DESIGN AND FABRICATION OF ELECTROMAGNETIC ENGINE

Ankita M. Jadhav[1], Ravindra S. Patil[2], Pragati A. Tingare[3], Prof. Monika Agrawal[4], Prof. Sumit Wani[5]

Department of Mechanical Engineering,
Keystone Schools of Engineering, Pune

Abstract –

Now a days IC engine plays an energetic role in demand of automobiles. The demand for fuel has increased so need of other energy has come necessary. The main generalization of this design is the zero point fuel consumption. The magnetic force principle is the basic demand to work for electromagnetic engine. The general property of magnet that is attraction and repulsion forces are converted into mechanical work. The glamorous driven engine derives it power from magnet power and constant magnetic energy is converted into mechanical energy. The useful output is rotating movements and the operation is grounded on electromagnetic engine which varies from different field. The electromagnetic engine should be perfectly perform exactly the equal as that of internal combustion engine. The engine, the strength of the field is controlled by the quantity of windings. This design applies the power every fourth stroke same as normal does now. It utilizes only the repulsive force that allows field to dissipate fully, and have no restrictive effects on the rising piston. The main advantages of electromagnetic engine are that if is pollution free and internal region like valves and cam- followers, can be avoided. Also no manifolds are needed since there is no fuel flow. The challenges faced in designing an electromagnetic engine is that's has to be as effective as an internal combustion engine.

***Key Words*:**
Electromagnet, Permanent Magnet, Efficiency, attraction and repulsion, mechanical power.

1. INTRODUCTION

In present's modern World, it's virtually insolvable to imagine a life without IC Engines, which is one of the topmost man made innovations. IC Engines are primarily used in automobiles, which is a major mode of transportation to humanity. IC engines work basically on gasoline and diesel which are deduced from fossil fuels. The demand of automobiles keeps adding as the Population increases. With this increase, the rate of fossil fuel consumption also increases. This creates a situation that brings up a need to switch to alternate sources of fuel to produce the power similar to that of IC engines. The challenge isn't to produce an engine that operates on an alternate fuel but to produce advanced effectiveness. The coming source of energy that strikes our minds is definitely electrical energy. Now-a-days, we can see automobiles that operate completely on electrical energy or a hybrid vehicle that operates both on electrical energy and an IC Engine. Speaking of electrical energy, it is quiet hard to store large quantities. Therefore a system has to be developed that uses electrical energy in combination to produce better effective engines. Government has taken many a way to reduce the vehicular emission by setting emission standards. Still, elaboration of scientific styles for emigration force is pivotal. Thus, analysis is done on the emigrations from colorful vehicles by using IVE model. The quality of air in developing countries like India has reached a horrifyingly low position. Modal analysis to estimate a vehicular emission to show the temporal emission of vehicles

2. Literature Review

A literature survey was carried out and following research paper were studied:

Abil Joseph Eapen et al [1], the project conducted on the principle of electromagnetism has a two stroke engine. The magnets used are Neodymium Iron Boron magnets. A relay is used to control the current flow. Cylinders having non-magnetic properties such as stainless steel, titanium are suggested to avoid unwanted magnetic field and losses. Here, Aluminium is used for cylinders. For piston, materials having high resistivity and low electrical conductivity are to be used. A flywheel made of mild steel is used. A 555IC timer is used to provide time delays, as an oscillator and as a flip-flop element. A lead acid battery is used. For an input voltage = 36V and input current= 1A. The obtained efficiency is 21.44%. Conducting the experimental analysis, the following observations are observed: For Force vs Current graph plotted, force increases as the current is increased. For Speed vs Current graph, the speed of shaft increases as current increases. Maximum efficiency obtained was 21.22% at 229rpm for input current of 1.2A Maximum output power obtained was 20.7% at 249 rpm for an input of 1.7 A[1]

Atul kumar singh, et al[2], the paper tries to diminish the disadvantages associated with the conventional two stroke engine keeping its desired advantages intact viz. power stroke in each revolution, lightness, compact design. This is achieved by changing its power source from fuel pressure to electromagnetic force. For changing the polarity of the magnet from south to north and vice-versa a microcontroller coupled with high rating current regulator is used. Lithium batteries are used because they are available in market at cheap price. Microcontroller is used to control the rpm of the motor by controlling the frequency of current supplied to the winding of the stationary electromagnet via current controller. And

