

8-Stroke Solenoid Engine and its Efficiency

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Abstract - In Automobile, Engine is the only Place where power is produced to drive the vehicle and today, Most of the Engine are Internal Combustion (IC) Engine which use either petrol or Diesel as the fundamental fuel source. The burning of these gasoline in the cylinder discharges heat Energy which is changed over into mechanical Energy. These powers discharge destructive gases after burning and thus contaminate the climate just as have antagonistic consequences for the living creatures.

Non-renewable energy sources will get depleted sooner rather than later and presently; Electric Vehicles are the excellent option in comparison to the Conventional vehicles. Electricity produce Power with nearly zero emissions and has clean source of energy. The aim of the Project is to design an 8-Stroke Solenoid Engine which deals with the Principle of Electromagnetism and then calculate its efficiency. This idea is used to utilize electrical energy into mechanical energy and then power store at Flywheel by rotating the crankshaft is used to drive the vehicle.

Key Words: Solenoid actuator, Electromagnetism, Relay, Crankshaft

1. INTRODUCTION

In present world, we can't imagine a day without IC engines, The IC engine which is used in automobiles for transporting goods and for travelling also. Day-by-Day population Growth increases, so the need of automobile is also increasing. The IC engine use petrol and diesel as main source of fuel. That is why needs of fossil fuel is also increasing which automatically increases the price of fuel. Now the time come when we need to switch to alternative source of fuel to produce the power similar to IC engine. The challenge for us is to create an engine that operates on an alternate fuel but also have higher efficiencies. The next source of energy that strike our minds is definitely electrical energy because it produces no emission of gases and completely safe for environment and Government has also taken many steps to reduce the vehicular emission by setting emission standards.

The quality of air in developing countries like India has reached a horrifyingly low level.

For solving these problems many Models had been proposed like Pistons and the cylinders of a conventional IC Engine are replaced by the permanent magnet pistons and non-ferro

magnetic materials respectively which led to the invention of electromagnetic reciprocating engine by Sherman S. Blalock [1]. Multi-cylinder electro mechanical engine for the automotive that consists of the cylinders containing samarium cobalt type of magnets in pistons located at right angle to the pistons [2]. Growth in this field has led to the invention of Maps Engines which are incorporated with various equipment and machineries whose application are in fields such as aircraft engine, ship engine, locomotive engine and lawn mower [3].

2. LITERATURE REVIEW

The American scientist Joseph Henry (1797-1878) constructed a small electromagnetic engine, with a reciprocating beam. He called it as a "philosophical toy", and there was certainly no intention of getting useful work out of it. It was first described in American Journal of Science, 1831, Vol 20 p342. In a British journal Philosophical Magazine in 1838, F Watkins examined Henry's invention in detail and described it as the first cyclic electric motor, i.e., one that continued working without manual switching or resetting [4].

Also, the paper published in Power and Energy Conference, 2008.PECon 2008. IEEE 2nd International states that, designing an electric vehicle (EV) using electric motor as its prime mover is very common. However, incorporating the electric motor to the overall EV design is relatively complex. The latest layout design of an EV requires a complex controller to govern the whole system especially the electric motors. Due to this complexity, the authors have developed an alternative electromagnetic prime mover for EV to replace the existing electric motor. This new prime mover is designed based on the solenoid concept and the internal combustion engine (ICE) working mechanisms. In this paper, the authors are introducing a new electromagnetic prime mover known as solenoid powered engine (SPE) [4].

3. ENGINE COMPONENTS

1. Solenoid Engine
2. Crankshaft
3. Relay with Microcontroller
4. Rectifier
5. Transformer for input supply
6. Bearings for smoothness
7. Rheostat

4. WORKING PRINCIPLE

Solenoid engine basically working on the electromagnetic attraction. It is an electromagnetic device which moves the plunger as per the coil magnetism (FIG-1). Whenever electric current is supplied to conductor a surrounding magnetic field is set up at its surface and it works as electromagnet. The electromagnetic force depend upon the current flowing through coil and number of turns that wound on coil. As the current passes through coil, it works as electromagnet and the basic idea is about to run the engine on magnetic attraction and repel principle [5].

