Experimental Investigation on the Effect of Fuel Magnetization for Improvement of Diesel Engine's Efficiency

Y. C. Kartik, R. Raja, *S. K. Mithun

Faculty of Engineering & Technology, M. S. Ramaiah University of Applied Sciences, Bangalore 560 054

*Contact Author e-mail: mithu138@gmail.com

Abstract

One of the greatest invention of the mankind is an internal combustion engine, which converts chemical energy of the fossil fuel into useful mechanical energy. The main disadvantage of IC engine is less fuel efficient and more emission of exhaust pollutant gases. It leads to higher demand for fossil fuel and pollute environment to a greater extent. In the current work, experimental investigation on existing single cylinder air cooled diesel engine was carried out by supplying the magnetized fuel. Experiments were carried out without fuel magnetizer and then with fuel magnetizer of different magnetic intensities. Brake Specific Fuel Consumption and exhaust emissions of the selected engine was experimentally investigated and performance variation with respect to the different magnetic intensity were studied. It is observed that brake specific fuel consumption is decreased upto 9% with permanent magnets having different intensities. It is also observed that exhaust emission is also reduced to certain extent; oxides of carbon, hydrogen and nitrogen emission level is reduced to 40-45% with magnetization compared to without magnetized fuel.

Key Words: Fuel Magnetization, Diesel Engine, Efficiency, Emission, Fuel Consumption

1. INTRODUCTION

One of the major problem of IC engine is increase in pollution at alarming rate. Hence the government authorities are forcing the OEMs to focus on emission control technologies without affecting the performance. Fuel magnetization is one of the research topic which deals with both reduction of pollution from the exhaust gases as well as to increase the engines fuel efficiency. The fuel magnetization is a process of energizing the fuel molecule before it enters the combustion chamber by using a powerful magnets. The ionization and realignment of fuel molecules can be achieved through the application of magnetic field as shown in Fig. 1. At the same time inter molecular force is considerably reduced hence fuel will actively interlocks with oxygen producing a more complete burn in the combustion chamber [1,2].

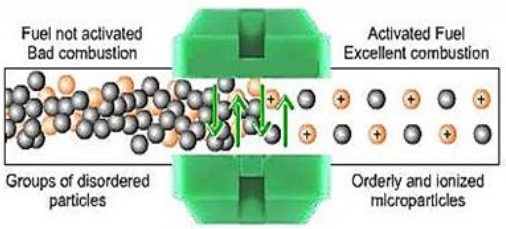

Fig. 1 Effect of Magnetization on Hydrocarbons

2. METHODOLOGY

The literature survey has been carried out for better understanding on the present state of research. On the basis of literature survey, market survey and available resources type of fuel, engine and type of magnet were selected. The experimental study has been carried out in a single cylinder diesel engine test rig. The hand held Gauss meter has been used to measure the magnetic intensity.

These tests were carried out for different cases as follows:

- Without any magnets at 2000, 2500 and 3000 rpm of engine
- With 1 set of permanent magnet of 1000 Gauss at 2000, 2500 and 3000 rpm of engine (Dimension of the magnet is 40 X 12 X 2.5 mm)
- With 2 set of permanent magnet of 3000 Gauss at 2000, 2500 and 3000 rpm (Dimension of the magnet is 50 X 10 X 7.0 mm)

3. EXPERIMENTAL SETUP

The performance test was carried out to analyse the effect of magnetic field on the performance of single cylinder air cooled diesel engine. The experimental setup consist of single cylinder forced air cooled engine, eddy current dynamometer and three sets of magnets with gauss value varying from 1000 to 6000 gauss. The layout of the experimental setup is shown in Fig. 2. The Fig. 3 shows the engine test rig used for this study. The specification of the engine test rig is shown in Table 1.

