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Performance Analysis of Compression Ignition Engine by Magnetic Treatment on Fuel

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ABSTRACT

The performance of I.C engine greatly depends on the complete combustion of the air fuel mixture. Incomplete combustion of fuel in cylinder emits harmful gases as well as reduces the thermal efficiency of an engine. It is found that complete combustion of fuel reduces the unburnt gases which results in less emissions. Also complete combustion of fuel result in increase in power output for the particular input of mass flow rate of fuel resulting in increase in thermal efficiency. The present research work aims to improve the complete combustion of fuel in the compression ignition engine. The experimental tests are conducted on four stroke single cylinder compression ignition engine which is practically used for agricultural applications as well as in light commercial vehicles. The magnetic field of different field strength is applied on fuel carrying line near the fuel injector. The performance of compression ignition engine is observed without magnetization & with magnetization of different field strength. The mass of fuel consumed at a particular load & the composition of exhaust gases are observed. From the series of experimental test conducted at a different loading condition it is observed that the brake specific fuel consumption reduces up to 10 % depending on the magnetic field strength. The Brake thermal Efficiency is found to be increasing up to 12%. The percentage of NOx and CO in the exhaust gases found to be decreasing due to magnetic field application. Unburnt HC emissions are found to be completely eliminated.

***Keywords*— C.I. Engine, Fuel Saver, Ionisation of fuel, Incomplete combustion, magnetic treatment**

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I INTRODUCTION

The Internal Combustion engine is the mechanical device which converts chemical energy of fuel into the mechanical energy by the combustion of the fuel inside the cylinder. The internal combustion engines use fossil fuels (most commonly petrol or diesel) for their functioning. But today the world is facing the problem of limited fossil fuel reservoir capacities and the pollution caused by extensive use of fossil fuels due to their incomplete combustion. The incomplete combustion will generate a series of harmful or toxic residues in their exhaust gases. The carbon particulate matter will be partially wiped out at the pistons, to become the PM in the exhaust gas. The incomplete combustion will generate toxic gases such as CO & HC. The incomplete combustion of fuel also remain oxygen inside the cylinders, the oxygen will react with N_2 in the air & Sulfur in the fuel under a high-pressure and high temperature environment of cylinders. This will generate NOx & SOx in gasoline engines. In the presence of sunlight, NOx reacts with volatile organic compounds to produce ground-level ozone or smog which is harmful to lung tissues & causes damaged vegetation and reduced crop yields. PM alone or in combination with other pollutants causes respiratory problems. PM acts as carriers of carcinogenic compounds & is potentially a cancer-causing agent. Environmental impacts of NOx & PM include acid rain, climate change, water & soil quality deterioration & visibility impairment. There is a tremendous research activities are focused to find the solution to these problems. Most of the research work is aimed at modifying the engines or its components. Modern engines are optimizing its efficiency via modifying mechanical designs and improving its fuel injection & fuel management computer systems & sensors technologies to adjust a better air-fuel-ratio or accurate fuel injection ration and timing. The performances of the engines almost have reached their limitation. There is also an extensive research to use noble metal type catalysts and ceramics filters to process and neutralize the harmful emissions in the exhaust gas. Although the above technologies have been improved a lot, still they cannot really perfectly solve the problem of incomplete combustion of fuels in every stroke. The current technologies can only process the harmful combustible fuel residues by burning them or oxidizing them. All these methods are costly & cannot prevent the wastage of fuels. From a long term studies, a root cause of the incomplete combustion was found out. It is the phase boundary potential of the various substance in the nature. Everything on the earth is affected by the terrestrial magnetic field and carry either positive or negative potential on its surface. The type of the potential that a matter carries is up to its nature but the strength of the potential could be affected by outer environment or other extra factors. Organic fuels that refined from the oil do not only have single contents, it is a complicated mixture of certain kinds of organic contents and sometime contents water molecules. The different types of complicated potentials of these molecules affect each other, create molecules clusters inside the fuel liquid. Thus, despite the most advanced fuel injection technologies, people still cannot crush the clusters yet. This means that the fuel mists injected into the engine chambers contents different sizes of clusters, this causes combusting speed differences. The cluster of fuel molecules does not allow the oxygen in the air to completely mix with each molecule. Due to this the fuel molecules inside the cluster remains unmixed with oxygen. This will gives rise to incomplete combustion.

I.

