International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 10 | Oct 2021 www.irjet.net p-ISSN: 2395-0072

EFFECT OF MAGNETIC FIELD ON EFFICIENCY OF CI ENGINE BY USING EIGHT PAIRS OF MAGNETS

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Abstract - *The present study investigates the effect of magnetic field on the performance of single cylinder four stroke compression ignition engine. The study concentrates on the effect of magnetic field the engine performance parameters such as fuel consumption, break thermal efficiency and exhaust emissions and on fuel properties like density and calorific value. The magnetic field is applied along the fuel line. The magnetic field is applied with the help of 8 Pair of strong permanent magnets. The experiments are conducted at different engine loading conditions. The exhaust gas emissions such as co, co2, hc and nox are measured by using an exhaust gas analyzer.*

Key Words: **Magnetic field, Combustion, Stable Structure, Air-Fuel Mixture, Hydrocarbons.**

1.INTRODUCTION

Fuels are used in the form of liquid; they don't combust until they are vaporized and mixed with air. Mostly in IC engines, the fuel is a compound of number of molecules. Every particular molecule consists of a number of atoms made up of number of nuclei and electrons, that orbit their nuclei. The occurrence of hydrogen exists in two distinct forms, namely, Para and ortho It is characterized by different opposite nucleus spins. The ortho state of hydrogen is more effective than the para state for optimum combustion. By the introduction of strong magnetic field along the fuel lining, the ortho state can be achieved. Clusters are formed from HC molecules, it has been technically possible to strengthen Van der Waals' discovery due to proper application of the magnetic field, a high power, permanent magnetic device that is strong enough to break down, i.e. to de-cluster these HC associations, maximum space acquisition for oxygen to combine with the HC[3].As already discussed, if strong magnetic field is applied along the fuel line, ortho form is achieved, similarly in para hydrogen molecule, the anti-parallel rotation is occupied and if the spin state of a particular atom relative to the other is in its opposite direction, then it's said to be diamagnetic. On the other hand, in ortho, the rotational levels are parallel, therefore the spin state of an atom relative to the other will be in the same direction only, hence making it paramagnetic[15].

Magnetic field ionization is based on the principle of magnetic field mutual action with HC molecules of oxygen and fuel molecules. There are various physical attraction forces that exist between hydrocarbons and they form dense and compact structures called pseudo-compounds which can further get organized into clusters [10]. Due to the physical attraction forces existing between hydrocarbons, oxygen atoms cannot penetrate into their interior when the mixture of fuel and air takes place. Further, stability is achieved. In order to polarize the hydrocarbon fuel, an external force by means of magnetic field is applied. Due to this, hydrocarbon fuel changes its orientation and the space increases between hydrogen. This hydrogen of fuel actively interlocks with oxygen and thus complete burning in the combustion chamber occurs.[1] It has also been noted the time the fuel passes through a magnetic field, it helps increasing the atomization process by improved mixture formation. Since the rate of disintegration increases, this results in the decrease of surface tension and the viscosity of the fuel.[9][8] Therefore fuel consumption of engine gets reduced and emission of carbon particles, carbon monoxide and hydrocarbons and other pollutants also get reduced.

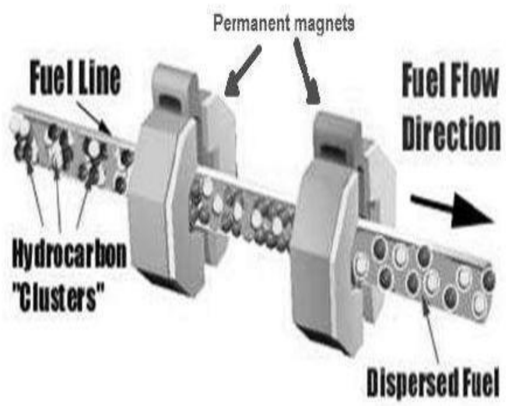

Fig 1.1: Direction of fuel flow using permanent magnets

2. CAD Modelling

The deisgn is needed to be compact as the fuel line is passed through the the product to the engine such the the setup consisting of magnets charges the fuel passing through the fuel pipe, this setup is kept just before the engine and can be said as an accessory of an engine.

