Journal of Advanced Engineering Research
ISSN: 2393-8447
Volume 3, Issue 1, 2016, pp.21-25

Evaluation of Neat Cashew Nut Shell Oil Performance in Diesel Engine

S. Santhanakrishnan[1], N. Senthilkumar[2], P. Lawrence[3]

[1]Department of Mechanical Engineering, Thirumalai Engineering College, Kancheepuram, India
[2]Department of Mechanical Engineering, Adhiparasakthi Engineering College, Kancheepuram, India
[3]Department of Mechanical Engineering, PSV College of Engineering & Technology, Krishnagiri, India

*Corresponding author email: skskashok@gmail.com, Phone: +91 9003846046

ABSTRACT

Vegetable oils can be directly used in compression ignition engine without any modification. This investigation is to study the performance and emission characteristics of a single cylinder diesel engine fuelled with diesel and neat cashew nut shell oil. Performance characteristics like brake thermal efficiency, exhaust gas temperature, specific fuel consumption, and emission characteristics like carbon monoxide, unburned hydrocarbon, oxides of nitrogen and smoke emissions were analyzed.

Keywords – Diesel engine, Cashew nut shell oil, performance, emission.

1. INTRODUCTION

Diesel engines are the most trusted power sources in the transportation industry. They breathe the atmospheric air and emit the harmful pollutants namely SO_2, NOx and particulate matter. There has been a continuous effort to reduce exhaust emissions in the development of I.C engines. Emission regulations are being tightened worldwide year by year. Therefore the use of alternative fuel is one of the key-technology to meet the forth-coming emission norms [1-3].

Ramadhas et al [4] investigated a diesel engine using rubber seed oil biodiesel blends and found that the lower blends increases the efficiency of the engine and lowers the fuel consumption compared to the higher biodiesel blends. Lawrence et al [5] performed the performance and emission study on a compression ignition engine using prickly poppy biodiesel blends and reported that the engine runs well in biodiesel blends and releases lesser carbon monoxide and unburned hydrocarbon emissions. Lapuerta et al [6] have investigated the use of waste cooking oil esters as alternative fuel in a naturally aspirated diesel engine and been reported that the smoke emission was lower than that of diesel. The NOx emissions were marginally higher than diesel and the soot formed at the point of impingement of ester was lower than diesel.

Schumacher [8] studied several blends of diesel and soybean methyl ester (SME) to determine and compare engine emissions from a diesel engine used in transit buses and heavy trucks) operated on those fuels and reported that increased percentage of SME blended with diesel led to increased emissions of NOx and decreased emissions of PM, HC, and CO. Deepanraj et al [5, 6] studied the performance and emission characteristics of a diesel engine using palm oil biodiesel and its blends with diesel and reported that the engine runs well with biodiesel and blends and releases lesser carbon monoxide and unburned hydrocarbon emissions. Kannan [11] investigated the effect of turpentine oil in HCCI engine and found that better emission characteristics were obtained while using turpentine oil.

The present investigation involves the use of neat cashew nut shell oil in the diesel engine and the performance and emission characteristics were determined and compared with diesel fuel.

2. EXPERIMENTAL SETUP

The engine used for the investigation is a four stroke water cooled, single cylinder, direct injection, vertical diesel engine developing a rated power of 3.7kW at 1500 rpm. The engine is coupled to an eddy current dynamometer. The engine was mounted on the engine test bed with suitable connections for cooling water supply. The fuel is supplied from a fuel tank and the fuel consumption rate was measured by digital stopwatch. Specification of the test engine is shown in Table 1. Cashew nut shell oil used in this experimental study was purchased from the local market in Panruti, Cuddalore district of Tamil Nadu. Diesel was purchased from the local bunk. The properties of diesel and cashew nut shell oil are given in Table 2. The fatty acid

composition of the cashew nut shell oil was determined using GC-MS and given in Table 3.

