dispersion of biodiesel and nano particles.

Table 2: Contains blended biodiesel at various proportions

	Diesel	Cotton seed oil	Silicon oxide (SiO_2)
1	90%	10%	50 ppm
2	80%	20%	50 ppm
3	70%	30%	50 ppm
4	60%	40%	50 ppm

Fig.2: The engine setup

2.3. Experimental set up

The experiment was performed using a Kirloskar diesel engine. In a diesel experiment the findings were analysed, tabled and compiled in graphs for discussion, as the basis reading and four additional fuels, the engine was run by the five fuels from 0 to 100 per cent load. The engine specification is illustrated in Fig.3 and Table 4.

3. Result and discussions

3.1 Brake thermal efficiency

Fig.4 shows that B40 csme+50ppm, B30 csme+50ppm and B20 csme+50ppm are thermal brake efficiency increases, the results (BTE) suggest a higher efficiency. Increased efficiency because enhancer of oxygen maximising biodiesel combustion process, the efficiencies of 7.5%, 10.6% and 21.3% compared to diesel fuel.

3.2 Brake specific fuel consumption

Less specific biodiesel fuel consumption. Increasing the cotton oil content compared to diesel, fuel consumption dropped by 11.5 per cent. Due to higher impact combustion, silicon oxide mixes less fuel to provide additional brake power, with Nano additions. The B30 csme+50ppm mix has highly specific diesel fuel consumption (Fig.5).

Table 3: The properties of cottonseed biodiesel is tabulated

Parameters	Diesel	B10+SIO50	B20+SIO50	B30 +SIO50	B40+SIO50
Calorific Value (kj/kg)	44800	42434	42012	41534	41054
Flash Point (°C)	51	104	106	110	116
Kinematic Viscosity at 40°C (cSt)	3.12	3.45	4.87	5.05	5.43
FFA (%)	0.02	0.09	0.08	0.073	0.07
Density at 15°C (g/CC)	0.831	0.843	0.852	0.862	0.871

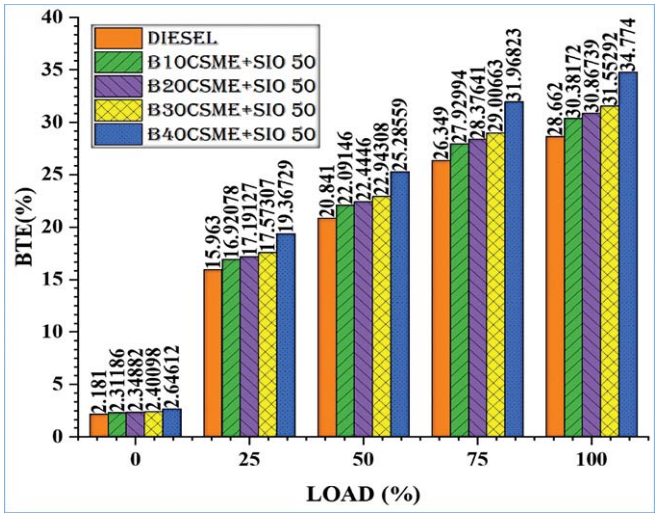

Fig.3: Brake thermal efficiency against load

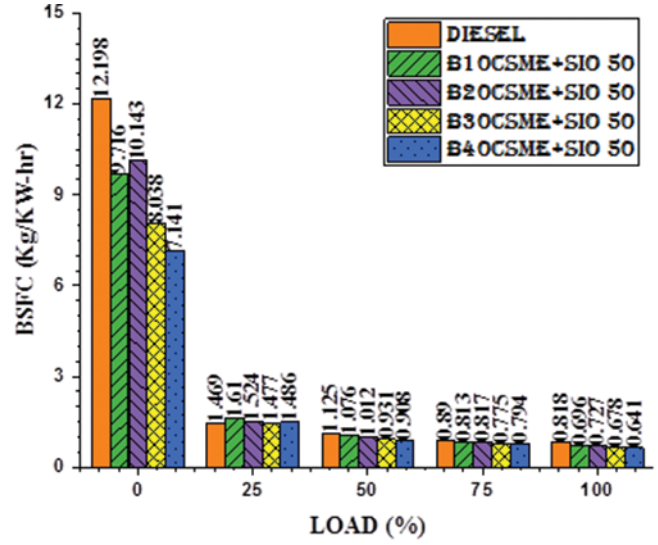

Fig.4: Brake specific fuel consumption against load

3.3 NO_x EMISSION

Fig.6 noted a reduction of the production of hydroxyl radicals (OH) during the combustion process by the addition of biodiesel silicon oxide. This decrease in OH-radicals reduces CO and HC oxidation within the combustion chamber resulting in low temperatures and high NO_x emissions for all bio-diesel additions of antioxidatives.