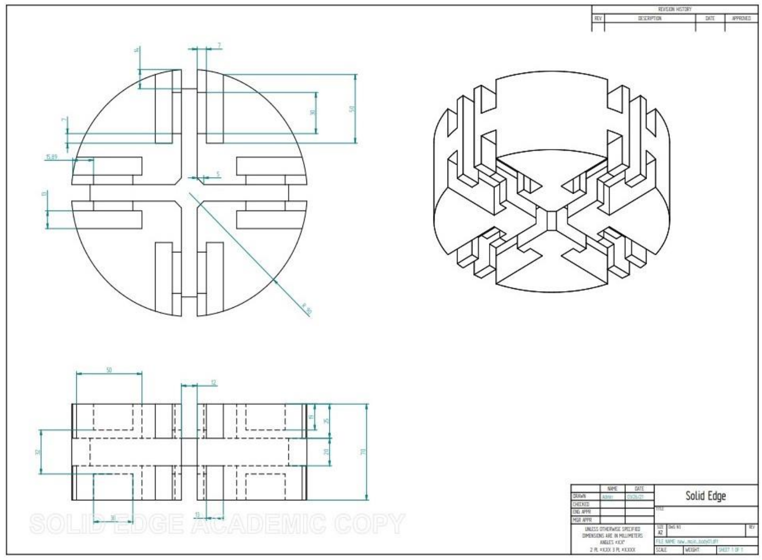

Fig 2: 2D sketch

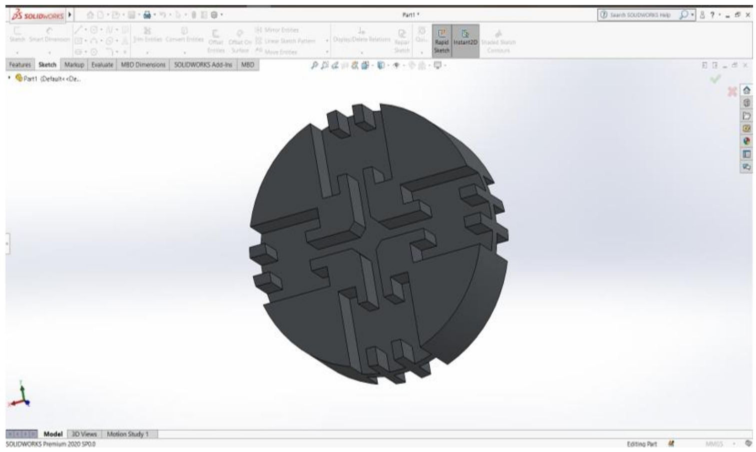

Fig 3: Model design

3. Calculations

Observation were taken on the 4-stroke one cylinder SI engine, at different load conditions and with corresponding magnetic pairs on the Fuel line.

After taking readings from the laboratory, we can proceed for the calculations as shown below.

4 Observation Tables :

Load (Kg)	Speed (rpm)	Manometer reading	Fuel Flow (sec/23 ml)
0	1576	68	140 s
3	1565	68	96 s
6	1544	68	80 s
9	1533	68	73 s
12	1510	68	62 s

Table 4.1 Observation table for 0 pair of magnets.

Load (Kg)	Speed (rpm)	Manometer reading	Fuel Flow (sec/23 ml)
0	1555	68	146 s
3	1540	68	99 s
6	1528	68	83 s
9	1510	68	76 s
12	1490	68	65 s

Table 4.2 Observation table for 2 pairs of magnets.

Load (Kg)	Speed (rpm)	Manometer reading	Fuel Flow (sec/23 ml)
0	1545	68	148 s
3	1531	68	105 s
6	1505	68	87 s
9	1495	68	80 s
12	1485	68	69 s

Table 4.3 Observation table for 4 pairs of magnets.

Load (Kg)	Speed (rpm)	Manometer reading	Fuel Flow (sec/23 ml)
0	1550	68	152 s
3	1520	68	109 s
6	1500	68	93 s
9	1493	68	85 s
12	1485	68	74 s

Table 4.4 Observation table for 6 pairs of magnets.

Load (Kg)	Speed (rpm)	Manometer reading	Fuel Flow (sec/23 ml)
0	1560	66	156 s
3	1532	68	113 s
6	1514	68	98 s
9	1498	67	89 s
12	1492	66	79 s

Table 4.5 Observation table for 8 pairs of magnets.

5 Calculations:

We have,

1.Dynamometer arm length (R) = 185 mm

2. Bore (D) = 87.5 mm

3. Stroke (L) = 110 mm

4. No. of Cylinders (x) = 1

5. Sp. Gravity of fuel (Diesel) = 0.83

6.Specific heat of water (Cp) = 4.187 kJ/kg K

7.CV of Diesel = 44000 kJ/k

Calculation for 3kg load without any magnet.