Table 1 Specification of the Engine

No. of Cylinder	Single cylinder
Stroke	Four stroke
Injection type	Direct injection
Power (kW)	3.7
Bore (mm)	80
Stroke (mm)	110
Dynamometer	Eddy current dynamometer
Method of cooling	Water cooling

Table 2 Properties of Test Fuels

Property	Diesel	CNSO
Calorific value (MJ/kg)	42.8	40.69
Flash point (°C)	61	256
Fire point (°C)	70	254
Cloud point (°C)	-11	-18
Pour point (°C)	-30	-45
Ash content (%)	0.01-0.1	0.01
Viscosity (cSt)	3.6	9.4
Density (kg/m^3)	840	952
Iodine value (Wij's)	-	261.6
Sulfur content (%)	2	0.01
Carbon residue (%)	0.35	4.82

Table 3 Fatty acid composition of Cashew nut shell oil

Acid	Percentage
Palmitic acid	38.7
Stearic acid	6.53
Oleic acid	42.07
Linoleic acid	12.33

3. RESULTS AND DISCUSSION

The brake thermal efficiency variation with different load conditions is shown in Fig 1. The brake thermal efficiency increases with increase in load. For all the load conditions, the brake thermal efficiency of the cashew nut shell oil is lesser than Diesel fuel. This is due to poor spray injection pattern and further no effective utilization of air resulting incomplete combustion At 25, 50, 75 and 100% load, the brake thermal efficiency of the cashew nut shell oil is 52, 42.1, 11.7, and 32.7% higher than diesel respectively.

The specific fuel consumption variation with different load conditions is shown in Fig 2. The specific fuel consumption decreases with increase in load. For all the load conditions, the specific fuel consumption of the cashew nut shell oil is higher than Diesel fuel. At 25, 50, 75 and 100% load, the specific fuel consumption of the cashew nut shell oil is 17.9, 25.2, 27.4 and 26.3% higher than diesel respectively.

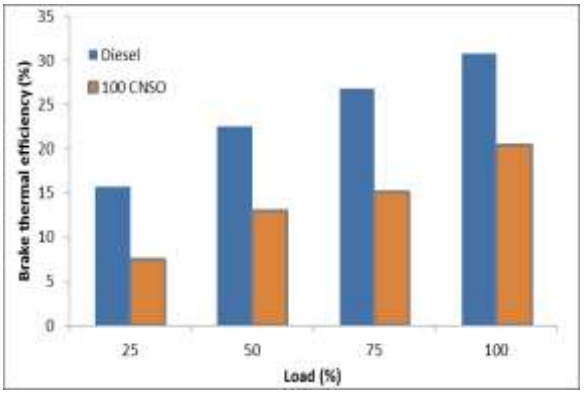

Fig. 1 Brake thermal efficiency

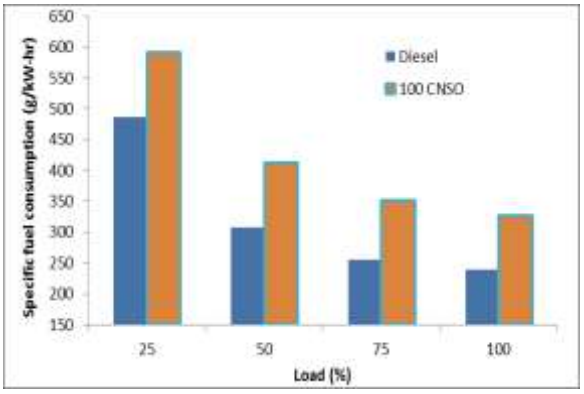

Fig. 2 Specific fuel consumption

The exhaust gas temperature variation with different load conditions is shown in Fig 3. The exhaust gas temperature increases with increase in load. For all the load conditions, the exhaust gas temperature of the cashew nut shell oil is higher than Diesel fuel. At zero, 25, 50, 75 and 100% load, the exhaust gas temperature of the cashew nut shell oil is 23.9, 27.1, 30.7, 31.9 and 31.1% higher than diesel respectively.

The carbon monoxide emission variation with different load conditions is shown in Fig 4. The carbon monoxide emission increases with increase in load. For all the load conditions, the carbon monoxide emission of the cashew nut shell oil is higher than Diesel fuel. At zero and maximum load, the carbon monoxide emission of the cashew nut shell oil is 38.5 and 33.7% higher than diesel respectively.

