International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 1, January 2014

Research Paper

EXPERIMENTAL STUDY OF A NOVEL MAGNETIC FUEL IONIZATION METHOD IN FOUR STROKE DIESEL ENGINES

P Vijaya Kumar[1]*, Santosh Kumar Patro[1] and Vedasamhita Pudi[1]

*Corresponding Author: P Vijaya Kumar, ✉ pjoel2013@gmail.com

The performance of I.C engine greatly depends on the complete combustion of the air fuel mixture which means less unburnt gases and hence results in higher efficiency, less emissions. The present work deals with fuel ionization by using magnetic field which will ensure complete combustion of air fuel mixture. Normally fuel injector converts the liquid fuel into fine particles (atomization and vaporization). An attempt is made in this work to improve the combustion efficiency of internal combustion engines by adopting a magnetic fuel ionization method in which the fuel is ionized due to the magnetic field. The magnetic field is created by high power magnets, which are mounted over fuel carrying pipe line before fuel is allowed to enter in to the combustion chamber. The magnetic fuel ionization method establishes improved fuel burning criteria not only ensures increased thermal efficiency and reduced emissions levels in an I.C engine but also environmental friendly nature of an I.C engine with further experimentation in near future. Experiments have been done on a four stroke diesel engine with the incorporation of magnetic fuel ionization method. The results yielded from the experiments show that thermal efficiency increases by 2% and emissions reduced to 5%.

Keywords: Four stroke diesel engine, Magnetic fuel ionization method, Performance enhancement, Reduced emissions

INTRODUCTION

Generally internal combustion engines, particularly reciprocating internal combustion engines, produce moderately high pollution levels, due to incomplete combustion of carbonaceous fuel, leading to carbon monoxide and some soot along with oxides of nitrogen and sulphur and some unburnt hydrocarbons depending on the operating conditions and the fuel/air ratio. Diesel engines produce a wide range of pollutants including aerosols of many small particles that

[1] Department of Mechanical Engineering, Lakireddy Balireddy College of Engineering (Autonomous), Mylavaram, Krishna Dist., AP, India.

are believed to penetrate deeply into human lungs.

In diesel engines, as many fuels contain sulphur leading to sulphur oxides (SOx) in the exhaust, promoting acid rain. The high temperature of combustion creates greater proportions of nitrogen oxides (NOx), demonstrated to be hazardous to both plant and animal health.Net carbon dioxide (CO_2) production is not a necessary feature of engines, but since most engines are run from fossil fuels this usually occurs.

Apart from these diesel engines are expected to give better efficiencies. The emission control methods like exhaust gas recirculation which reduces the formation of NOx and in catalytic converters the catalytic converter is a device placed in the exhaust pipe, which converts hydrocarbons, carbon monoxide, and NOx into less harmful gases by using a combination of platinum, palladium and rhodium as catalysts.

In view of the above inherent problems in diesel engines, in the present work authors incorporated a novel method named magnetic fuel ionization which was proved to be promising in enhancing the performance and reducing emission levels in diesel engines.

Ali Farisa *et al.* (2012) have done their work on the effect of magnetic field on fuel consumption and exhaust emissions in two stroke engines. Hydrocarbon fuels leave natural deposit of carbon residue that clogs carburetor, fuel injector, leading to reduced efficiency and wasted fuel. Generally a fuel for internal combustion engine is compound of molecules. Magnetic movements already exist in their molecules and they therefore already have positive and negative electrical charges. However these molecules have not been realigned, the fuel is not actively interlocked with oxygen during combustion, the fuel molecule or hydrocarbon chains must be ionized and realigned. The ionization and realignment is achieved through the application of magnetic field. The results yielded from their work include The overall performance and exhaust emission tests showed a good result, where the rate of reduction in gasoline consumption ranges between (–1)%, and the higher the value of a reduction in the rate of 1% was obtained using field intensity 6000 Gauss as well as the intensity 9000 Gauss. It was found that the percentages of exhaust gas components (CO, HC) were decreased considerably, but CO_2 percentage increased up to 10%. Engr. Okoronkwo *et al.* (2010) carried their work on the effect of electromagnetic flux density on the ionization and the combustion of fuel. Results obtained during the test, gave a considerable reduction in the hydrocarbon constituent of the exhaust product and PPM in the carbon monoxide. Shweta Jain *et al.* (2012) made an experimental investigation of magnetic fuel conditioner in internal combustion engine. The results yielded from their work MFC increases the internal energy of a fuel to cause specific changes at a molecular level which obtained easier combustion. They concluded that incorporation of MFC increased mileage of vehicle considerably, reduction in HC emission other pollutants, avoid clogging problems in diesel engine.