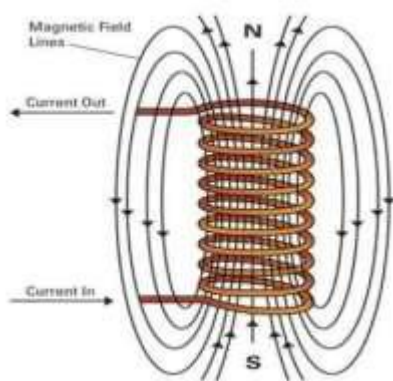


FIG-1: Electromagnetic waves in a solenoid

The mechanical sub-system consists of a 12V Solenoid Engine. Further the Plunger of Solenoid Engine was connected to a connecting rod which in turn was connected to a crankshaft, offering rotary output. The Number of Solenoid Engine used was 8, which consists of connecting rods, linked to a common crankshaft. The system consists of electromagnet which was adhered to the top surface of piston in all eight Engines.

During reciprocating motion magnets travelled along with the piston. The magnets were fixed in such a way that the pole orientation was in the same direction. For e.g., if the south poles of both the magnets were fixed to piston surface then the north poles were exposed to the atmosphere. A solenoid is an electromagnet which creates a dipole at the two end faces when the current is passed through it resulting in the formation of North and South Pole. A standard Transformer of 12V was used to supply energy. When current was passed through one of the Solenoid, the piston got attracted. The electromagnet was placed over the cylinders, which were nonmagnetic. It would not break easily with the help of a rigid frame consisting of differential positioning arrangements. At the time when Piston 1 is at BDC, the electromagnet is charged in such a way that it results in opposite pole. thus, generating an attractive force on the piston. Two Solenoid are working at the same time as it connected with each single relay which run one at a time. With the help of 12V Relay, the continuous process through piston in achieved (TO and FRO) which help in rotating the crankshaft and then energy was stored at Flywheel. The switching of the direction of current in the electromagnet was

controlled by the microcontroller by turning ON/OFF relay, which control the position of cranks and positioning were such a way that they provide a high output when the piston reaches close to BDC (FIG-2).

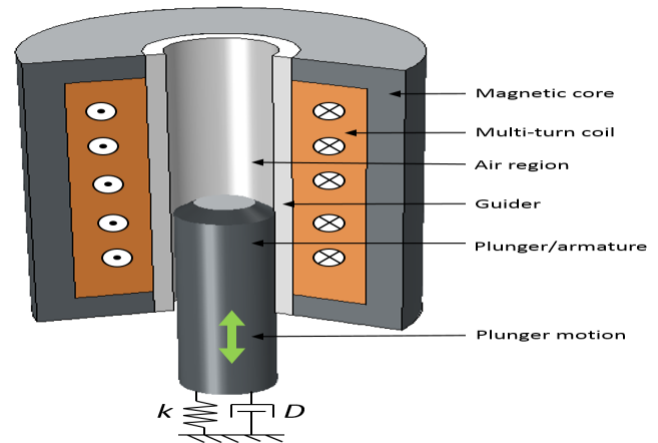


FIG-2: Linear Solenoid Actuator

ON/OFF frequency can be controlled by using Rheostat, which acts as a variable resistor which can be used to control the current supply to the spark distributor and it works as an accelerator. The main function of a spark distributor is to provide variation in speed. It actually provides power to the solenoids and control the movement.

5. CALCULATIONS

Input voltage = 12 V
 Input current = 2 A
 Input Power = Voltage × Current
 = 12 × 2 = 24W

Max. Force exerted by electromagnet on piston

$$F_1 = (N^2 \cdot I^2 \cdot K \cdot A) / 2G^2$$

Where;

N: number of turns = 1000

I: Current flowing through coil = 2 A

K: Permeability of free space = $4\pi \times 10^{-7}$

A; Cross-sectional area of electromagnet (radius $r = 0.0025$ m)

G: Least distance between electromagnet and permanent magnet = 0.004 m

On substitution, we get Max. Force

$$F_1 = 77.10 \text{ N}$$

Force exerted by permanent magnet

$$\text{Force } F_2 = (B^2 \cdot A) / 2\mu$$

Where;