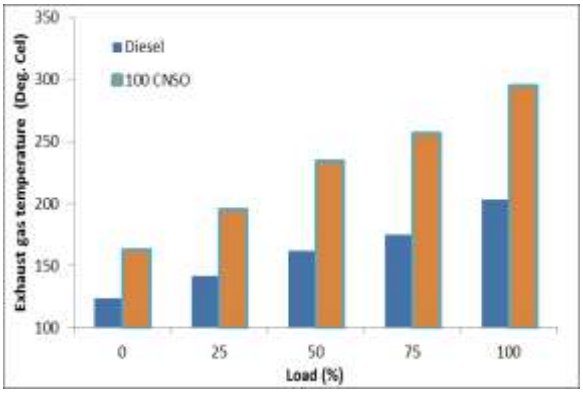

Fig. 3 Exhaust gas temperature

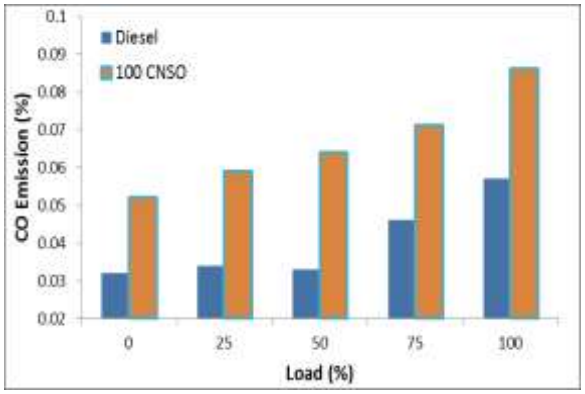

Fig. 4 Carbon monoxide emission

The unburned hydrocarbon emission variation with different load conditions is shown in Fig 5. The unburned hydrocarbon emission increases with increase in load. For all the load conditions, the unburned hydrocarbon emission of the cashew nut shell oil is higher than Diesel fuel. At zero, 25, 50, 75 and 100% load, the unburned hydrocarbon emission of the cashew nut shell oil is 35.8, 42.1, 32.7, 27.2 and 34.2% higher than diesel respectively.

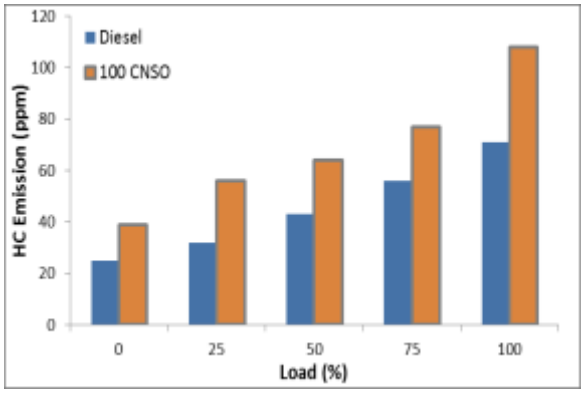

Fig. 5 Hydrocarbon emission

The oxides of nitrogen emission variation with different load conditions are shown in Fig 6. The oxides of nitrogen emission increases with increase in load. For all the load conditions, the oxides of nitrogen emissions of the cashew nut shell oil is higher than Diesel fuel. At 25, 50, 75 and 100% load, the oxides of nitrogen emission of the cashew nut shell oil is 56.4, 62.1, 42.7, 39.8 and 25.6% higher than diesel respectively.

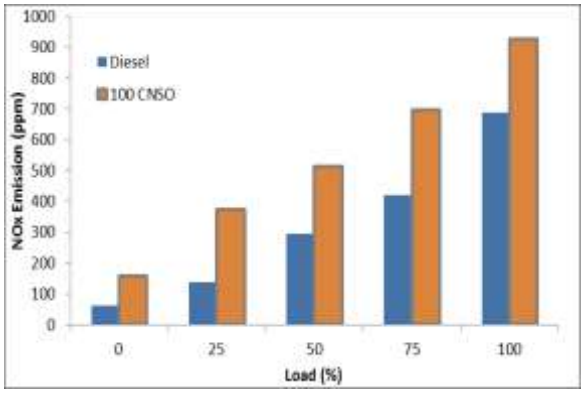

Fig. 6 Oxides of nitrogen emission

Smoke is nothing but the exhaust gas stream in which the solid soot particles are suspended. Fig 7 shows the variation of smoke emission with respect to load. The smoke emission increases with increase in load. The long chain aromatics of the CSNO create high level of smoke due to poor combustion. At maximum load, the smoke emission of the cashew nut shell oil is 29.31% higher than neat diesel fuel.

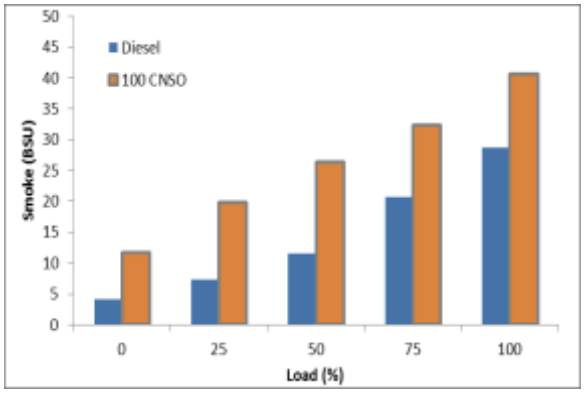

Fig. 7 Smoke emission

4. CONCLUSION

Experiments were conducted on a single cylinder, four stroke, water cooled, direct injection, diesel engine using neat diesel with cashew nut shell oil. Based on the experimental results the following conclusions are made.

