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*RESEARCH ARTICLE*

# FABRICATION OF ELECTROMAGNETIC ENGINE USING PULL FORCE.

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## *Abstract*

In our modern scenario with increasing population use of energy resources such as fuels from crude oil increases and the amount of resources decreases as the time increases. So, in near future there will be limited amount of fuel to overcome this problem the project focus on the zero-fuel consumption. The working principle is based on the electromagnetism. Here the hollow cylinder contains coil which produce the magnetic field and at top of the piston is made up of the ferrous rod. When the current is supplied due to pulls force of the solenoid the ferrous rod gets pulled with great amount of force. Thus, the reciprocating motion is achieved, and some IC engine components and electronic circuits are used to control the motion.



## Introduction:-

With the increasing population the use of resources like fossil fuel, air, water, solar energy, geo thermal energy etc. also increases. By increased usage of fossil fuel mainly two harmful effects are produced the first is environmental pollution and second is the availability in near will be limited. So, to overcome these two challenges the era of modern scenario should be changed with the concept of electromagnetism.

As a good example of maglev trains which runs effectively with high speed and safe for environmental. Designing the electromagnetic engine gives variety of advantages. The working mechanism of this engine is same as of IC engine, but it does not contain inlet or exhaust port or spark plug.

**Objective:-**

1. The main objective is to run an engine model with help of magnetism principle which will obsolete the fuel consumption.
2. This model produces zero percent carbon emission i.e. no pollution.
3. To gain the speed and torque using the pull force of the solenoid with good efficiency more than that of petrol or Diesel engine.
4. As solenoid can run on AC and DC both so this type of engine will be helpful in near future.

**Working Principle:-**

In IC engine the fuel drives the engine but in this the principle of magnetism is used to drive the electromagnetic engine. Like in IC engine, the electromagnetic engine also contains the same basic components which are cylinder, piston, crank shaft, flywheel and connecting rod.

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An electromagnet contains coil of copper wire wounded around a hollow cylinder in which the plunger of soft iron can move linearly. When the current is applied the solenoid creates dipole at the end faces resulting the formation of north and south poles. Due to the poles created at the ends the solenoid pulls the plunger with huge amount of force and will pull up to the center of plunger. Now as the plunger is placed fixed at the top of piston, so it will also move with plunger. This way we get the linear motion.

In our engine there are two electromagnets. Taking a case, when first electromagnet is switched on the plunger gets pulled by solenoid so first piston moves to TDC and the second piston moves to BDC. As the first piston reaches the TDC first electromagnet will be switched OFF and the second electromagnet will be switched ON which will pull the second piston by plunger up to TDC. This way we get the reciprocating motion and is transferred to rotary motion by crank shaft. A flywheel attached with the crank shaft regulates the steady speed.

The setup contains the electronic circuit and Cam which controls the speed of engine. The block diagram of the model is shown below.

