ISSN 2277 – 5528
Impact Factor- 4.015
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT

The study on the Effect of humidity on performance & exhaust emission of diesel engine fuelled with diesel & biodiesel

R.Seetharamamaiah[1], Dr. A.S.Ravindran[2], Dr. H.B.Niranjan[3], Dr. A.Sathyanarayana Swamy4 and Dr. R. Chandrashekar[5]
[1]Associate Prof, Dept. of Mechanical Engineering, Sambhram Institute of Technology
[2]Prof. &HOD, Department of Mechanical Engineering, Dr SSSMCE
[3]Prof. & HOD, Department of Mechanical Engineering, Sambhram Institute of Technology
[4]Prof, Department of Mechanical Engineering, Sambhram Institute of Technology
[5]Former Prof. & HOD, Department of Mechanical Engineering, MSRIT

ABSTRACT
A study on the effect of humidity on performance and emissions of diesel engine running with blend of diesel and biofuel. The parameters considered were, brake power, and emission contents. For this studies, a four-stroke direct injection Diesel Engine was tested with diesel and biodiesel such as simarouba fuel. The test was conducted at full load conditions, at a speed of 1500 rpm. A steam generator was used to supply the steam to vary the humidification. The study reveals that biodiesel B30 shows an emission decrease in brake power around 1%, NOx decrease by 14%, CO increase by 16%, and HC by 8%.

Keywords: *Simarouba, Transesterifcation, Biodiesel, Vegetable oil.*

1. Introduction
The world is presently confronted with twin crisis of fossil fuel depletion and environmental degradation, indiscriminate extraction, together with lavish consumption of fossil fuels has led to reduction in underground based carbon resources. The search for an alternative fuel which promises harmonious correlation with sustainable development, energy conservation, management efficiency and environmental preservation, have become highly pronounced for the present context. As the power consumption in agricultural and transportation sector is essentially based on diesel fuel, it is very necessary to have a fuel substitute .The study concentrates on assessing the viability of using vegetable oils in the existing diesel engines. Vegetable oils have compatible energy density, cetane number, heat of vaporization and stoichiometric air fuel ratio with mineral diesel fuel. The large molecule sizes of the component triglycerides results in the oils having higher viscosity. Viscosity affects the flow properties of the fuel, air fuel mixing and combustion. The problem is that, the viscosity has an adverse effect, utility of the vegetable oils in the existing diesel engines. Hence the problem needs to overcome by various means, like transesterification etc. which optimizes the viscosity of the oil.
Transesterification process utilizes methanol, ethanol and vegetable oils as the process inputs. The present work was carried out using a typical vegetable oil by formulating its properties closer to the conventional diesel oil. System design approach has taken care to see that these modified fuels can be utilized in existing diesel engine without any substantial hardware modifications. In this regard several modes of fuel combination such as blending, transesterification and emulsification were adopted to identify the, most appropriate mechanism.

Vegetable oils in their raw form cannot be used in IC engines. They need to be converted into biodiesel. Biodiesel is a chemically modified alternative fuel for diesel engines, derived from vegetable oils, fatty acids and animal fat. Since biodiesel is a fuel made up of esters derived from oils and fats from renewable biological sources, it has been reported that they emit far less regulated pollutants than petroleum/ diesel fuels. Further this paper describes the influence of humidification on the performance and emission characteristics of the diesel engine using a blend of diesel & biodiesel blend as a fuel.

2. Literature review
Hindren A et al [1]: Is the study on increasing the inlet air temperature entry to the engine using electric heater. The results indicated that brake specific fuel consumption increased with increasing inlet air temperature, and decreased with increasing the brake mean effective pressure. Experimental data obtained were compared with other references and found to be in good agreement with those results.

Patel Sagar.H et al [2]: Their work observed that in diesel engines, NOx formation is a highly temperature-dependent phenomenon and takes place when the temperature in the combustion chamber exceeds 500 K. One simple way of reducing the NOx emission of a diesel engine was by late injection of fuel into the combustion chamber. This technique was effective but increases fuel consumption by 10–15%, which necessitates the use of more effective NOx reduction techniques like water injection in intake manifold. Water injection method was applied to a direct injection (DI) diesel engine to control NOx emissions. This method affects the intake air of an internal combustion engine with cool purified Water, deriving benefits of preventing the formation of excessive oxides of nitrogen and Carbon, affecting a more Complete Combustion of hydrocarbon fuels, reducing the latent heat of combustion and increasing the power of combustion.

Lee G. Dodge et al [3]: Reported that the defining temperature for NO_x emissions is the intake manifold air temperature, which is dependent on the ambient temperature but is also influenced by the engine configuration, turbocharged-after cooled, naturally aspirated, or scavenged.