Decrease in the brake thermal efficiency of the engine and increase in the specific fuel consumption was noticed for the cashew nut shell oil fuel. Increase in exhaust gas temperature is noticed for cashew nut shell oil compared with neat diesel fuel. The CO, HC, NOx and smoke level in the exhaust emissions were increased compared with diesel fuel.

REFERENCE

[1] D. Agarwal, L. Kumar, A.K. Agarwal, Performance evaluation of a vegetable oil fuelled CI engine, *Renewable Energy*, .33, 2008, 1147-1156.

[2] G.R. Kannan, R. Anand, Biodiesel as an alternative fuel for direct injection diesel engines: A review, *Journal of Renewable and Sustainable Energy*, 4, 2012, 012703.

[3] B. Singh, J. Kaur, K. Singh, Production of biodiesel from used mustard oil and its performance analysis in internal combustion engine, *Journal of Energy Resource Technology*, 132, 2010, 031001.

[4] A.S. Ramadhas, C. Muraleedharan, S. Jayaraj, Performance and emission evaluation of a diesel engine fueled with methyl esters of rubber seed oil, *Renewable Energy*, 30, 2005, 1789-1800.

[5] P. Lawrence, P. Koshy Mathews and B. Deepanraj, Effect of prickly poppy methyl ester blends on CI engine performance and emission characteristics, *American Journal of Environmental Sciences*, 7, 2011, 145-149.

[6] M. Lapuerta, J.R. Agudelo, J.R. Fernandez, Diesel particulate emissions from used cooking oil biodiesel, *Bioresource Technology*, 99, 2008, 731-740.

[8] L.G. Schumacher, S.C. Borgelt, 6V-92TA DDC engine exhaust emission test using methyl ester soybean oil/diesel fuel blends, *Bioresource Technolo*gy, 57, 1996, 31-36.

[9] B. Deepanraj, N.S. Kumar, A. Santhoshkumar, P. Lawrence, V. Sivaramakrishnan, R. Valarmathi, Transesterified palm oil as an alternate fuel for compression ignition engine. *Proc. IEEE-International Conference on Advances in Engineering, Science And Management (ICAESM – 2012),* India March 30-31, 2012.

[10] B. Deepanraj, C. Dhanesh, R. Senthil, M. Kannan, A. Santhoshkumar, P. Lawrence, Use of palm oil biodiesel blends as a fuel for compression ignition engine, *American Journal of Applied Sciences*, 8, 2011, 1154-1158.

[11] M. Kannan, R. Karthikeyan, B. Deepanraj, R. Baskaran, Feasibility and performance study of turpentine fueled DI diesel engine operated under HCCI combustion mode, *Journal of Mechanical Science and Technolog*y, 28, 2014, 729-737.

[12] G. Arunkumar, A. Santhoshkumar, M. Vivek, L. Anantha. Raman, G. Sankaranarayanan, C. Dhanesh, Performance and Emission Characteristics of Low Heat Rejection Diesel Engine Fuelled with Rice Bran Oil Biodiesel, Advanced Materials Research, Vol. 768, pp. 245-249, 2013.

[13] S. Santhanakrishnan, B.K.M Ramani, Performance emission and combustion characteristics of a low heat rejection engine fuelled with diesel-CNSO-EEA blend, *Journal of Advanced Engineering Research*, 2, 2015, 29-33.

[14] B Deepanraj, G Sankaranarayanan, P Lawrence, Performance and emission characteristics of a Diesel engine fueled with rice bran oil methyl Ester blends, *Daffodil International University Journal*

of Science & Technology, 7 (2), 2012, 51-55.

[15] S. Karthikeyan, G. Sankaranarayanan, R. Karthikeyan, Green technology effect of injection pressure, timing and compression ratio in constant pressure heat addition cycle by an eco-friendly material, *Ecotoxicology and Environmental Safety*, 121, 2015, 63-66.

[16] G. Arunkumar, A. Santhoshkumar, C. Dhanesh, M. Vivek, G. Arunkumar, L. Anantha Raman, Investigation of rice bran oil biodiesel as fuel in a compression ignition engine, *Proc. International Conference on Energy Efficient Technologies for Sustainability (ICEETS)*, India, April 10-12, 2013.