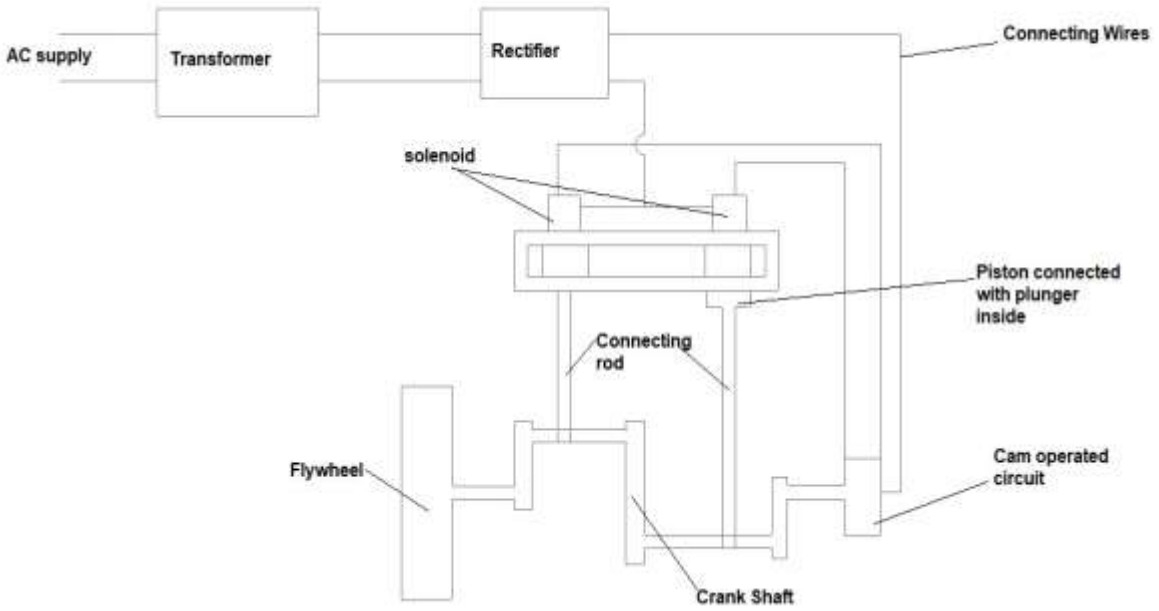


**Fig. 1:-** Block Diagram of the Electromagnetic Engine

**Components:-**

**Cylinder:-**

Cylinder is one of the main component, it guides the piston to reciprocate linearly. In our engine there are two cylinder which are of non-ferrous material because to prevent the interference losses created by magnetic field of solenoid. So, the material that can be used are stainless steel, aluminium or titanium. It must have low electrical conductivity and high resistivity. As inside the cylinder piston reciprocates so inside surfaces of the cylinder must be smooth enough to reduce the friction between them.

**Piston:-**

The piston is also made up of nonmagnetic material which should have low electrical conductivity and high resistivity. Its outer surface must be smooth to reduce friction. At the top surface plunger made of soft iron is attached and at the bottom the it is connected to crank shaft by connecting rod.

**Connecting Rod:-**

Connecting rod is used to connect between the piston end and the crank shaft. It is made of light weight material like Aluminium. It converts reciprocating motion of piston into rotary motion at crank shaft.

**Crank Shaft:-**
It contains set of offset shafts which gives rotary motion from reciprocating motion given by piston. The material used in the crank shaft is generally the steel or steel alloys.

**Flywheel:-**
Flywheel is attached to end of the crank shaft. It stores the kinetic energy and runs the engine with steady speed. Amount of the energy stored is probational to square of the speed of crank shaft. The material used in the flywheel is mild steel or steel alloys.

**Electromagnet:-**
It is an electrical powered magnet i.e. when the current is applied it generates the magnetic flux. It contains the hollow cylinder as a core in which the solid insulated copper windings are to be done. The winding can be series or parallel.

**Transformer and Rectifier Circuit:-**
Transformer is electrical device used to give desired voltage from the input source by varying current. Rectifier is also an electrical device used to convert the alternating current (AC) to direct current (DC). Here in our model we are use the AC source in which transformer and rectifier are used to get specific voltage

**Design calculation of solenoid:-**
The design of the solenoid mainly depends on two things that are:

**Number of turns:-**
**Current:-**
The number of turns can be in series or parallel. In our model the turns are in parallel with the 26-gauge copper wire. The diameter of the hollow cylindrical core is 42 mm with length of 50 mm. By winding on the core, the diameter also increases at layer by layer assuming here that the diameter of the core remains constant through carrying out calculation.