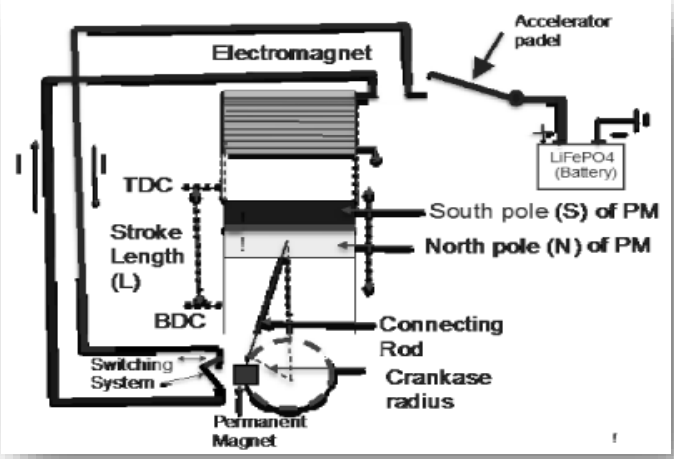
a current controller is used to provide the adequate current to the electromagnet which is controlled by microcontroller. For proposed electromagnetic engine: - Diameter of piston =140 mm Length of piston = 60 mm, Distance between two electromagnets at TDC=20mm, Distance between two electromagnets at BDC=70mm, No. of turns of wire for winding = 400, Current supplied = 20 ampere, F =8905.63 N? m2 at TDC, F = 451.30 N/m^2. [2]

Vishal Abasaheb Misal et al [3], the project is about to design electricity operated engine construction. An electromagnet is positioned on the top of the cylinder, while construction of engine is traditional. And piston is just a permanent magnet (Neodymium magnet). There is no combustion within the cylinder so design of piston and cylinder arrangement is simpler as compared to IC Engine. Switching of electromagnet is controlled by cam and follower arrangement. The total power supplied by battery will be just to fulfill the copper losses of winding and power required to magnetize the windings. Piston is made of a very strong Neodymium magnet. Connecting rod is made of aluminium alloy. Crank shaft is made of steel alloy. Cam and follower is used to control switching of the circuit for electromagnets. Capacitors are used to balance the reactive power in electromagnets. Switches used are operated by cam and follower arrangement and are normal DC circuit switches. Crank case is made of aluminium alloy. Movement of magnet doesn't induce back electromotive force in windings of electromagnet. Hence nothing happens similar to electric motor. Power to be produced at shaft of the engine is much more than the power to be consumed by electromagnet to repel permanent magnet. [3]

Gaurav S. Chavan, et al [4], the project focuses on the history of electromagnetism, electromagnetic engine and the advantages that took places through ages. For switching current flow, relays are used which are operated using electrical switches. Lithium batteries with high power rating are used with high duty cycle which are perfect for the application. Power magnets are used out of which one is attached on the head of the piston and other to flywheel. A switch is used to enable the supply the current from the battery to the coil, relay and magnetic switch i.e. on and off current supply. As there is no combustion, need of cooling system is eliminated. Magnetic energy eliminates the need of air filter, fuel tank, supply system, fuel filter, fuel injector, fuel pump, valves etc. Thus, design of the engine is made simple. Also by the use of materials like Aluminium, titanium etc. weight of the electromagnetic engine can be reduced. [4]

3. WORKING PRINCIPLE

This is based on attraction & repulsive force of the magnet. The working of the magnetic engine greatly resembles the working of a two- stroke engine. To start, let us begin from the situation, when piston is located in the smaller position. A coil is connected through a battery and the copper coil is energized to produce a magnetic field a piston in the side of the large power Neodymium Iron Boron magnets and the piston moved upper and lower the fly wheel connected through the piston link the copper coil energized the piston moves overhead and copper coil is de-energized the piston move to over. With the help of relay and control unit. The nonstop process through piston is move to (up and down) with also rotated the fly wheel. Electromagnetic engines are working with the principle of relation between the Magnetic fields. The Permanent magnet is fixed in a piston and iron material is connected to the copper coil. So that the iron material is converted into an electro magnet when the power force is given to it. When piston is located in the lower position, the coil is connected through the battery. The copper coil is energized to produce the magnetic field. With the help of relay and control unit, when the copper coil energized the piston move overhead and copper coil is de-energized the piston move to over. The nonstop process through which the piston is move (up and down) and it also rotate the flywheel.



4. DESIGN OF ENGINE COMPONENTS

A. Cylinder:

Cylinder of an electromagnetic engine is the simple rectangular block with a visionless opening in it. The temperature within the electromagnetic engine cylinder is actually low and so no fins are demanded for heat transfer. This makes the cylinder easily manufacturable. Also the cylinder is made of aluminium, anon- glamorous material which limits the magnetic field within the boundaries of cylinder edge. Operation of aluminium material makes the engine lighter unlike the cast- iron cylinder applied in internal combustion engine.