MAGNETIC IONIZATION METHOD

In the oxidation/combustion of hydrocarbon fuels, it is the outer shell of the hydrogen that is combusted first, it possesses two distinctive forms: ortho-hydrogen and para-hydrogen. To secure conversion of para to ortho state, it is necessary to change the energy of interaction between nuclear spins. The molecules of the two gases, para and ortho-hydrogen differ in the relative orientation of the nuclear spins of the two protons. In para molecules the spins of the protons are anti-parallel, while in the ortho molecule the spins are parallel. The para molecules occupy the even rotational levels, and the ortho molecules occupy the odd levels.

The orientations of the spins have a pronounced effect on the behavior of the molecule. In fact, ortho-hydrogen is unstable and more reactive than its para-hydrogen counterpart. The liquid hydrogen fuel that is used to power the space shuttle is stored in the para-hydrogen form, which is less volatile. It should be noted that magnets are the prime source of control of the position of electrons. Few people realize that carbon monoxide can be subsequently burned-carbon monoxide can be viewed as a fuel. As related in stoichiometric charts representing ideal combustion parameters, the highest burning efficiency will be achieved at the highest carbon dioxide level, since carbon dioxide cannot be subsequently oxidized. The purpose of a catalytic converter is to reduce all carbon monoxide to carbon dioxide.

The amazing part is that the Magnetizer reduces emissions on cars with catalytic converters. The increased combustion efficiency is occurring within the engine due to increased fuel reactivity with oxygen (increased oxidation), the main factor responsible for increased combustion efficiency.

Fuel Ionizaton

The molecules of any gas or liquid carry +ve/–ve electric charges. These molecules get attracted to each other and form 'clusters'. In such condition, when the fuel is mixed with air, all the molecules of the fuel may not combine

Figure 1: Fuel Ionization Process

with the oxygen molecules in the air, in order to burn and give out heat energy. Some of the fuel molecules burn and the rest escape in the atmosphere as un-burnt gases. This leads to poor fuel efficiency and pollution of the atmosphere.

In the presence of the magnetic field created by the permanent magnets', the fuel molecules are oriented in a particular direction and the molecular clusters are opened out (as shown in the diagram above). This is called 'ionization'. Ionized fuel molecules combine with oxygen molecules in the air quickly and burn effectively. This more effective burning increases the flame temperature and higher heat energy, leading to fuel saving and reduction of air pollution.

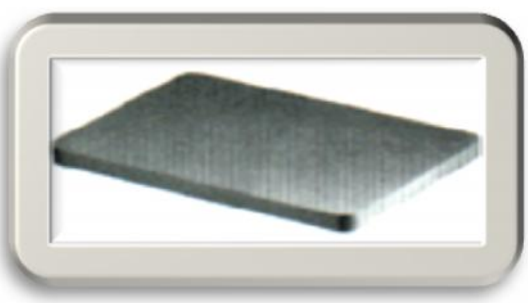
Specifications of Magnet

The permanent magnet has certain specifications like shape, size, gauss value, curie temperature.

Shape	Rectangular Type
Gauss value	6000 gauss
Type	NbFe
Curie temperature	250 °C-300 °C

One tesla (T) is equal to the 10000 gauss. Gauss is the unit for magnetic field.

Figure 2: Rectangular Type Magnet



In this we used two magnets which are attracting each other, in between the magnets the fuel pipe will be there. The magnetic lines will pass through the fuel, which will ionize the fuel. The ionized fuel will combust in combustion chamber, which results in fuel economy.