**Taking 26-gauge copper wire:-**
Diameter of copper wire = 0.4086 mm = $0.4086 \times 10^{-3}$ m
Cross section area of wire a = 0.1311 $mm^2$ = $0.1311 \times 10^{-6}$ $m^2$
Resistivity of copper $\rho = 0.01724 \times 10^{-6}\ \Omega.m$
Outer Diameter of core D = 42 mm
Let, the voltage be fixed = 10 V

**Series winding:-**
Let, number of turns N = 1200

Total Length of wire when winding done of 1200 turns $L = 1200\pi D$
L = 158.34 m
Resistance of the winding $R = \rho \frac{L}{a} = 20.822\ \Omega$
Current passing through windings $I = \frac{V}{R} = 0.480$ A

Total ampere turns $\bar{A}$ = 576 AT

Now, the pull force is proportional to the square of the ampere turns i.e.

$F \alpha (\bar{A})^2$
F = 331776 K
Here K is the proportionality constant

**Parallel winding:-**
Taking number of turns with three equal parallel winding i.e.
$N_1$ = 400

$N_2$ = 400
$N_3$ = 400

Length of each wire L = 400πD
$L_1$ = 52.77 m
$L_2$ = 52.77 m
$L_3$ = 52.77 m

Resistance of each windings $R = \rho \frac{L}{a}$ = 6.9405 Ω

Current in each winding $I = I_1 = I_2 = I_3 = \frac{V}{R}$ = 1.44 A

Ampere turns of each winding $\bar{A}_1 = \bar{A}_2 = \bar{A}_3$ = 576 AT

Total ampere turns $\bar{A} = \bar{A}_1 + \bar{A}_2 + \bar{A}_3 = 3\bar{A}_1$ = 1728 AT

The pull force is given as F α $(\bar{A})^2$
F α $(3\bar{A}_1)^2$
F = $9\bar{A}_1{}^2 K$

Here K is the proportionality constant

From the above calculation we observed that the pull force in parallel winding is 9 times that of series winding. So, more number parallel winding the more pull force is achieved. Hence parallel winding is better than series winding.

**Experimental results:-**
An experimental data has been analysed from the model in which the DC power was supplied at different voltage. The different voltages were achieved with the help of transformer. In the analysis we measured the power input, speed, torque, power output and efficiency.
The data table is attached below is shown as

**Table I:-** Experimental data of model

| Voltage(V) | Current(A) | Power Input (W) | Speed (RPM) | Torque (Nm) | Power output (W) | Efficiency (%) |
|---|---|---|---|---|---|---|
| 18 | 5.4 | 97.2 | 194 | 1.244 | 25.2706 | 25.999 |
| 20 | 5.8 | 116 | 227 | 1.283 | 30.4987 | 26.292 |
| 24 | 7.2 | 172.8 | 241 | 1.821 | 45.9574 | 26.596 |
| 30 | 8.8 | 264 | 250 | 2.722 | 71.2618 | 26.993 |
| 35 | 9.4 | 329 | 286 | 2.998 | 89.7896 | 27.292 |
| 40 | 10.5 | 420 | 308 | 3.541 | 114.2103 | 27.193 |

From the above data and results the graphs have been plotted: -

The graph of efficiency vs power input gives idea that as power input increases the efficiency increases up to certain limit.

