JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Conversion of Futile IC Engine into Eco-Friendly Electromagnetic Engine

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Abstract: Over the last few decades, internal combustion engine which is one of the greatest inventions of mankind, seems to be the paramount cause of environmental pollution since these engines operates by burning of fuels, that directly contaminate and deteriorates the surrounding and environment through its exhaust gases. Moreover with the advancement and technology development ,we are moving towards the zero emission or possible less exhaust producing engines so that we can replace and utilize an alternative source instead of fossil fuel which is a non- renewable source of energy and is declining rapidly due to its increased rate of utilization .Due to the increasing use of electrical energy in almost all the sectors of development, we through this paper came up with an effort to address an alternative method of producing energy without the utilization of fossil fuel or any other kind of non-renewable sources. Keeping in the mind the arising needs of industry (i.e., maximum power, eco-friendly and high efficiency) we tried to design an electromagnetic engine that works on the principle of electromagnetic induction. The modifications are made to an old one-cylinder moped engine for this particular study so that it can give a basic idea for further changes and modifications that can further aid in reducing the scraps of automobiles after introduction of electric vehicles in the automotive industry**.**

Index Terms **- IC Engine, Electromagnetic Engine, Eco-Friendly, Solenoid, Automobiles, Repulsion, Piston**

I. INTRODUCTION

In today's modern world due increasing population people are going more towards automotive for their comfort. The Internal Combustion (IC) Engine was at first a boon to mankind even so the major demerits of IC Engine are air pollution, Noise Pollution and emission of toxic gases Like CO, CO_2, SO_2, NO_x, which are hazardous to the environment, also the day by day increasing fuel price is a major issue.

The next source that strikes our mind after fossil fuels is electric energy, and as we know that the scenario of traveling is changing rapidly with electric vehicles, electric buses, hybrid cars, metros, electric rails, etc. At the end of the day it indicates that electrical energy is being used almost everywhere to drive our life. Also speaking of electrical vehicles, the main disadvantage of electrical vehicles is the lack of capability of storing sufficient energy to run the vehicle for a long time. The energy storage capacity of the battery used in electric vehicles is very low compared to conventional fuel used in modern automobiles. Thus, a method has to be developed that uses electrical energy in combination, to produce better efficient engines. This is where magnetism gets its spot

Keeping this in mind, there is a need to come up with an engine that does not harm the environment, is cheap to manufacture and is also sustainable. Electromagnetic engine is an option. It has all the components of normal IC Engine such as piston, cylinder, connecting rod, crankshaft, etc. there's no piston rings. cylinder, connecting rod, crankshaft, etc. this engine uses a solenoid which when electricity is supplied attracts the magnet that is mounted on the top of piston.

When solenoid is energized it attracts the magnet i.e., piston. Similarly, when current direction is changed the polarity changes and piston is repelled. This creates a reciprocating motion that is converted into mechanical energy by the crankshaft and connecting rod. The engine performs just like conventional IC Engine.

II. OBJECTIVES

- To run an engine using the magnetic principle of solenoid.
- Make an engine that produce zero carbon emission i.e., zero pollution.
- To gain the speed and torque using the pull force between solenoid and permanent magnet with good efficiency.
- This engine can run on both AC or DC supply.
- Can be used in small machines instead of using motor.

III. LITERATURE REVIEW

Adarsha. H et al presented the detailed description of the development of the engine. They experimented with different core materials for electromagnets like ceramic, iron, steel and found that the maximum power generated is from the ceramic material.

They used I-bar electromagnet and the number of turns was 160 turns due to which efficiency was very low. They used neodymium magnet as permanent magnet. The iron cylinder was replaced by aluminum cylinder and also the piston was made of cast aluminum because of its high heat transfer rate. The power of the engine can be increase by increasing the number of turns on electromagnet and current supplied. Also, torque depends on the radius of the crank therefore by increasing the radius of the crank we can increase the power of the engine.

According to Manoj Anto A et al in the paper "Design and Fabrication of Electromagnetic Engine", the electromagnetic engine should be performing exactly like an internal combustion engine. The strength of the field is controlled by the number of windings given to the copper coil in the electromagnet. The advantage of this report is that it is pollution free and the extra internal parts such as piston rings, oil rings, fins, etc. is eliminated.