3.4 CO EMISSION

B10 csme+Sio50ppm, B20 csme+Sio50ppm, B30 csme+ sio50ppm B40 csme+sio50ppm have least CO emission At 75% and 100% load, respectively. Reduction of biodiesel emissions compared to diesel. Silicon oxide improves the fuel's characteristics. The combustion of this increased oxygen presence leads to less emission of carbon monoxide. Biodiesel has a lower CO emission than diesel by up to 36.3 per cent. Fig.7 shows the investigation of emissions of carbon monoxide (CO).

TABLE 4: THE SPECIFICATION OF ENGINE

Description	Parameter/values
Engine	Make Kirloskar, power 3.5 kW at 1500 rpm, stroke 110 mm bore 87.5mm. CR17.5
Dynamometer	Type eddy current, water-cooled
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Rotameter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Overall dimensions	W 2000×D2500×H1500 mm

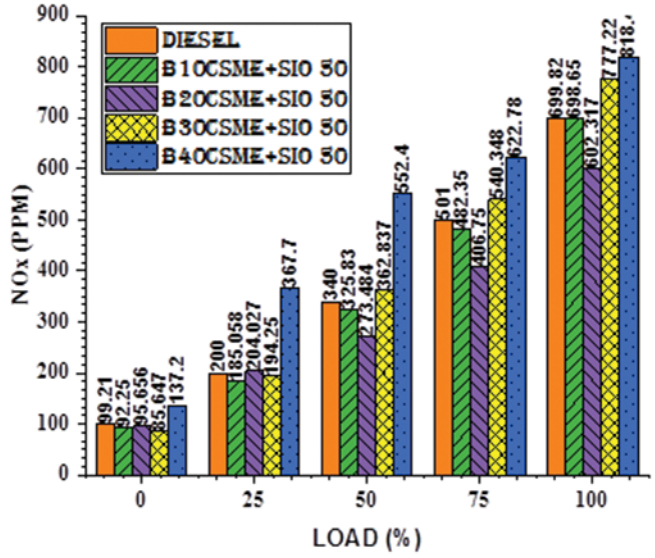

Fig.5: Oxides of nitrogen against load

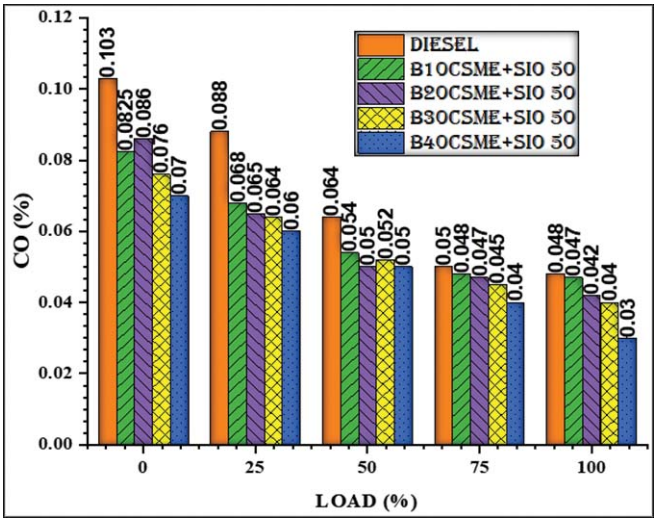

Fig.6: Carbon monoxide against load

3.5 HC EMISSION

Oil from cotton has a low percentage of moisture. The presence of hydrocarbon emissions from the engine exhaust decreases when combined with diesel. Silicon oxide-based biodiesel enhances combustion, leading to lower HC