Nadir Yilmaz et al [4] : Studied the effects of intake air preheat on performance and emissions of a compression ignition engine running on fuel concentrations of biodiesel (85%)–methanol (15%), biodiesel (90%)–methanol (10%), biodiesel (95%)–methanol (5%), neat biodiesel (B100). Fuels were evaluated in the engine at two elevated intake air temperatures at 30°C and 85°C The resulting emissions indicate that the high heat of vaporization of methanol affects CO and HC emissions significantly. Preheating the intake air or lowering the methanol concentration in biodiesel–methanol blends tends to reduce the production of CO and HC while increasing NO emission.

R.D.Melton et al [5]: Reported that the direct water injection cooling of diesel engines can be accomplished with increased power & better BSFC Optimum total engine cooling by direct water injection was accomplished over a wide range of water injection timings at water/fuel ratios 2.9 to 3.7 with output power & BSFC improved 5 to 20% respectively with standard jacket cooled engine. The emissions were effected in an expected manner by the presence of water NOx decreased, while HC & CO tend to increase.

3. Comparison between diesel and simarouba biofuel

(i) The characteristics of variety of available vegetable oils fall within a fairly narrow band and are close to those of diesel oil. The kinematic viscosity is, however, in the same range of that of the diesel oil. (ii)The viscosity of 4-6 CST against 3- 4 CST for diesel oil at 40˚C does not done a problem in pumping and atomization in the injection system of a diesel engine. (iii)The viscosity factor acts a as a major advantage for the simarouba oil blend to be directly used in modern engine without any modifications. (iv)The lower heating value of the simarouba oil is 10% less than that of the diesel oil due to the oxygen content in their molecules. (v)Cetane number of diesel oil is 47, whereas the cetane number of the simarouba oil blend is more than that of the diesel oil which reduces the risk of knocking together with an upper hand when flash point is considered.

Table1: properties of diesel & simarouba biofuel.

Properties	Diesel	Simarouba biofuel
Specific gravity	0.84	0.87
Kinematic viscosity @40^{0}c in CST	4.59	5.4
Flash point	45^{0}C	160^{0}c
Fire point	56^{0}C	172^{0}c
Pour point	-23^{0}c	2^{0}c
Calorific value KJ/kg	45,000	38,480
Cetane no	47	64

4. Materials and method of oil extraction

Simarouba glauca with its origin at Central America is a new crop having multi utilities that can be tapped for production of biofuel .As the kernel has high non-edible oil content, this can be an appropriate candidate for production of biodiesel (simarouba oil methyl ester). Simarouba fruit was procured for the study from GKVK, (Gandhi Krishi vignana Kendra) Bengaluru, Karnataka. The sample was cleaned manually to remove all foreign materials such as dust, dirt, immature fruits etc., and pooled together to obtain approximately 10kg of fruit materials. The fruits were sun-dried and kept in jute bags and allowed to dry under ambient room conditions (27-32^{0}C) to the equilibrium moisture. The simarouba fruits were decorticated with the help of a decorticating equipment to obtain kernels. The fruit breaks into two halves when it is hit on the rib, more easily when the fruit is kept in an upright position. The shells and kernels were separated manually. Once the seeds are separated from the kernels, the seeds are passed into the mechanical crusher to extract the crude oil.

Transesterification: 1 liter of simarouba oil is initially heated to 35^o- 40^{o}C in the beaker and refined using membrane paper. It is further heated to 65^0-70^0 C and then transferred to reaction flask where a mixture of 300ml of methanol and 10 ml sulphuric acid is added with constant stirring using magnetic stirrer and heating it until 70^0 C is reached. This condition is maintained for 5 min, and then transferred to a heating flask, maintained in same condition for 45min to separate free fatty acid from the oil. Simarouba crude oil is transferred to reaction flask and the mixture of 300ml methanol and 5.8gms of NaOH is added, heated to 65^0-70^0 C with constant stirring and maintained for 5-10min.This mixture then transferred to the separating flask, made to settle for 45min and glycerin separated out. It is now washed with fresh water in separate flask and made to settle for10-15min to remove soap water; this process is repeated until water added remains as water. Now, the double stage processed simarouba oil is heated until its temperature reaches 105-110^0C and cooled until its temperature reaches to room temperature. Thus, simarouba Bio-fuel is obtained which is blended with diesel oil to use as alternative fuel in C I engine.

5. EXPERIMENTAL SET UP & PROCEDURE

The engine tests were conducted on four stroke single cylinder, direct injection, water cooled, naturally aspirated, diesel engine. The engine was operated at constant rated speed. The specification of the engine is given in table-2.The exhaust gas analyzer used for measuring emissions is MICO Bosch gas analyzer.