B. Connecting rod:

In a reciprocating engine, the connecting rod is used to connect the piston to the crankshaft. It converts the direct motion or reciprocating motion of the piston to the indirect motion of the crankshaft.

C. Piston:

The piston is the reciprocating part of an engine. The permanent magnet attached in the piston and the electro magnet attached in the cylinder creates a magnetic force which drives the crank shaft with the help of the connecting rod. At the piston top, few grooves are cut to

accommodate the piston rings and the bands left between the grooves are known as lands.

D. Fly wheel:

The Flywheel is made up of mild steel, it is used to convert a reciprocating energy into rotational energy. It regulates the engine's rotation to makes its operation at a steady speed. Flywheel have a significant moment of inertia and thus resist changes it rotational speed. An amount of the energy stored in the flywheel is proportional to square of its rotational speed. Energy is transferred to the flywheel by applying torque to it. It is used to store rotational kinetic energy.

E. Electromagnetic coil:

Electromagnetic coil is formed when an insulated solid copper wire is curled around the core or form to create the inductor or electromagnet. When electricity is passed through a coil, it generates the magnetic field. One loop of the wire are usually referred to as a turn or winding, and a coil consists of one or more turns.

F. Permanent magnet (NdFeB):

Most powerful 'rare-earth' permanent magnet composition is known to mankind, our specialty. This formulation is a relatively modern, first became commercially available in 1984. NdFeB magnets have highest B& Br of any magnet formula, and also have very high Hc. However they are very brittle, and hard to machine and sensitive to corrosion and high temperatures. It is used in home, workshop, pickup truck, laboratory, wind turbine, starship and etc.

I. Lead acid battery:

The lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A One cell has a nominal output of 2.1V, but lead-acid cells are frequently used in a series combination of three for a 6V battery and six for a 12V battery.

5. DESIGN CALCULATIONS

THEROTICAL CALCULATIONS

Input voltage = 12V

Input current = 1 A

Input Power = Voltage × Current = 12× 1 = 12W Max.

Force exerted by electromagnet on piston F1 = (N2 I 2KA)/2G2

Where, N = number of turns = 1000

I = Current flowing through coil = 1 A

K = Permeability of free space = 4π×10-7

A = Cross-sectional area of electromagnet (radius r = 0.0175 m)

G = Least distance between electromagnet and permanent magnet = 0.005 m

On substitution, we get Max. Force F1 = 24.18 N

Force exerted by permanent magnet Force F2 = (B2A)/2μ0

Where, B = Flux density (T)

A = Cross-sectional area of magnet (radius r = 0.0125 m) μ

0 = Permeability of free space = 4π×10-7

Now flux density B = Br /2 × [(D + z)/ (R2 + (D + z) 2) 0.5 – z/ (R2 + z 2) 0.5]

Where, Br = Remanence field = 1.21 T z = distance from a pole face = 0.005 m

D = thickness of magnet = 0.012 m

R = semi-diameter of the magnet = 0.0125 m

On substitution we get flux density, B = 0.2547 T

Now substituting B in the equation of force, F 2 = 12.67 N

Since, force F 1 and F 2 are repulsive,

Total force F = F 1 + F 2 F = 36.85 N Torque T = F × r

Where F = total force on piston r = crank radius = 0.01m Torque T = 0.3685 N-m

Mass of Fly wheel ω = (2πN)/60, where N = speed = 200rpm

Therefore, ω = 20.94 rad/s

Energy stored on flywheel E = T × θ

Where T = torque θ = Angle of rotation = 180o = π radians

On substitution we get energy stored E = 1.157 J

Also E = 0.5 × I × ω 2Where, I = moment of inertia of flywheel ω = angular velocity

On substitution we get moment of inertia, I = 5.277 × 10-7 Kg-m 2

Moment of inertia, I = 0.5 × m × r 2

Where, m = mass of fly wheel r = radius of fly wheel = 0.07 m

On substitution,

We get m = 2.154 Kg

P = (2πNT)/60 Where, N = speed = 200 rpm T = Torque = 0.3685 N-m

On substitution, we get Output Power P = 7.718 W

Efficiency = (Output/Input) × 100 = (7.718/36) × 100 Therefore,

Efficiency = 21.44 %

EXPERIMENTAL CALCULATIONS

Input voltage = 12 V Input current = 1 A Input power = Voltage × Current = 12 × 1 = 12W Max. Force exerted by electromagnet on piston F1 = (N2 I 2 KA)/2G2

Where, N = number of turns = 904

I = Current flowing through coil = 1 A

K = Permeability of free space = 4π×10-7

A = Cross-sectional area of electromagnet (radius r = 0.0078 m) G = Least distance between electromagnet and permanent magnet = 0.01 m

On substitution, we get Max.