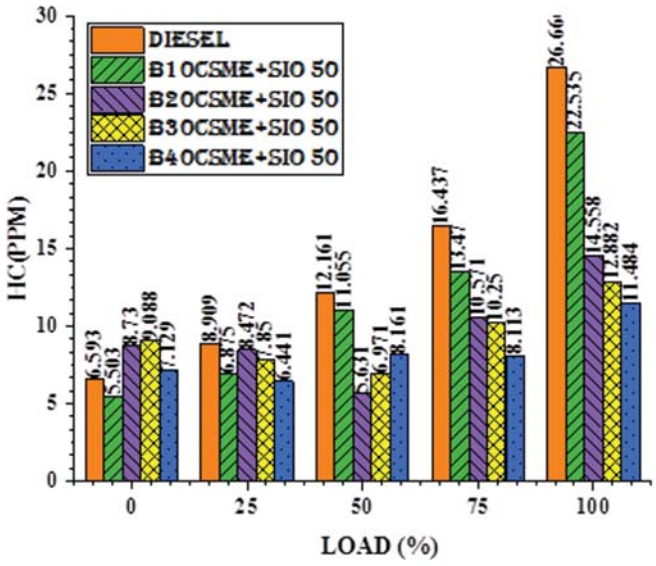

Fig.7: Hydrocarbon against load

emissions. Fig.8 refers to hydrocarbon emissions in diesel. hydrocarbon emissions. Biodiesel is relatively more efficient than diesel with a 46.14 per cent decrease.

4.0 Conclusions

The investigation on the performance and emission characteristics of cottonseed oil combined fuel in the Kirloskar engine is based on the following experimental conclusion:

1. In addition to silicon oxide nanoparticles, calorific value, flashpoint and fire point were enhanced with cottonseed oil.
2. Fuel specific fuel consumption (SFC) by inclusion of sio nano particles is lowered to 13.8 per cent.
3. By mixing up to 22 per cent of cottonseed oil with SiO nanoparticles, brake thermal efficiency (BTE) is optimized.
4. The presence of SiO_2 emissions in biodiesel decreased by 36.3% and 36.4%, respectively, hydrocarbons (HC) and carbon monoxide (CO).
5. Due to the inclusion of the SiO and cotton oil in biodiesel, the NO has been raised because of enhanced combustion.
6. Biodiesel blends at B20 and B30 are reasonably efficient compared to diesel

References

[1] B.L. Salvi, K.A et al. (2013): Alternative fuels for transportation vehicles: a technical review, *Renew. Sustain. Energy Rev*. 25. 404e419.

[2] Wang, Q. et al., (2020): Comparative analysis of drivers of energy consumption in China, the USA and India – a perspective from stratified heterogeneity. *Sci. Total Environ*. 698, 134117. https://doi.org/10.1016/j.scitotenv. 2019.

[3] Mehta, A. et al., (2019): Band gap tuning and surface modification of carbon dots for sustainable environmental remediation and photocatalytic hydrogen production – a review. *J. Environ. Manag.* 250, 109486

[4] Sharma, S. et al., (2020): Waste-to-energy nexus for circular economy and environmental protection: recent trends in hydrogen energy. *Sci. Total Environ*. 713, 136633. https://doi.org/10.1016/j.scitotenv.2020.136633.

[5] Srivastava, R.K. et al., (2020): Biofuels, biodiesel and biohydrogen production using bioprocesses. A review. *Environ. Chem. Lett.* https://doi.org/10.1007/s10311-020-00999-7

[6] Kong, W. et al., (2018): Towards an energy-friendly and cleaner solvent-extraction of vegetable oil. *J. Environ. Manag.* 217, 196–206.

[7] Sharma, S. et al., (2019): Ethanol production from NaOH pretreated rice straw: a cost effective option to manage rice crop residue. Waste and Biomass Valorization 10, 3427–3434

[8] Gavahian, M. et al., (2016): Ethanol concentration of fermented broth by ohmic-assisted hydrodistillation. Innovat. *Food Sci. Emerg*. Technol. 35, 45–51.

[9] Shekofteh, M.et a.l, (2020): Performance and emission characteristics of a diesel engine fueled with functionalized multi-wall carbon nanotubes (MWCNTs-OH) and diesel–biodiesel–bioethanol blends. Energy Rep. 6, 1438-1447

[10] Murat Kadir Yesilyurta et al., February 2020, Experimental investigation on the performance, combustion and exhaust emission characteristics of a compression-ignition engine fueled with cottonseed oil biodiesel/diethyl ether/diesel fuel blends, Elsevier Volume 205, 1, 112355