3.1 Selection of the Magnet

Permanent magnet with features like high curing temperature, corrosion resistance, high intensity and availability are taken into consideration for the selection of magnet. By considering all these aspects Samarium cobalt (rare earths N35 grade) magnets of 1000, 2000 and 3000 Gauss intensity have been selected to conduct the experiment. This magnet has high curing temperature of 250-3500C. This magnet doesn't require any coating to protect it from the working condition, also it is one of the high intensity magnets which are easily available in the market.

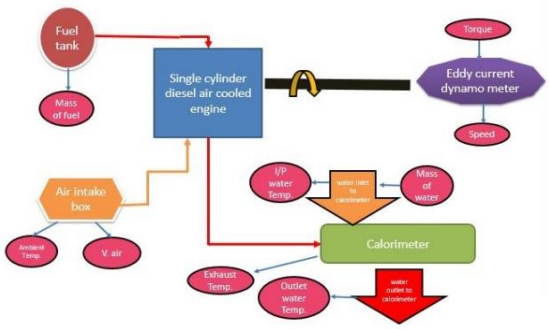

Fig. 2 Experimental setup layout

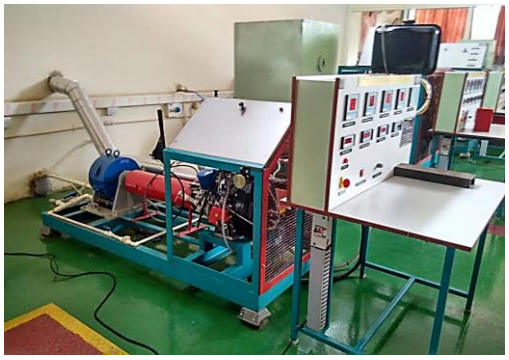

Fig. 3 Engine test rig

Table 1. Engine test rig specification

Type of Engine	**Four stroke, forced air and oil cooled CI engine**
Number of cylinders	One
Number of valves	Two
Maximum net power	8.32 BHP @ 3400 rpm
Maximum net torque	19.4 Nm @ 2600 rpm
Bore	86 mm
Stroke	77 mm
Compression ratio	24:1
Cylinder capacity	447.3 cc
Dynamometer	Eddy current dynamometer
Sensors used	
Cylinder pressure	Piezo electric sensor
Torque and fuel flow	load cell
Air and water flow	Transducer with digital indicator
Temperature	RTD sensor and K type thermocouple
Speed	Proximity sensor with digital indicators

3.2 Fuel Magnetizer Fixture Design

Fixture has been designed to hold the permanent magnets of different sizes in specified place and orientation. Fixture has to hold the permanent magnets in two different locations. The Fig. 4 shows the designed fixture to hold two sets of permanent magnets at two different places. The Teflon material has been used for fixture.

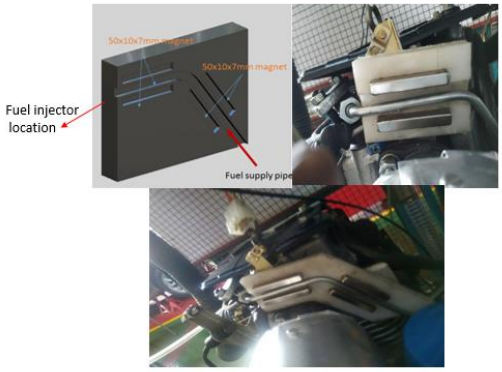

Fig. 4 Fixture to hold permanent magnets

3.3 Validation of Magnetic Intensity

The magnetic intensity of the selected magnet will be calculated based on their width and thickness. The intensity of the selected magnets were validated using Gauss Meter (Model EMF-ECO) by keeping probe at the surface of N35 grade permanent magnet as well as on the surface of fuel line. Fig. 5 shows the gauss meter which is used to measure the magnetic intensity.