Force, F1= (9042 ×12 ×4π×10-7 ×0.0078)/2× (0.01)2 = (817216×1×12.5664×10-7 ×0.0078)/2×0.0001 = (80101.8125×10-7)/0.0002 = 400509062.5×10-7 =40.05 N

Force exerted by permanent magnet Force F2 = (B2 A)/2μ0

Where, Max. Force, F1= 40.05 N 25 B = Flux density (T)

A = Cross-sectional area of magnet (radius r = 0.015 m) A=π×r 2 A =π× (0.015)2 A = π× 0.000225 A =0.0007 m2 μ0 = Permeability of free space = 4π×10-7

Now flux density B = Br/2 × [(D + z)/ (R2 + (D + z) 2) 0.5] – z/ (R2 + z2) 0.5

Where, Br = Remanence field = 1.21

T z = distance from a pole face = 0.01 m

D = thickness of magnet = 0.01 m R = semi-diameter of the magnet = 0.015 m

On substitution we get flux density, B = 1.21/2 × [(0.01 + 0.01)/ (0.0152 + (0.01 + 0.01)2) 0.5] – 0.01/ (0.0152 + 0.012) 0.5 =0.605 × [0.02/ (0.000225 + 0.0004)0.5] – 0.01/ (0.000225 + 0.0001)0.5 B =0.148 T

Now substituting B in the equation of force,

F2= [(0.148)2 × 0.0007]/2× 4π× 10-7 = [0.0219× 0.0007]/25.1327× 10-7 = (1.533× 10-5)/ (25.1327× 10-7) =0.06099×102 = 6.1 N

Force Exerted by the Permanent Magnet, F2= 6.1 N

Since, force F1 and F2 are repulsive, Total force F = F1+ F2 F = 40.05+ 6.1 = 46.1 N… (Torque T = F × r)

Where, F = total force on piston r = crank radius = 0.012 m

On substituting F and r, T= 46.1× 0.012 = 0.5532 N-m

Output Power P = (2πNT)/60

Where, N = speed = 125 rpm T = Torque = 0.5532 N-m

On substitution, P = (2π × 125 × 0.5532)/ 60 = (434.4822)/ 60 = 7.2414 W

Total Force, F= 46.1 N

Torque, T= 0.5532 N-m

Output Power, P= 7.2414 W

Efficiency, E = (Output/Input) × 100 = (7.2414/ 48) × 100 = 0.1508 × 100 = 15.08%

RESULT

- Total Force Exerted, F= 46.1 N
- Torque, T= 0.5532 N-m
- Output Power, P= 7.2414 W= 0.00971 bhp
- Efficiency, E= 15.08%

6. CONCLUSION

The Electromagnetic engine developed is an attempt to check the pollution generated by present Internal Combustion Engines. We have successfully demonstrated the concept of using electromagnetics to produce crank shaft rotation in an Internal Combustion Engine model. The research conducted is an example that the present internal combustion engines can be modified and made eco-friendly by using the suggested concept. Though the research conducted in this report in not adequate to be commercially applied but we believe that with

adequate funding and further research we would be able to develop the first ever commercially usable electromagnetic engine. The electromagnetic engine designed is totally different from motor, because the working principle of both are different as well as the power consumption is also very less in electromagnetic engine. The only power consumed is the power consumed by electromagnet. Electromagnet used here is to repel the permanent magnet. There are no other power consuming components. Movement of magnet doesn't induce back electromotive force in windings of electromagnet and hence nothing happens similar to electric motor here. Power to be produced at shaft of the engine is much more than the power to be consumed by electromagnet to repulse.

7. REFERENCES

[1] Atul kumar singh, Prabhat Ranjan Tripathi "Micro control Electromagnetic Engine" International Conference on Advances in Electrical and Electronics Engineering (ICAEE'2011)

[2] Himanshu T. Shah (2014), "Fabrication of Electromagnetic Engine"- International Journal for Technological Research In Engineering, ISSN- 2347- 4718

[3] Sherman S. Blalock, Electro-magnetic reciprocating engine; US 4317058 A https://www.google.ch/patents/US4317058

[4] Leland W. Gifford; Reciprocating Electromagnetic engine; US 5457349 A http://www.google.com/patents/US5457349

[5] Radhakrishna Shesha Iyengar Togare; Magnetic Piston Engine; 2010: US 7667356
B2http://www.google.ch/peatents/US76673
56

[6] Leland W. Gifford 'Reciprocating electromagnetic engine'.(June 30 1993)