Experental Set Up

Four-Stroke, Single Cylinder, Water Cooled Diesel Engine with Mechanical Rope Brake Dynamometer

Performance (load) test on four stroke, single cylinder, water cooled diesel engine at constant speed and to draw performance characteristics of the engine.

Engine Specifications

Make	:	Kirloskar
Power	:	5 H.P
Speed	:	1500 rpm
No. of cylinders	:	01
Compression ratio	:	16.5 : 1
Bore	:	80 mm
Stroke	:	110 mm
Orifice diameter	:	20 mm
Type of ignition	:	Compression ignition
Method of loading	:	Rope brake
Method of cooling	:	Water

Loading System

The engine test rig is directly coupled with a brake drum and a rope brake around the drum. One end of the rope (Top end) is connected to a spring balance and the other end to a weight plat form. The load to the engine can be varied by adding slotted weight provided on to the platform. Please see that the weight platform is above the base (hanging) while the engine is loaded, to do so use the hand wheel provided on the loading frame. The engine is fitted with a brake drum and a rope around it with a dead weight plat form at one end (bottom end) and a spring balance at the other (top end). The engine can be loaded in terms of ¼, ½, ¾ full load by adding necessary dead weight on to the plat form.

Installation of Magnetizer

Magnetizer is installed to fuel injector pipe between fuel pump and fuel injector.

If nearer the position of magnetizer, better the improve in performance. So the position must be nearer to fuel injector.

Figure 3: Dynamometer

Figure 4: Dynamometer with Magnetizer

Specifications of Magnet

The permanent magnet has certain specifications like shape, size, gauss value, curie temperature.

Shape	Rectangular Type
Gauss value	13000 gauss
Type	NbFeB
Curie temperature	250 °C-300 °C

One tesla (T) is equal to the 10000 gauss. Gauss is the unit for magnetic field.

Fuel Injector Pipe

Injector pipe is the fuel line. It carries high pressure fuel from fuel pump to fuel injector in diesel engines. The injector on a diesel engine is its most complex component and located in a variety of places. The fuel injector pipes are made up of ferrite material

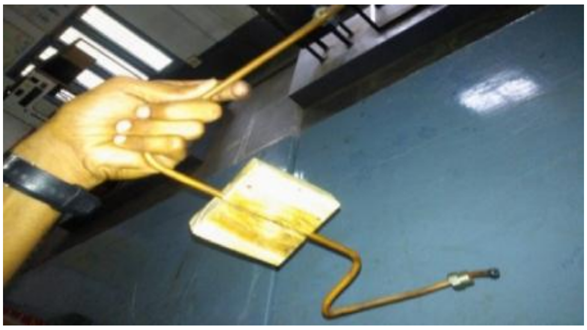
Figure 5: Mild Steel Fuel Injector Pipe

Ferrite materials do not allow magnetic lines of force. If magnetizer is strapped to fuel line, magnets attract the ferrite fuel injector pipe.

Installation of Magnetizer Set Up

The magnetizer should be installed just before the carburetor or injector on inlet pipe or housing for maximum alignment and maximum effect.

Figure 6: Injector Pipe with Magnetizer



PERFORMANCE OF ENGINE

The performance parameters with magnetizer and without magnetizer are compared.

Table 1: Comparison of Performance Parameters

Parameters	Units	Without Ionizer	With Ionizer
BP	KW	1.94072	1.94072
FP	KW	2.4	2.25
IP	KW	4.34	4.19
η_m	%	37.99	39.32
η_{BTE}	%	16.763	17.1352
η_{vol}	%	81.576	82.36
ISFC	kw/kg-hr	0.1944	0.1924
BSFC	kw/kg-hr	0.43475	0.4245
m_f	kg/sec	0.000234	0.000225
Ma	kg/sec	0.006566	0.00663
A/F	–	31.386	33.82
SMOKE	–	6.644	5.916

The comparison shows an improvement in some parameters like, η_m, η_{BTE}, η_{vol}, and a reduction in mass flow rate of fuel, BSFC and smoke levels.