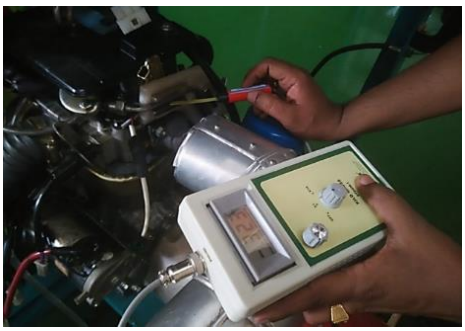

Fig. 5 Measurement of magnetic intensity using gauss meter

3.4 Emission Test

Emission test is conducted by 5-gas exhaust gas analyzer which is shown in Fig. 6. It has an ability to measure five pollutant gasses concentration. The gasses like carbon monoxide, carbon di oxide, molecules of oxygen, hydro carbons and oxides of nitrogen are measured as per the standard units specified. Carbon monoxide, carbon di oxide and oxygen are measured in terms of percentage. NOx and hydrocarbon measured in Part Per Million (PPM).

Fig. 6 Indus five gas analyser

4. RESULTS AND DISCUSSION

The performance test was carried out on single cylinder air cooled diesel engine. Also emission tests were carried out for the selected cases.

4.1 Engine Performance Test

The magnets were placed just before the fuel injector on the fuel line. Fig. 7 to Fig. 11 represents the test results carried out for various engine speed. At each engine speed, tests were carried out without magnet, with one pair of magnet (1P) and with two pairs of magnets (2P).

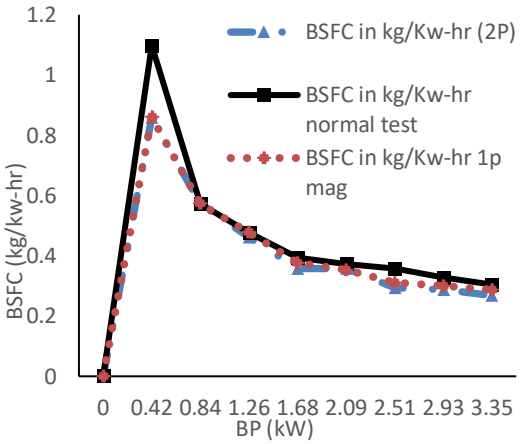

Fig. 7 BSFC Vs BP comparison at 2000 rpm

From the results it's observed that, a single set of permanent magnet has not influenced the engine performance as shown in Fig. 7, 8 and 9. But when the intensity of the magnet has increased some changes in the engine performance has been observed. By using two sets of 3000 gauss N35 permanent magnets BSFC is improved around 10% at different engine speed (2000, 2500, 3000 rpm) at various loads as shown in Fig. 7, 8 and 9. The experimental results shows that the magnetization with two pair of magnets with 3000 gauss intensity at 2000 rpm gives 10.04 % better BSFC at various loads. Results also shows that the magnetization with two pair of magnets of 3000 gauss intensity at 2500 rpm and 3000 rpm gives 9% and 9.8 % better BSFC at various loads respectively.