Table-2: Specification of diesel engine

Sl no	parameters	specifications
1	Number of cylinders	1
2	Bore	85 mm
3	Stroke	110 mm
4	Volume	553 cc
5	Compression ratio	16.5 :1
6	power	3.6 kW(5 HP)
7	speed	1500 rpm
8	load	Electrical loading

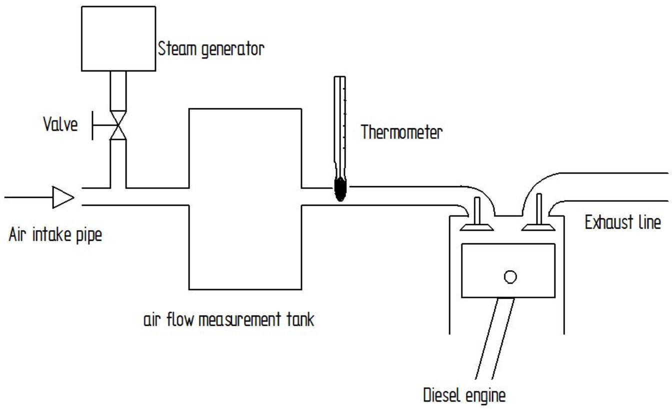

Fig: 1. Schematic diagram of experiment set up

The performance test gives the impact of working of diesel engine with diesel and simarouba blended with diesel. A series of tests were conducted using diesel & simarouba blended with diesel designates as B10, B20, and B30 as fuel, varying humidification (50% to 80%) at constant load. In each test, the values of voltmeter & ammeter, readings were noted down at full load conditions. Also the values of emissions from the engine, such as HC, CO, and NO_X, were also measured during the tests. The above procedure is repeated for different input conditions.

6. Results & Discussions

The results of the engine emissions like, carbon monoxide (CO), hydro carbon (HC), & Oxides of nitrogen (NO_X) for various humidification rates (50%, 60%, 70% and 80%) & blends (B10, B20,B30) are as depicted in the graphs.

(1) The variation of Oxides of Nitrogen with % humidification at full load conditions for diesel, and biodiesel blends (B10, B20, and B30) is as shown in fig2. From the graph it is clear that humidity is varies from 50% to 80%.The blend B30 shows less pollutants. Simarouba biodiesel has low calorific value compared to diesel fuel. The production of NOx in the combustion chamber is temperature dependent; hence biodiesel (B30) produces less pollutant.

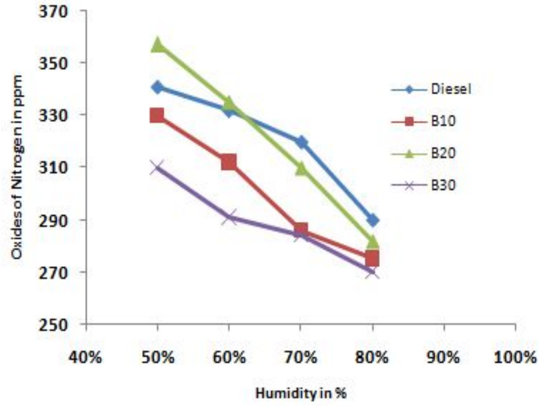

Fig.2: Variation of NOx with % humidification

2) The variation of Hydro carbon with % humidification at full load conditions for diesel, and biodiesel blends (B10, B20, and B30) is as shown in fig 3. From the graph it is clear that B30 shows less pollutants. Due to increase in inlet air temperature, this affects the air fuel ratio. Hence diesel fuel shows increase in HC emission. Biodiesel (B30) shows less HC level because of high blending ratio.

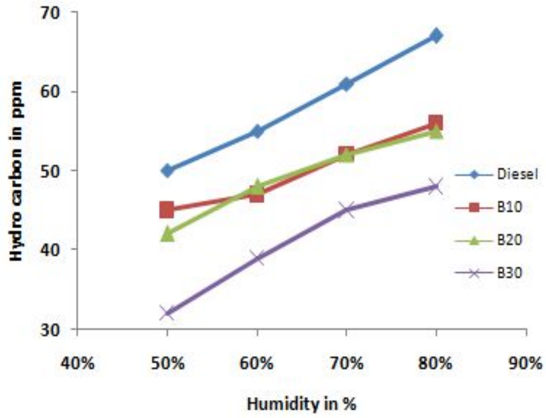

Fig.3: Variation of HC with % humidification

3) The variation of Carbon monoxide with % humidification at full load conditions for diesel, and biodiesel blends (B10, B20, and B30) is as shown in fig 4. From the graph it is clear that B30 shows less pollutants. Simarouba biodiesel (B30) contains more Oxygen content than diesel fuel. This oxygen supports for combustion results in lower CO level in biodiesel (B30).