I. LITERATURE REVIEW

Okoronkwo C. A et al has conducted an experimental study on the effect of electromagnetic field on the ionization and combustion of fuel in an internal combustion engine. The experimental set up consist a HGA 200 computerized exhaust gas analyzer, single cylinder 4 stroke engine, a copper wire wound round a hollow cylindrical rod which is connected to a DC 12 V battery. Results obtained during the test, gave a 50% reduction in the HC constituent of the exhaust product in PPM and 35% reduction in the carbon monoxide. The study suggests that the materials for the inlet manifold and the top cylinder of the engine be made from a magnetic material. This will create magnetic field around the combustion chamber for proper mixing & burning of the fuel. [1]

P. Vijaya Kumar et al has made an attempt in their 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. 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%. [2]

Farrag A. El Fatih et al in their research investigated the effect of magnetic field on internal combustion engines. The magnetic field was applied to spark ignition engine. The fuel is subjected to a permanent magnet mounted on fuel inlet lines. The experiments were conducted at different idling engine speeds. The magnetic effect on fuel consumption reduction was up to 15%. CO reduction at all idling speed was range up to 7%. The effect on NO emission reduction at all idling speed was range up to 30%. The reduction of CH_4 at all idling speed was range up to 40%. [3]

Ali S. Faris et al have used the energy of permanent magnets in this research for the treatment of vehicle fuel. The experiments in current research comprise the using of permanent magnets with different intensity (2000, 4000, 6000, 9000) Gauss, which installed on the fuel line of the two-stroke engine. The overall performance and exhaust emission tests showed the rate of reduction in gasoline consumption ranges between (9-14%) and the higher value of a reduction in the rate of 14% was obtained using field intensity 6000 Gauss & 9000 Gauss. The percentages of CO & HC were decreased by 30%, 40% respectively. [4]

Y. Al Ali et al has conducted two experiments, each using a different type of magnetic device. The first type of magnetic device is installed within the fuel tank and the second is installed onto the fuel line. Experiment was performed on ten separate vehicles from the Dubai Taxi Corporation fleet. When compared to the baseline data, reductions of 70 % for both HC and carbon monoxide emissions and 68 % for oxides of nitrogen were recorded. Results also demonstrated an average fuel consumption reduction of 18 %. [5]

P. Govindasamy et al in their research work applied a magnetic field on 2 stroke S.I. engine. The experimental results show that the magnetic flux on fuel reduces the carbon monoxide emission up to 13% for base engine, 23% in copper coated (inside the cylinder head) engine and 29% in zirconia coated (inside the cylinder head) engine. [6]

II. EXPERIMENTAL SET UP

The proposed experimental set up is as shown in fig.1.The engine to be used is 4 stroke single cylinder diesel engine. The engine is naturally aspirated, hand cranked for initiating combustion. The magnets of suitable intensity are placed around the fuel supply line of the engine. The location of placement of magnets may be changed depending on the requirement. The burette attached to fuel tank can be used to measure the quantity of a fuel flowing. Exhaust gas analyzer is used to measure the exhaust gas constituents.

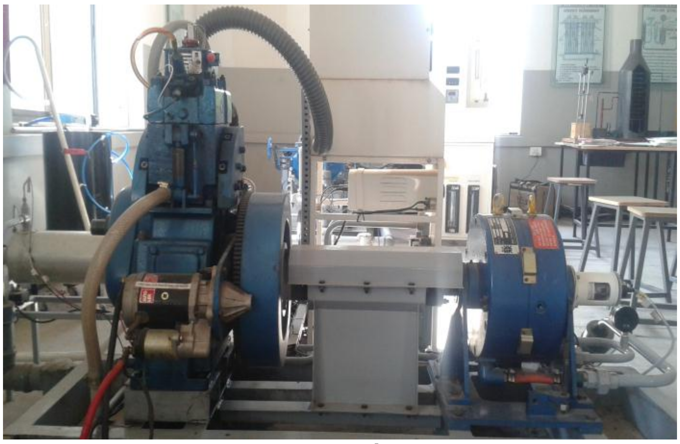


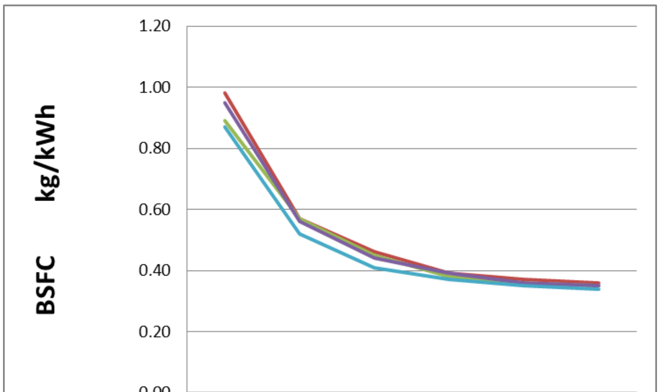
Fig.1 Experimental Set up

The magnetic field is created with the help of strong permanent magnets. Permanent magnets are made of special alloys to create increasingly power of magnets. Neodymium-iron-boron (ndfeb) magnets are selected for this work. The selection of magnets is done on the basis of strength of magnets. Various shapes of these type of magnets are shown in the fig.2.