According to Syed Abdul Rafay Hammad et al in the paper **"Conversion of IC Engine into Magnetic Engine with minor Modifications"** the idea of running a magnetic repulsive engine without changing the design of conventional engines was practically achieved through proper experiment but the efficiency was not enough to be implemented in industry. The engine produced different rpms at different current. At 3 and 8 A this engine produced no rpm but at 14A only one revolution. But at 44A it produced 189 rpms. The main problem of this engine was not having enough torque.

Raj Solanki et al fabricated a model of twin-cylinder electromagnet engine and carried out an experimental analysis of the model. They supplied varying DC power with the help of transformer and plotted graphs like efficiency vs. input power, speed vs. current etc. They observed that parallel winding rather than series winding produced more pull force. They concluded that speed can be increased by increasing the voltage. At the same time due to friction between the piston-cylinder high power losses were found, other losses were found due to improper alignment of connecting rod and crankshaft. Also, the efficiency can be increased by proper and tight winding on the core so that there are no losses in potential energy.

According to Syed Suhel et al, with repeated handling, the windings of the electromagnet got loosened up which increases the gaps between the windings. This causes a drop in the potential energy from the power source and prevents the effective generation of magnetic flux. They also noticed that the energy of the permanent magnet is higher than that of electromagnet.

IV. ENGINE COMPONENT

- Old IC Engine
- Electromagnetic Solenoid
- Proximity Sensor
- Permanent Magnet
- Relays
- Flywheel
- Iron Frame Stand
- DC Regulated Power Supply
- Electrical Circuit

4.1 Old IC Engine

In this experiment we used an old, light weight IC Engine from a generator. Other components like piston, connecting rod, crankshaft etc. was already present in it. Cylinder head with fins was removed. The engine was thoroughly cleaned and lubricated so that its movement is free.

Fig 1: Old IC Engine

4.2 Electromagnetic Solenoid

Electromagnetic coil is formed when an insulated copper wire of 26 gauge is winded around the PVC pipe. There are more than 1300 numbers of turns around the cylinder which all together formed a solenoid. Coils are coated with a varnish or wrapped with insulating tape to provide additional insulation and secure them in place.

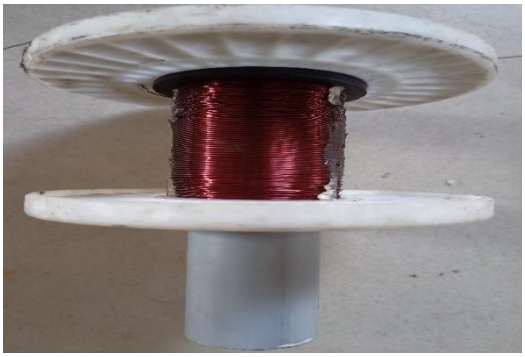


Fig 2: Electromagnetic Solenoid

4.3 Proximity Sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. The maximum distance that this sensor can detect is defined "nominal range". Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. For this experiment w have used PNP proximity sensor. It had nominal range of 12mm.

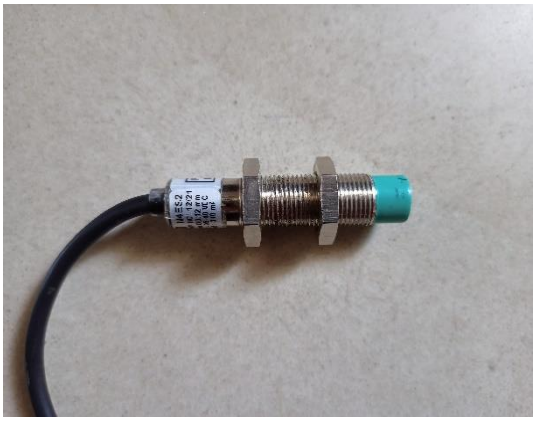


Fig 3: Proximity Sensor

4.4 Permanent Magnet

For this study neodymium magnets of 36 X 10 mm were used. Neodymium magnets are a member of the Rare Earth magnet family and are the most powerful permanent magnets in the world. They are also referred to as NdFeB magnets, or NIB, because they are composed mainly of Neodymium (Nd), Iron (Fe) and Boron (B).

Fig 4: Permanent Magnet

4.5 Relays

A relay is an electrically operated or electromechanical switch composed of an electromagnet, an armature, a spring and a set of electrical contacts. The electromagnetic switch is operated by a small electric current that turns a larger current on or off by either releasing or retracting the armature contact, thereby cutting or completing the circuit. In this engine 5 pin, 10A relays have been used.