We know,

- I.P= B. P+F.P (Kw) (Where FP is friction power)

$$BP = \frac{2\pi NT}{60000} = \frac{2\pi NW9.81R}{60000} = 0.89KW$$

IP=0.89+0.4 (F.P.=0.4)

=>IP=1.29 kW

- IMEP (indicated mean effective pressure) =

$$\frac{IP}{\left(\frac{\pi}{4}\right)d^2L * n * x} = \frac{1.2928}{0.785 * (0.20^2) * 0.110 * \left(\frac{1566}{120}\right) * 1}$$

IMEP=28.6667 kPa

- BMEP(Brake mean effective Pressure) =

$$\frac{BP}{\left(\left(\frac{\pi}{4}\right) * d^2 * L * n * x\right)} = \frac{0.3928}{0.785 * 0.00875^2 * 0.110 * \left(\frac{1566}{120}\right) * 1}$$

$$BMEP = 103.4297KPa$$

$$\eta ith = \frac{IP}{mf * cv} = \frac{28.6667}{(8.3 * 10^{-4}) * 44000} = 78\%$$

$$\eta bth = \frac{BP}{mf * cv} = \frac{0.8928}{(8.3 * 10^{-4}) * 44000} = 24\%$$

- To calculate mass of fuel :

$$m = \frac{\rho va}{RT} = \frac{100 * 10^5 * 0.6731}{0.287 * 10^3 * 273}$$

$$m = 85.908$$

$$mf = \frac{10 * 10^{-6} * pf}{t} = \frac{10 * 10^{-6} * 0.83 * 1000}{10}$$

$$mf = 8.30 * 10^{-4}$$

Calculations for 3kg load with magnets:

I.P= B. P+F.P (Kw) (Where FP= friction power)

$$BP = \frac{2*\pi*N*W}{60000} = 0.9102Kw$$

IP= 0.9102 +F.P⇒Willian Line Method

IP= 0.9102 +0.40

IP=1.310 kW

$$\eta mech = \frac{BP}{IP}$$

$$\eta mech = \frac{0.9102}{1.279} = 71.16\%$$

- IMEP (indicated mean effective pressure) =

$$IMEP = \frac{IP}{\left(\frac{\pi}{4}\right) D\times D\times L\times n\times x} = \frac{1.310}{0.785\times(87.5\times10^{3})^{2}\times0.110\times13\times1}$$

IMEP=150.7955KPa

- BMEP(Brake mean effective pressure)

$$BMEP = \frac{BP}{\left(\frac{\pi}{4}\right)\times D^2\times L\times n\times x} = \frac{0.8734}{(0.785\times 87.5\times 10^{-3})\times 0.110\times\left(\frac{1532}{120}\right)}$$

BMEP=103.4363KPa

- To calculate mass of fuel:

$$Mf = \frac{(10\times 10^{-6}\times 0.83\times 1000)}{113} = 7.345\times 10^{-5}Kg$$

With the obtained calculations we can clearly note down the differences for indicated mean effective pressure, Brake mean effective pressure and mechanical efficiency.

Table 5.1: Calculation Table: Without magnets(Diesel)

Load (W)	BP (kW)	BMEP (bar)	BSFC (kg/kwhr)	IP (kW)	IMEP (bar)	Time (s/23ml)	Brake Thermal eff.	Mech efficiency	Mass of fuel (kg/hr)
3	0.8922	103.42	9.690* 10^-5	1.2922	149.7	96	23.453	69.04	8.6458* 10^-5
6	1.7606	206.87	5.892* 10^-5	2.1606	253.8	80	38.56	81.486	1.0375* 10^-4
9	2.622	310.30	4.336* 10^-5	3.0221	357.6	73	52.41%	86.76	1.1369* 10^-4
12	3.443	413.74	3.887* 10^-5	3.8437	461.8	62	58.46%	89.59	1.3387* 10^-4

Load (W)	BP (kW)	BMEP (bar)	BSFC (kg/kw hr)	IP (kW)	IMEP (bar)	Time (s/23 ml)	Brake Thermal eff.	Mech efficiency	Mass of fuel (kg/hr)
3	0.8734	103.46	8.40* 10^-5	1.2734	150.79	27%	71.16%	7.34* 10^-5	3
6	1.7264	206.87	4.905* 10^-5	2.1264	254.85	46.3%	84.68%	8.46* 10^-5	6
9	2.5622	310.30	3.639* 10^-5	2.9622	358.74	62.4%	89.8 %	9.32* 10^-5	9
12	3.4026	412.63	3.087* 10^-4	3.8026	461.13	73.6%	91.89%	10.5* 10^-5	12