Fig.2 Permanent Magnets

III. Results

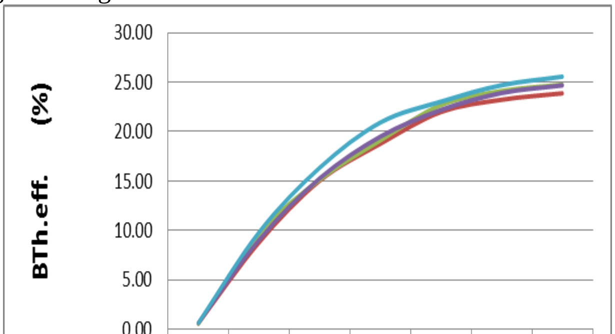
The experimental tests are carried out on set up without magnetisation and with magnets of different strengths such as 350, 500 & 1000 Gauss. From the observations, the calculations are carried out. The parameters like brake specific fuel consumptions and brake thermal efficiency are calculated at different loads. The various graphs are plotted as follows



	1.9	3.9	6	7.9	10	12
W/O Magnets	0.98	0.57	0.46	0.39	0.37	0.36
350 Gauss	0.89	0.57	0.45	0.38	0.36	0.35
500 Gauss	0.95	0.56	0.44	0.39	0.36	0.35
1000 Gauss	0.87	0.52	0.41	0.37	0.35	0.34

Fig.3. Variation in Brake Specific fuel consumption with load at different magnetic fields.

From fig.3, it can be seen that Brake Specific Fuel consumption is maximum at a particular load on the engine when there is no magnetic field is applied on fuel line. Brake specific fuel consumption at a particular load decreases with respect to magnetic field strength. More the magnetic field strength more decrease in the brake specific fuel consumption is observed. Brake specific fuel consumption decreases with the load in compression ignition engine.



	0.1	1.9	3.9	5.9	8	10	12
W/O Magnet	0.61	8.78	15.03	18.77	21.99	23.23	23.88
350 Gauss	0.58	9.63	15.15	19.11	22.69	24.11	24.75
500 Gauss	0.64	9.05	15.28	19.50	22.19	23.91	24.68
1000 Gauss	0.66	9.83	16.35	20.92	23.04	24.70	25.56

Fig.4. Variation in Brake Thermal Efficiency with load at different magnetic fields.

Fig. 4 shows the Brake Thermal Efficiency in compression ignition engine increases with the load and maximum Brake Thermal Efficiency occurs at full load. It can be seen that Brake Thermal Efficiency increases with magnetic field strength at a particular load. Maximum brake thermal efficiency is observed at a higher magnetic field strength.

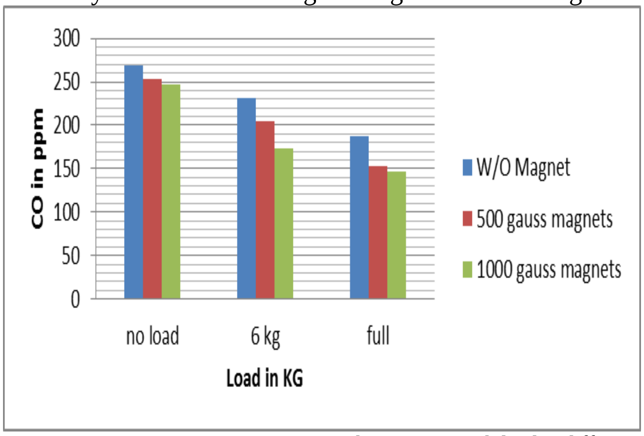


Fig.5. Variation in CO emission in exhaust gases with load at different magnetic fields.

Fig. 5 shows the CO percentage in the exhaust of compression ignition engine decreases with the application of magnetic field. The CO percentage decreases with increase in magnetic field strength. The variation in CO percentage decreases as the load on the engine increases as shown in figure.

Fig. 6 shows that NO_x in the exhaust is more if magnetic field strength is not applied at a particular load. The NO_x percentage in the exhaust decreases with application of magnetic field. Also the percentage of NO_x decreases with increase in the magnetic field strength.

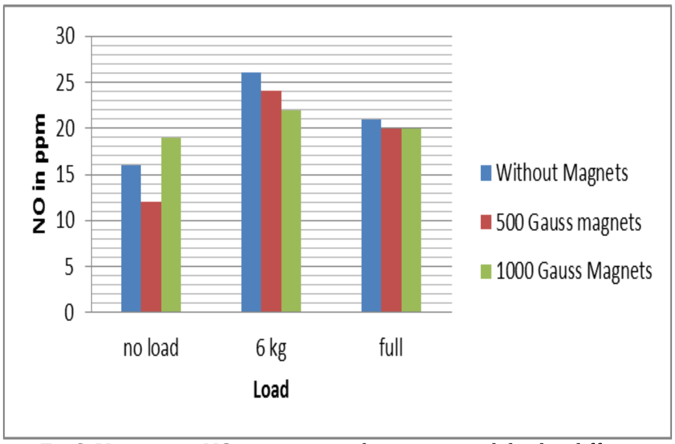


Fig.6. Variation in NO emission in exhaust gases with load at different magnetic fields.

IV. Conclusion

The performance of compression ignition engine is observed without magnetization and with magnetization of different field strength. The mass of fuel consumed at a particular load as well as the composition of exhaust gases are observed. From the series of experimental test conducted at a different loading condition it is observed that the brake specific fuel consumption reduces up to 10 % depending on the magnetic field strength. The Brake thermal Efficiency is found to be increasing up to 12%. The percentage of NO_x and CO in the exhaust gases found to be decreasing due to magnetic field application. Unburnt HC emissions are found to be completely eliminated.

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