PERFORMANCE GRAPHS

The engine performance has been analyzed with the following graphs which are plotted between Brake Power and other parameters from the experimental results.

It is observed from the Figure 7 that the mass flow rate of fuel for with magnet case is always below the curve that is drawn for with out magnet case. At 50% load both the values are coincided. The lesser the mass flow rate the better the fuel economy. A graph is drawn between brake power and mechanical efficiency as shown in Figure 8. It is found that

Figure 7: BP vs Mass Flow Rate

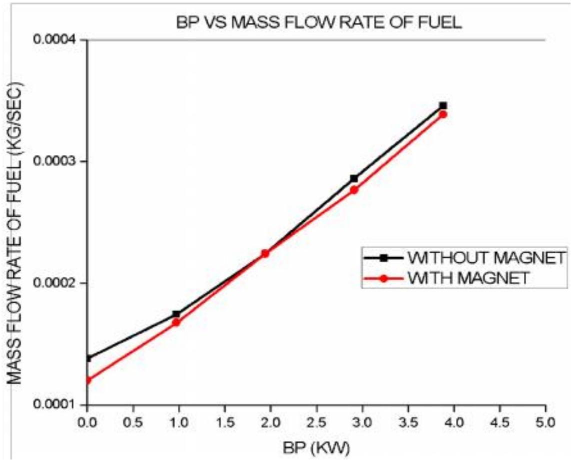
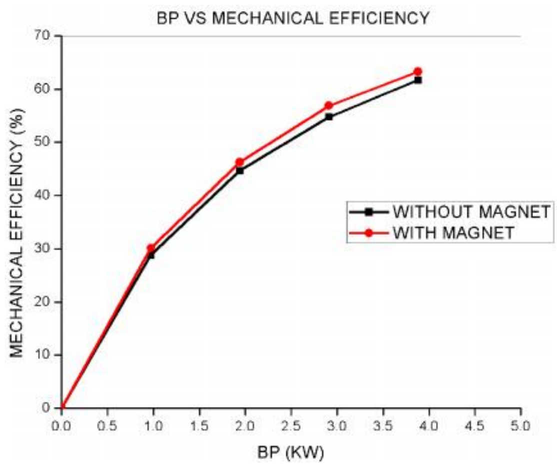


Figure 8: BP vs Mech. Efficiency



an increase in mechanical efficiency by 2% for the magnet case. This is because of less frictional power developed in the engine.

In Figure 9 brake specific fuel consumption was little less at all loads in case of with magnet which means that a direct reduction in the fuel consumption by the engine and hence better fuel economy. It is observed from the Figure 10 that the curve drawn for brake thermal efficiency appears to be always ahead of other line drawn for with out magnet case. This is because of an increase in brake power of the engine.