Fig 5: Relay

4.6 Flywheel

The flywheel is used to store the rotational energy. It regulated the engine rotation to make its operation at a steady speed. Flywheel has a significant moment of inertia and thus resist changes in rotational speed. The amount of 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.

Fig 6: Flywheel

4.7 Iron Frame Stand

To fix the engine upright an iron frame stand was made. The engine system was attached erect to the base of the frame and fixed with nuts and bolts. Proximity sensor was also attached with the frame at apposition it can sense the flywheel. Along with it the circuit was also fixed in it.

Fig 7: Iron Frame Stand

4.8 DC Regulated power Supply

A regulated power supply is an embedded circuit; it converts unregulated AC (Alternating Current) into a constant DC. With the help of a rectifier, it converts AC supply into DC. Its function is to supply a stable voltage and current, to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC. The type of stabilization used may be restricted to ensuring that the output remains within certain limits under various load conditions, or it may also include compensation for variations in its own supply source. Here 30V,2A power supply was used.

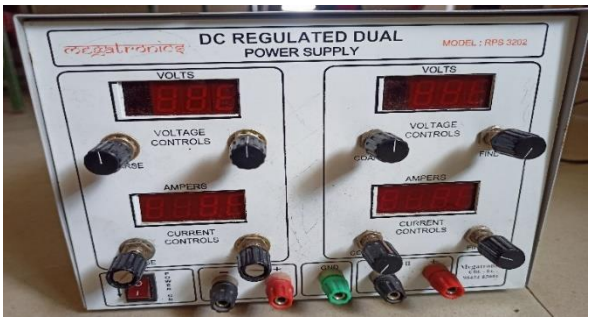


Fig 8: DC Regulated Power Supply

4.9 Electrical Circuit

A circuit was made using a PCB where the relays were connected to the proximity sensor. Also, relays were connected to the solenoid. Connection for both power source was also made

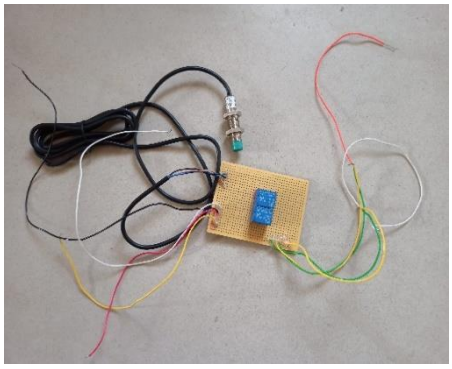
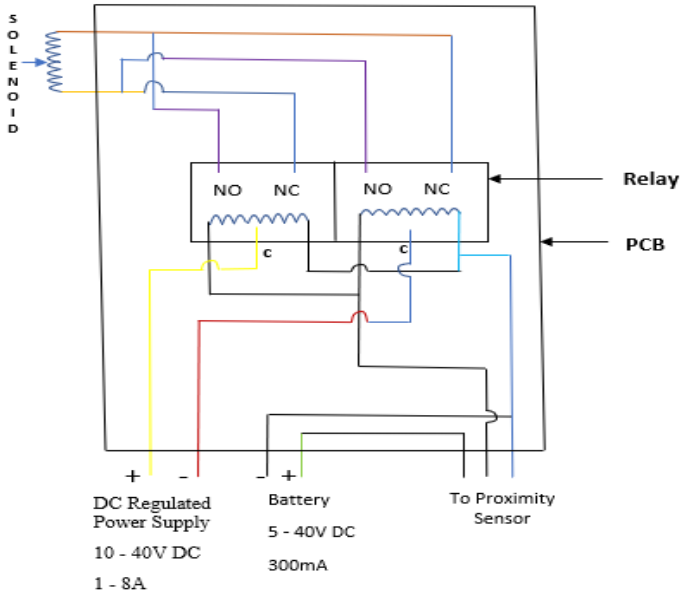


Fig 9: Electrical Circuit

V. CIRCUIT DIAGRAM

Two relays were used switch current direction. Relays were so connected that it act as one switch. The relays were energized by the proximity sensor when it sensed a metal object near the sensor. Different set of power supply is used for proximity sensor and for electromagnetic solenoid. For proximity sensor 20V,300mA of constant power was supplied.