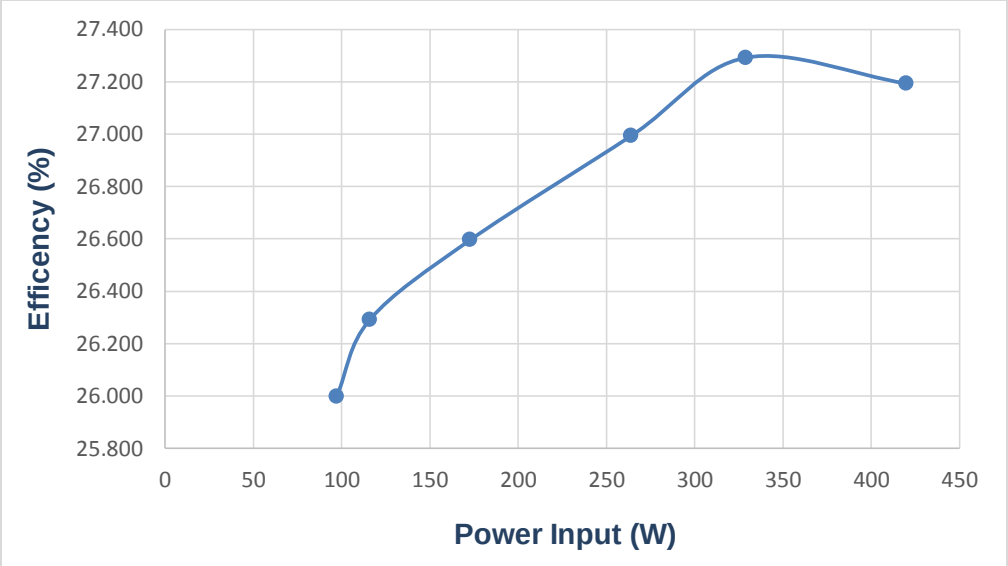


**Fig. 2:-** Efficiency vs. power input

The graph of Power input vs Speed shows that increasing in the power input increases the speed.

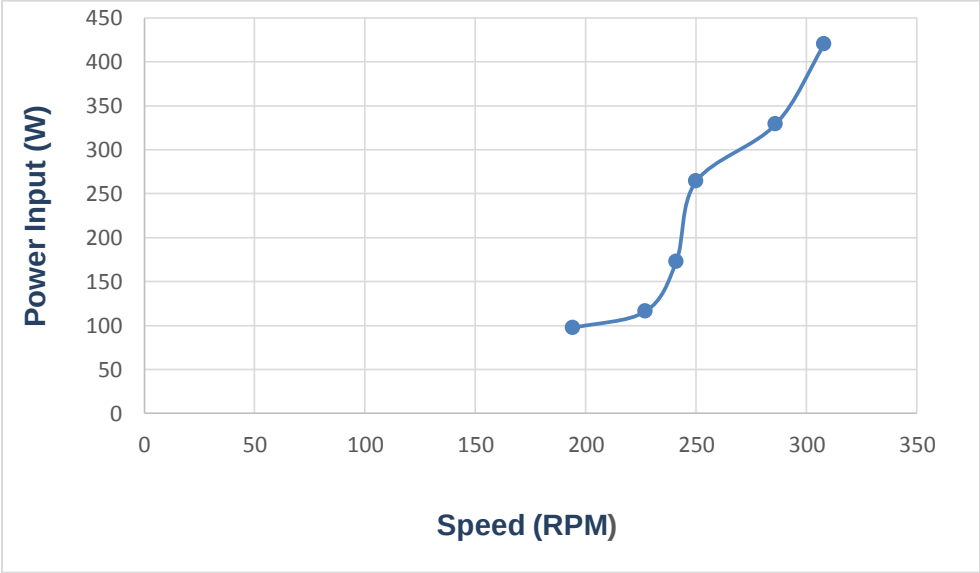


**Fig. 3:-** Power input vs. Speed

The graph of Speed vs. Current shows that increase in current gives minor increase in Speed.