Table 5.2: Calculation Table: With magnet

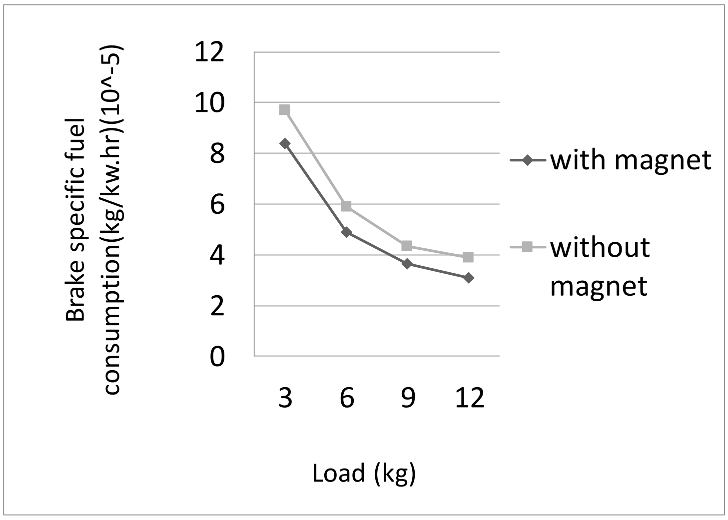

Fig 5.3 : Load vs BSFC

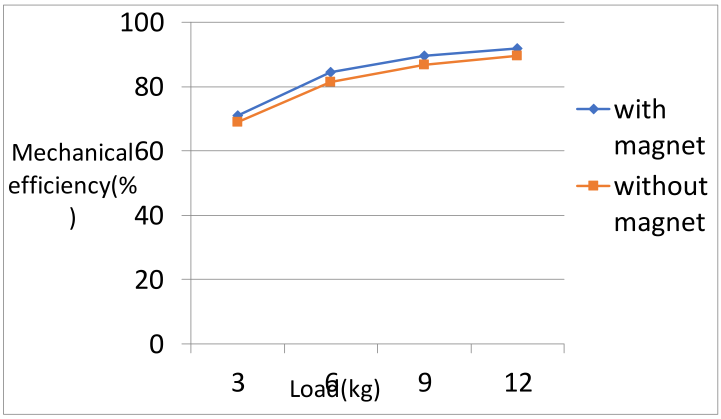

Fig 5.4: Mechanical Efficiency vs Load

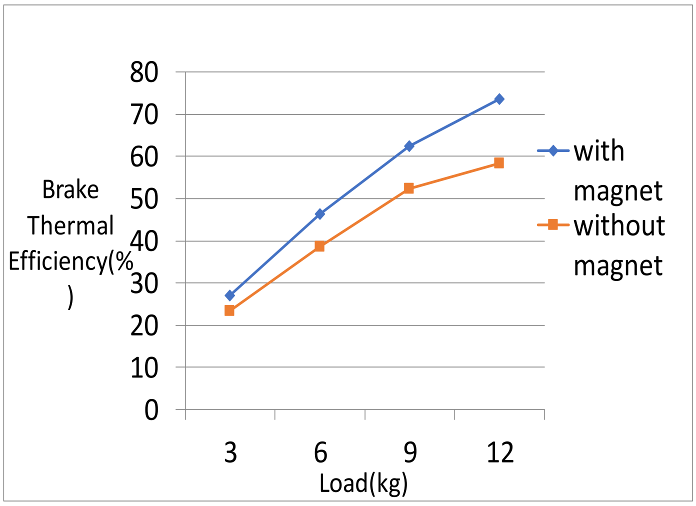

Fig 5.5 : Brake Thermal Efficiency vs Load

- BSFC value change: Reduced from 8.40x10^-5 to 3.08x10^-5 kg/kwhr for 3 to 12 kg load.
- Mechanical Efficiency: Increased from 68.58% to 89.48 % 3 to 12 kg load.
- Thermal efficiency: Increased from 27.02% to 73.60% for 3 to 12 kg load

6. Conclusion

- Use of such magnet mounted in path of fuel lines improves mileage & reduces emission of vehicle, removes surface tension and viscosity of fuel and leads to better combustion. We have conducted this experiments with different loads.
- The work in particular is very significant on account of its impact on the global automobile market
- An exhaust gas analyzer is used to measure the exhaust gas emissions such as CO, CO2, HC and NOX but we are using magnets which offers greater advantages in comparison.