Fig 10: Circuit diagram



VI. CONSTRUCTION

First, the old IC Engine was thoroughly examined. Then the sparkplug, inlet and outlet valves were removed from the cylinder head. Then cylinder head with fins were also removed. Piston rings were also removed from the piston. And at last unnecessary parts that added more weight to the engine were finally removed. Now the engine arrangements were thoroughly cleaned and well lubricated until the arrangement's movement was free. Neodymium magnets were adhered to the top of the piston with strong adhesive. The magnet was fixed in such a way that the pole orientation was in the same direction.

A PVC was cut as per the linear displacement of the piston and magnet. Copper wire of 26 gauge was winded with more than 1300 turns and thus solenoid was made. Inside the PVC too was well lubricated.

The position of proximity sensor was adjusted with the flywheel and was fixed in the frame. The circuit was also attached to the frame. Now as per the circuit diagram connection were given. AC voltage was supplied to DC regulated power supply and output DC voltage was connected to the circuit which connected it to the solenoid.

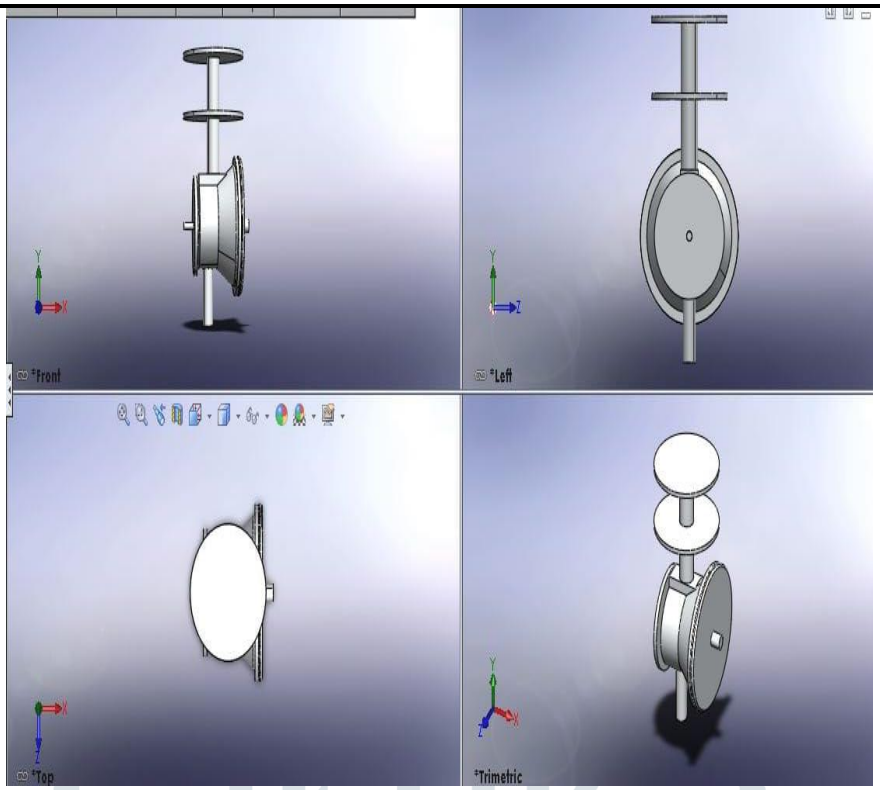


Fig 11: Design in Solid Works

Fig 13: Construction

VII. WORKING PRINCIPLE

Electromagnetic engine basically working on the electromagnetic attraction. It is an electromagnetic device which moves the piston as per the coil magnetism. 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.

At the time when Piston is at BDC, the electromagnet is charged in such a way that it results in opposite pole to that of the Permanent Magnet thus generating an attractive force on the piston. The piston moves from BDC to TDC. The flywheel rotates 180°. Now proximity sensor senses the flywheel position and switches the relays and opposite current starts flowing through the coil. Thus, opposite polarity is created inside the coil. This polarity is similar to the magnet polarity. Thus, the magnet is repelled and the piston moves from TDC to BDC. Flywheel moves another 180° making a full 360° rotation. With the help of relay and Proximity Sensor the continuous process through piston in achieved (up and down) by also rotating the flywheel. A metallic strip was placed on the flywheel of the engine. The strip was adjusted so that when the piston was at TDC position the metallic strip was in front of the sensor and a signal was generated that operated the electromagnet. When the electromagnet magnetized at TDC position and same

poles repelled each other and the shaft rotated. Thus, power stroke was obtained. The switching of the direction of current in the electromagnet was controlled by the controlling circuit.