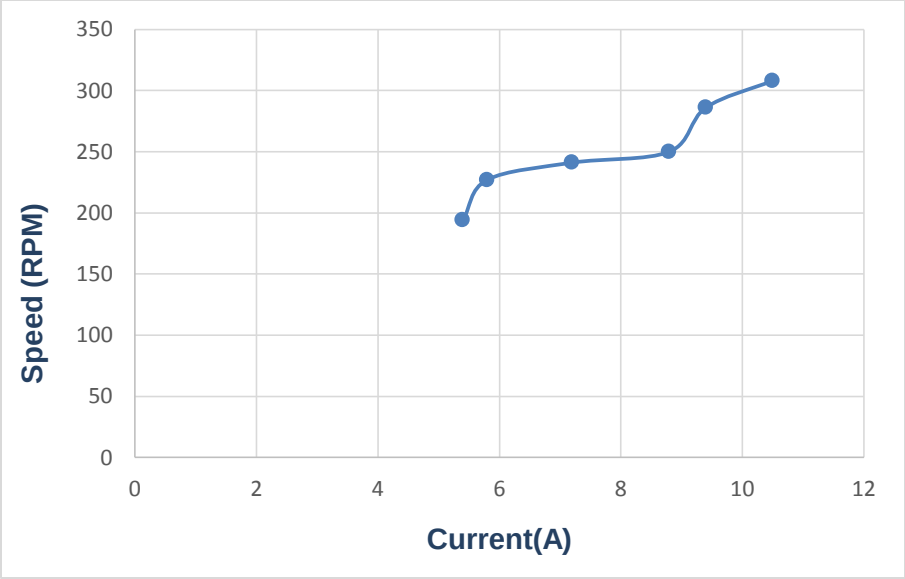


**Fig. 4:-** Speed vs. Current

The graph of Power input vs. Torque shows that increasing in the power input increases the Torque.

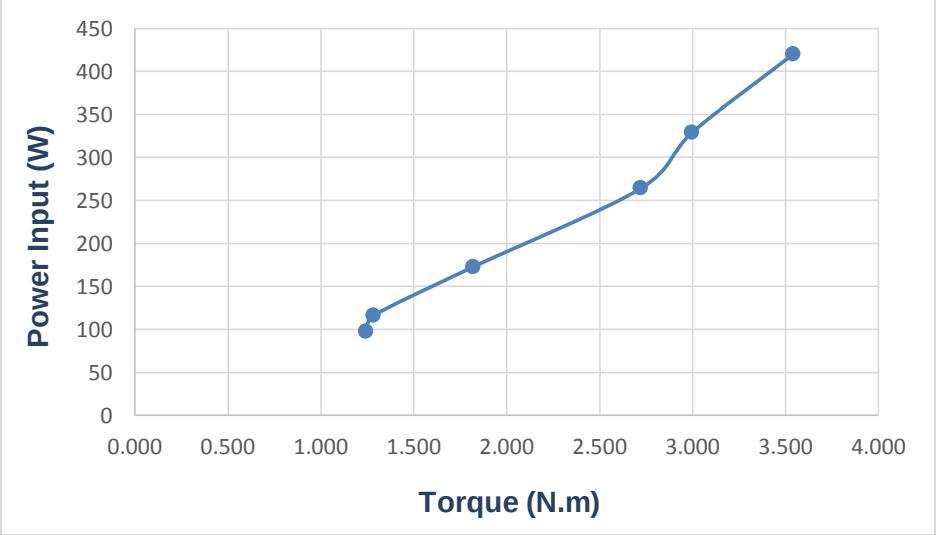


**Fig. 5:-** Power Input vs. Torque

**Scope of improvement:-**

As gradual increasing use of crude oil fuels today's world suffer a lot with pollution so an alternate mode of energy to be used for betterment of the world. Using the principle of magnetism with proper design the model will be useful in near future.

This model will replace the IC engine hence creating the safe environment with zero carbon emission. The model can run with AC or DC current so giving a good advantage.

## Conclusion:-

The design model of electromagnetic engine was successfully fabricated. We also carried out the experimental analysis of model. The model fabricated was two strokes with pull force engine. The speed can be increased by increasing the voltage as per requirement. There is no motor use for initial start like in IC engine. The design of model is quite simple.

As there is no fuel used so no combustion takes place, so heat generated is very much less compared to the IC engine and very less noise is produced. So, the no pollution in our model due to the friction between the piston-cylinder the high power loses was found. Other losses were found due to improper alignment of connecting rod and crank shaft. So, with the perfect design the friction between the moving parts can be reduce greatly hence increasing the efficiency. The efficiency can also be increased by proper and tight winding on the core so that no losses in potential energy to be achieved. We observed that by doing parallel winding rather than series winding more power is achieved with a constant

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