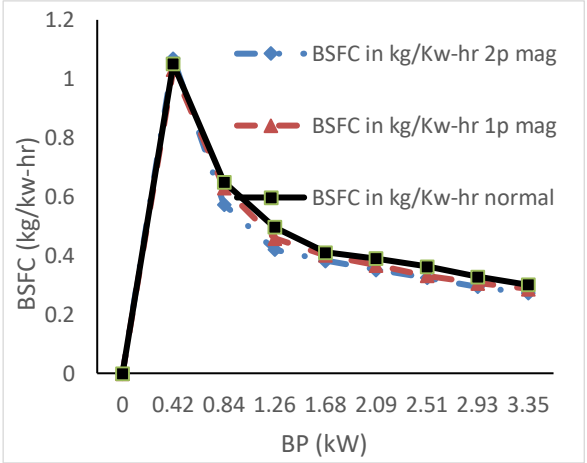

Fig. 8 BSFC Vs BP comparison at 2500 rpm

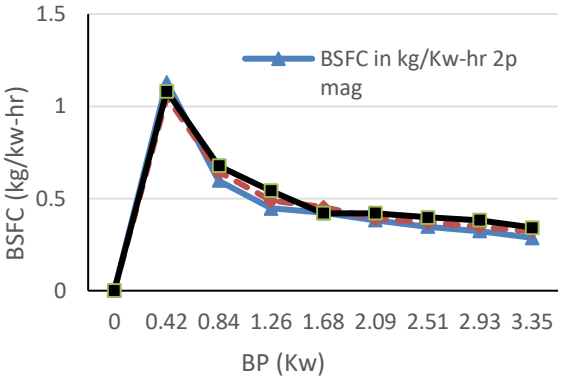

Fig. 9 BSFC Vs BP comparison at 3000 rpm

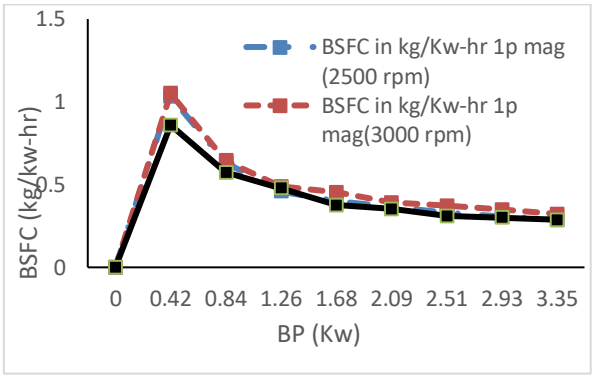

Fig. 10 One set of permanent magnet (1000Gauss) with different engine speed

4.2 Engine Emission Test

The emission tests were carried out for two sets of 3000 gauss magnetic intensity at 2000 rpm case because of its better performance during engine performance test. The Fig. 12, 13 and 14 show the CO emission, HC emission and NOX emission respectively.

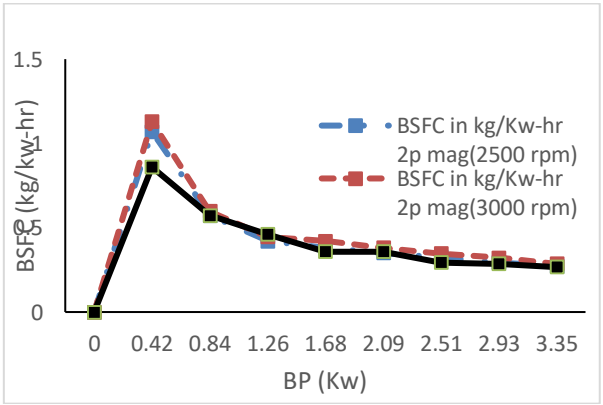

Fig. 11 Two sets of Permanent of magnets (3000 Gauss) with different engine speed

It is observed from the graph that the emission of carbon monoxide reduces considerably compared to without magnet case as shown in Fig. 12. This has happened mainly because of the realignment of the hydrocarbon molecules due to magnetization. The realignment of the hydrocarbon allow the oxygen molecules to actively interlock with the hydrocarbons and for better mixture of air and fuel [3]. It is observed from that the difference in the carbon monoxide emission between the two cases are

varying with the engine load. The difference is more at the lower loads compare to higher engine loads. In the same way unburnt hydrocarbon emission is reduced with magnets as shown in Fig. 13. Even though the emission of unburnt hydrocarbon has reduced, NOx emission has not increased as shown in Fig. 14. This may be because of the combustion which has happened at the normal temperature in the combustion chamber. The Table 2 shows the comparison of emission gasses during different cases of experiment.