Rotation speed depends upon the current value and number of coils. Higher the number of coils higher the magnetic flux created inside the cylinder. Also, the more current is supplied the more magnetic flux is created which eventually increases the magnetic force of attraction and repulsion.

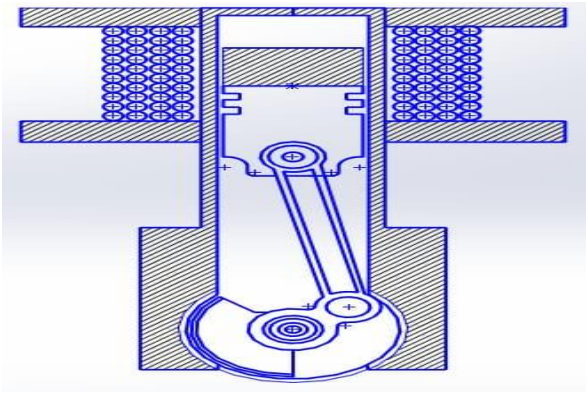


Fig 14: Sectional View

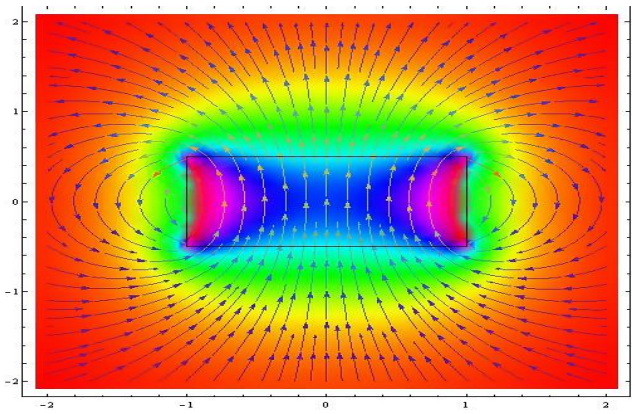


Fig 15: Magnetic field line and density created by solenoid with surface current density

VIII. CALCULATIONS

Input voltage = 14.5 V
Input current = 0.554 A
Input power P_i = v*i = 8.033 W
N = number of turns = 800
I = Current flowing through coil = 0.554 A
K = Permeability of free space = $4\pi\times10^{-7}$
A = Cross-sectional area of electromagnet (radius r = 0.020 m) = 0.001256 m^2
G = Least distance between electromagnet and permanent magnet = 0.005 m
Max. Force exerted by electromagnet on piston is given by,
$F_1 = (N^2 I^2 KA)/2G^2$
On substitution, we get Max. Force
F_1= 5.9787 N
Now,
B = Flux density (T)
A = Cross-sectional area of magnet (radius r = 0.018 m) =1.0178 x $10^{-3} m^2$
μ_0 = Permeability of free space = $4\pi\times10^{-7}$
Now flux density,

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

B_r = Remanence field = 1.21 T
z = distance from a pole face = 0.005 m
D = thickness of magnet = 0.040 m
R = Radius of the magnet = 0.018 m
On substitution we get flux density,
B = 0.1140 T
Force exerted by permanent magnet
Force $F_2 = (B^2A)/2\mu_0$
Now substituting B in the equation of force,
F_2 = 5.2665 N
Since, force F_1 and F_2 are repulsive,
Total force $F = F_1 + F_2$
F = 11.2452 N
Total force on piston = 11.2452 N
Now,
r = crank radius = 0.012 m
Torque (T) = F × r = 0.1349 N-m
Now,
N = speed = 163 rpm
Angular velocity of Fly wheel is given by,
$\omega = (2\pi N)/60$
Therefore, ω = 17.0693 rad/s
Output power

$P = (2\pi NT)/60$
Where,
N = speed = 163 rpm
T = Torque = 0.1349 N-m
on substitution, we get
Output power P = 2.3029 W
Efficiency,
η = (Output/Input) × 100%
= (2.3029/8.033) × 100%
Therefore, Efficiency, η = 28.67%

TABLE 1: Torque generation in different power input.