Figure 9: Brake Power vs BSFC

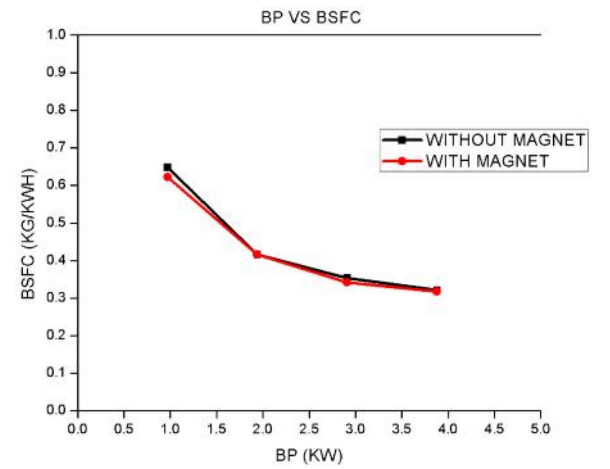


Figure 10: BP vs Brake Thermal Efficiency

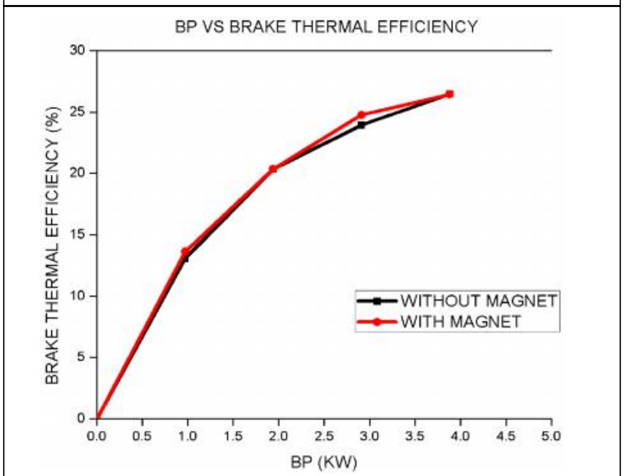


Figure 11: BP vs Indicated Specific Fuel Consumption

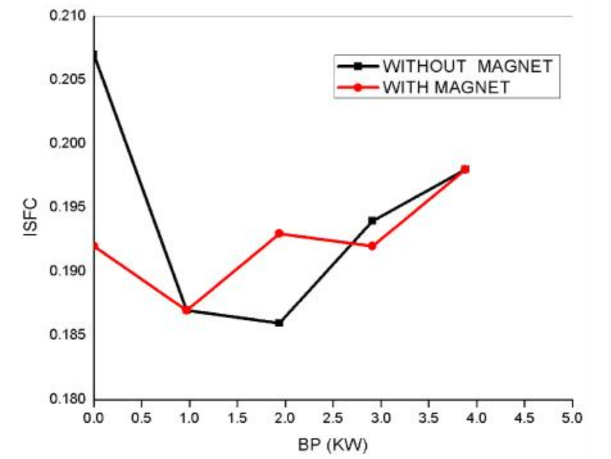


Figure 12: BP vs Volumetric Efficiency

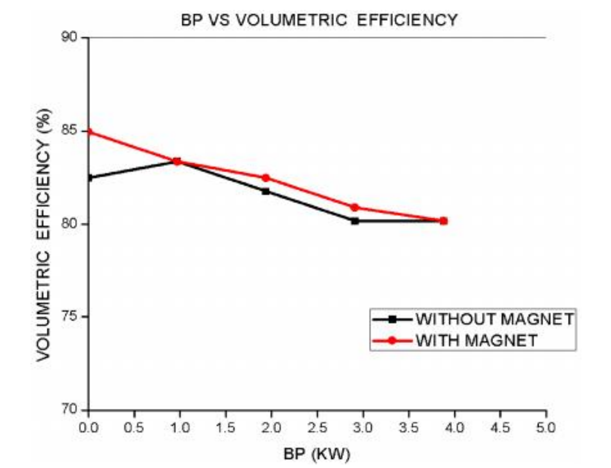
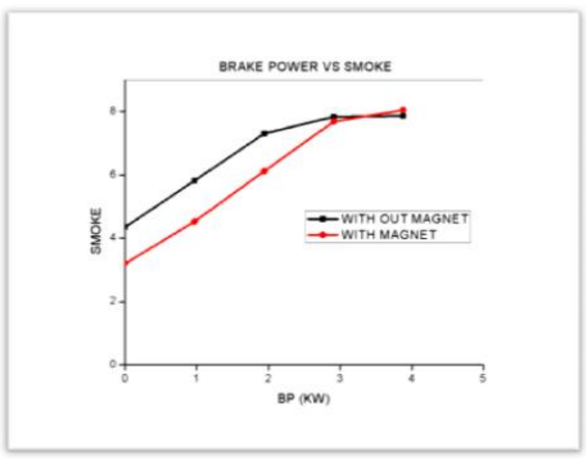


Figure 13: BP vs Smoke



The indicated specific fuel consumption seem to be less for the lower load values, higher at 50% load and lower at other loads as observed from the Figure 11. Lower ISFC values results in low indicated power and hence higher mechanical efficiency. It is noticed from the Figure 12 that for all loads the volumetric efficiency seem to be far better for the magnet case when compared with the case of with out magnet. The smoke levels are observed to be comparably less for the magnet case. This is because of the reason that there was better mixing of air fuel mixture which leads to better combustion and ultimately less smoke levels from the engine as shown in Figure 13.