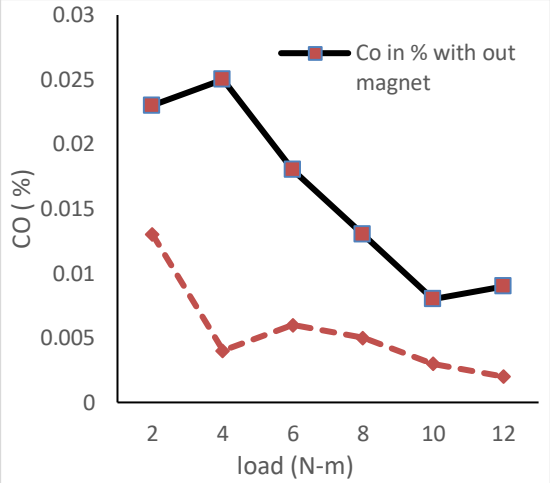

Fig. 12 CO emission test

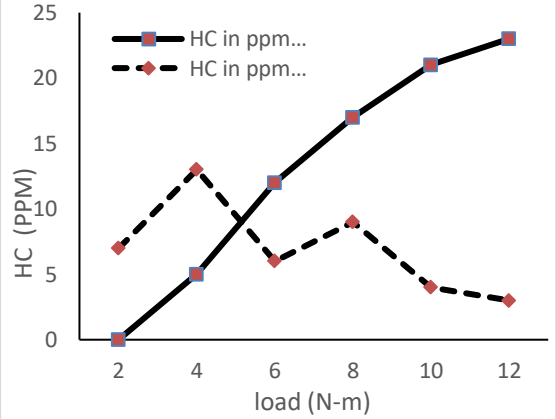

Fig. 13 HC emission test

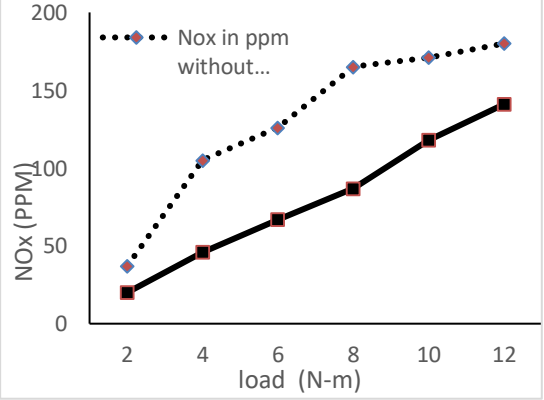

Fig. 14 NO_X emission test

Table 2. Comparison of emission gases

Exhaust Gases in Emission ↓	Different Cases →	With Fuel Magnetizer	Without Fuel Magnetizer	Percentage Reduction in Emission
CO IN %		0.006	0.18	33.33 %
HC IN PPM		6	12	50 %
NOX IN PPM		67	126	53.17 %

It has been observed that the CO is reduced to 33.33%, HC is reduced to 50% and NOX is reduced to 53.17% for the specified engine load and rpm.

5. CONCLUSIONS

It has been observed that the magnetization of fuel is improving the BSFC of the engine. By using two sets of 3000 gauss N35 permeant magnets BSFC is improved by 10%-11% during different engine speed (2000, 2500, 3000 rpm) at various loads. The experimental results shows that the magnetization with two pair of magnets with 3000 gauss intensity at 2000 rpm gives 10.04 % better BSFC at various loads. Fuel magnetization with two pair of magnets of 3000 gauss intensity at 2500 rpm and 3000 rpm gives 9.0% and 9.8 % better BSFC at various loads respectively. By using two sets of 3000 gauss magnets it has been observed the reduction of 34% in CO, 53% in HC and 61% in NOx in the exhaust emission. Fuel magnetizer with one pair of magnet can be used for low load and low speed and two pair of magnets can be used for higher speed and higher load engines.

REFERENCES

[1] Daniel C. Uguru Okorie, Ademola A. Dare (2013) Combustion Enhancers in Diesel Engines: Magnetic Field Option, *IOSR Journal of Mechanical and Civil Engineering*, 5(5), pp. 21-24.

[2] Farrag A. EI Fatih, Gad M. Saber (2010) Effect of Fuel Magnetism on Engine Performance and Emissions, *Australian Journal of Basic and Applied Sciences*, 4(12), pp. 6354-6358.

[3] Okoronkwo C.A., Nwachukwu, Ngozi L.C., Igbokwe (2010) The Effect of Electromagnetic Flux Density on the Ionization and the Combustion of Fuel (An economy design project), *American journal of scientific and research*, 1(3), pp. 527-531.