B: Flux density (T)

A: Cross-sectional area of magnet (radius $r = 0.0025$ m)

μ : Permeability of free space = $4\pi \times 10^{-7}$

Now flux density

$$B = \frac{B_r}{2} \times \left[\frac{(D+z)}{\{R^2 + (D+z)^2\}^{0.5}} - \frac{z}{(R^2 + z^2)^{0.5}} \right]$$

Where;

B_r : Remanence field = 1.21 T

z : distance from a pole face = 0.004 m

D : thickness of magnet = 0.0015 m

R : semi-diameter of the magnet = 0.021 m

On substitution we get flux density,

$$B = 0.04 \text{ T}$$

Now substituting B in the equation of force,

$$F_2 = 1.25 \text{ N}$$

Since, force F_1 and F_2 are repulsive,

$$\text{Total force } F = F_1 + F_2$$

$$F = 25.25 \text{ N}$$

$$\text{Torque } T = F \times r$$

Where;

F : total force on piston

r : crank radius = 0.015m

$$\text{Torque (T)} = 0.378 \text{ N-m}$$

Angular velocity of Fly wheel

$$\omega = (2\pi N)/60$$

Where;

N : speed = 160rpm

Therefore, $\omega = 16.75$ rad/s

Energy stored on flywheel

$$E = T \times \theta$$

Where;

T : torque

θ : Angle of rotation = π radians

On substitution, we get energy stored

$$E = 1.18 \text{ J}$$

Output power

$$P = (2\pi NT)/60$$

Where;

N : speed = 160 rpm

T : Torque = 0.378 N-m

On substitution, we get

$$\text{Output power } P = 6.3 \text{ W}$$

$$\begin{aligned} \text{Efficiency} &= (\text{Output/Input}) \times 100\% \\ &= (6.3/24) \times 100\% \end{aligned}$$

Therefore, Efficiency = 26.38%

6. RESULT AND DISCUSSION

The results are as follows:

1. We are able to make a working model of 8-Stroke Solenoid engine. This works on principle of electromagnetism.
2. A fully emission free and clean source of energy is developed by the arrangement of 8 electromagnetic coil engine mechanism.
3. This engine has less efficiency than conventional IC engines.
4. Its speed can be controlled by a Rheostat act as a variable resistor.

This model needs more development for future use.

Further improvement is needed for increasing its efficiency so, that it can be used in daily life.

7. MERITS OF SOLENOID ENGINE

- It has less running cost than an internal combustion engine.
- It does not create pollution and can help in checking global warming as Electrical Energy is best alternative Source of Power.
- Solenoid Engine is lighter than an internal combustion engine
- It takes less amount of charge from battery in every revolution of the crankshaft for few seconds.

8. CONCLUSIONS

With using repletely, the windings of the electromagnet got loos which increases the gaps between the windings. This causes a drop in the potential energy from the power source that prevents the effective generation of magnetic flux. It is also noticed that the energy of the permanent magnet is higher than that of electromagnet. The design of the engine is to be done with low density materials. It requires accurate manufacturing and utmost care of windings. The Solenoid Engine has various advantages over an internal combustion engine. The most important advantage is that it is eco-

friendly. It does not require any fossil fuels, does not harm natural resources, and does not pollute the environment, no heat generation within the engine.

While running Solenoid Engine, the electromagnet heats up with continuous operation, but the temperatures are very low as compared to IC engines. So, it doesn't require any need of a cooling system as we seen in case of IC Engine. While operating, the level of noise and vibration are low in case of Solenoid Engine.

These engines run a crankshaft using the solenoid coils and obtain power. The power obtained through this engine cannot be compared to the power of IC Engine because these vehicles use Gasolines to run the engine. But the power of the solenoid engine can be reached to the extent of the power obtained through the IC Engine if the number of turns in the solenoid coil are increased by doing this the force applied on the piston increases, hence the power obtained increases and apart from it studying the effect of other parameters also help in improving the power. Proper development of this engine can increase its efficiency. The Most important Point is that its development of this type of engine can decrease the dependency on Petrol and Diesel, which is a very important in today world. With further research and development, it can be proved to be a boon in the Automobile sector.

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