Table 2: Experimental Data for Without Magnetizer

Load %	Mass Flowrate of Fuel Kg/sec	Indicated Power kw	¦Mech %	¦Bth %	¦Ith %	¦Vol %	I.S.F.C Kg/kw-hr	B.S.F.C Kg/kw-hr	Air-Fuel Ratio
0	0.0001383	2.40	0	0	–	82.47	0.207	–	48.01
25	0.0001747	3.37	28.78	13.06	–	83.34	0.187	0.648	38.41
50	0.0002243	4.340	44.71	20.35	–	81.75	0.186	0.416	29.33
75	0.0002862	5.3112	54.8	23.933	–	80.16	0.194	0.354	22.53
100	0.0003458	6.2818	61.7	26.472	–	80.16	0.198	0.321	18.65

Table 3: Experimental Data for with Magnetizer

Load %	Mass Flowrate of Fuel Kg/sec	Indicated Power kw	¦Mech %	¦Bth %	¦Ith %	¦Vol %	I.S.F.C Kg/kw-hr	B.S.F.C Kg/kw-hr	Air-Fuel Ratio
0	0.0001202	2.25	0	0	–	84.94	0.192	-	56.90
25	0.0001676	3.22	30.12	13.61	–	83.35	0.187	0.622	40.03
50	0.0002243	4.190	46.31	20.33	–	82.47	0.193	0.416	29.60
75	0.0002766	5.162	56.87	24.771	–	80.88	0.192	0.342	23.53
100	0.0003387	6.1316	63.30	26.965	–	80.16	0.198	0.318	19.04

SCOPE OF FUTURE WORK

Further, in this work some case studies may be taken up where in ferrite magnets will be used as Magnetic Fuel Conditioner (MFC), for further improving efficiency and minimizing emissions by providing a permanent magnet mounted in path of fuel lines.

This will tackle and control the pollution issues due to CO, HC, SOx and NOx, etc., apart from improving the engine life. Authors would like to take up the work of developing mechanism and other parameters that affects the efficiency of a Magnetic Fuel Conditioner (MFC).

CONCLUSION

The performance of a four stroke diesel engine incorporated with magnetic ionization method has been studied experimentally. The adopted magnetic fuel ionization method was seem to be promising in enhancing engine efficiency as well as reducing emission levels in a four stroke diesel engine. The magnets mounted on fuel line resulted in enhancement of fuel properties such as its aligns and orients, hydrocarbon molecules, better atomization of fuel (proper mixing of air with fuel), etc. This has resulted in improved efficiency due to better atomization and reduced emissions because of complete combustion. Implementation of such magnetic fuel ionization fuel method also improves mileage of vehicle. The incorporation of magnetic fuel ionization method in a four stroke diesel engine has resulted in an increase in brake power, mechanical efficiency, volumetric efficiency apart from a reduction in mass flow rate, brake specific fuel consumption and smoke levels. This method is considered to be eco friendly, cost benefit and provides extra life for the engine.

REFERENCES

1. Ali S Farisa *et al.* (2012), "Effects of Magnetic Field on Fuel Consumption and Exhaust Emissions in Two-Stroke Engine", *Science Direct Energy Procede*, Vol. 18, pp. 327-338.
2. Engr Okoronkwo *et al.* (2010), "The Effect of Electromagnetic Flux Density on the Ionization and Combustion of Fuel (An Economy Design Project)", *American Journal of Scientific and Industrial Research*, pp. 528-531.
3. Ganesan V (2007), "I.C Engines", McGraw-Hill.
4. http://fuelfuelmagnet.net
5. http://fuelsaving.info/magnets,htm
6. http://fuelwww.ecomagnets.com/therguoflow.htm
7. Shweta Jain *et al.* (2012), "Experimental Investigation of Magnetic Fuel Conditioner (MFC) in I.C. Engine", *IOSR Journal of Engineering (IOSRJEN)*, Vol. 2, pp. 27-31, ISSN: 2250-3021.
8. www.techalone.com