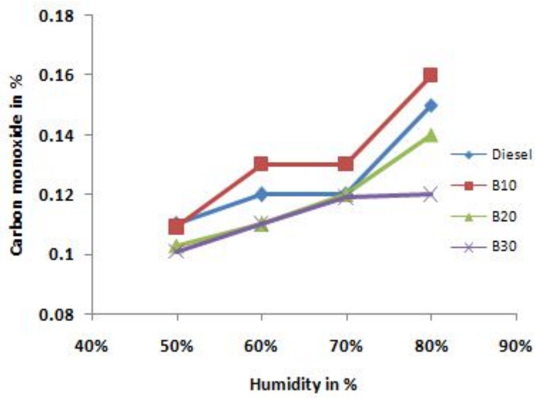

Fig.4: Variation of CO with % humidification

4) The variation of Brake power with % humidification at full load conditions for diesel, and biodiesel blends (B10, B20, and B30) is as shown in fig 5. The Diesel fuel produces higher Brake power. Diesel fuel has higher calorific value compared to biodiesel. Hence brake power produced by diesel is higher than biodiesel fuel.

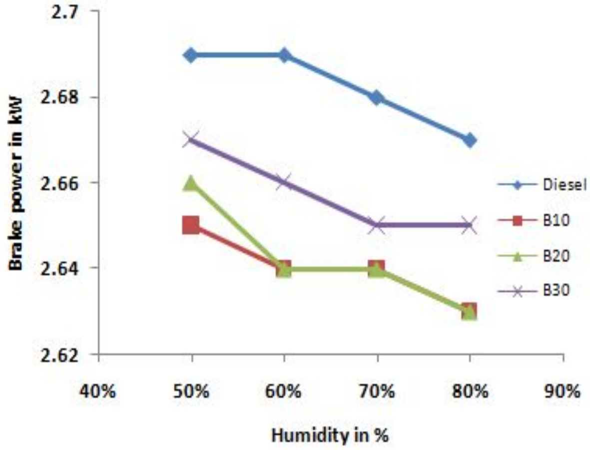

Fig.4: Variation of brake power with % humidification

7. Conclusions

Compared to diesel the biodiesel blends, results lower levels of CO, HC & NO_X at 80% humidification.

- Diesel fuel produces more Brake power than biofuels. At 80% humidification, there was 0.7% decrease in BP compared to 50% humidity for diesel fuel.
- Biodiesel (B30) produces less Oxides of Nitrogen at 80% humidification. At 80% humidification there was 14% decrease in NOx compared to 50% humidity for biodiesel (B30).
- Biodiesel (B30) produces less Carbon monoxide at 80% humidification. At 80% humidification there was 16% increase in CO compared to 50% humidity for biodiesel (B30).
- All the fuels results increase in HC emission levels, but Biodiesel (B30) produces less Hydro Carbon at 50% humidification. At 80% humidification there was 30% increase in HC compared to 50% humidity for biodiesel (B30).

In recent years biodiesel has become more attractive because of its economic & environmental benefits. The biodiesel production plants can be grown in wastelands. The demand for biodiesel is expected to increase sharply in the near future.

References

1. *Hindren a. saber, Ramzi r. Ibraheem al-barwari, Ziyad j. Talabany,"Effect of ambient air temperature on specific fuel consumption of naturally aspirated diesel engine"Journal of Science and Engineering , vol. 1 (1), 2013, 1-7.*
2. *Patel Sagar.H, Rathod Gaurav. P and Patel Tushar .M, "Effect of water injection system on diesel engine emission", Mechanical & Automobile Engineering, ICCIET-2014. Pp 1-4.*
3. *Lee G. Dodge, Timothy J. Callahan, and Thomas W. Ryan, "humidity and temperature correction factors for NOx emissions from diesel engines", south west research institute , 6220, Culebra Road,San Antonio,Texas78238,pp 1-13.*
4. *Nadir Yilmaz," Effects of intake air preheat and fuel blend ratio on a diesel engine operating on biodiesel–methanol blends" Fuel 94 (2012) 444-447.*
5. *R.D.Melton, S.J. Lestz, R.D. Quillian, E.J. Rambie, " US Army fuels & lubricants research Laboratory", South West Research Institute, San Antonio, Texas pp1389-1399.*
6. *P.K. Devan , N.V. Mahalakshmi "Utilization of unattended ethyl ester of paradise oil in diesel engine", Fuel 88 (2009) 1828-1833.*