Current(A)	Voltage(V)	Speed (RPM)	Input Power(W)	Total Force, F(N)	Torque(N-m)	Output Power(W)	Efficiency (η)
0.5	11.5	0	5.75	10.3171	0.1238	0.0000	0.0000
0.554	14.5	163	8.033	11.2452	0.1349	2.3029	0.2867
0.6	15.5	198	9.3	12.5394	0.1505	3.1194	0.3354
0.8	21.7	320	17.36	18.1962	0.2184	7.3157	0.4214
1	27.6	490	27.6	25.4692	0.3056	15.6798	0.5681
1.12	31.1	549	34.832	30.6087	0.3673	21.1128	0.6061
1.21	33.2	649	43.492	34.8452	0.4181	28.4129	0.6533

IX. ANALYSIS

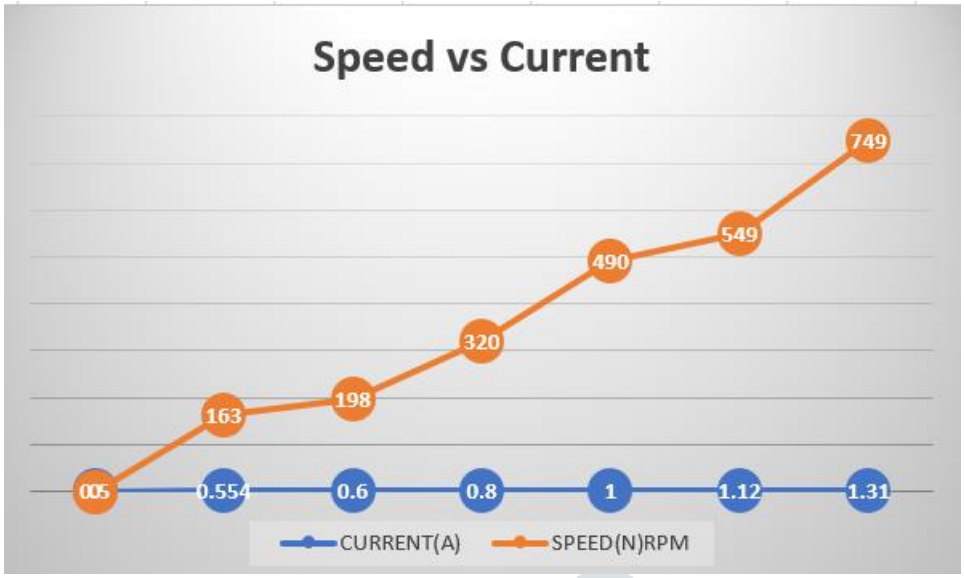


Fig 16: Variation of Speed with Current

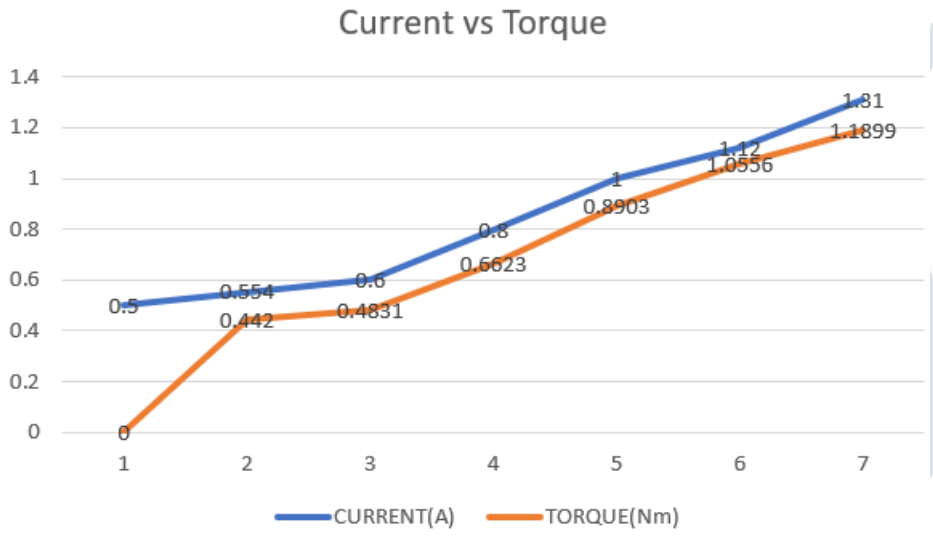


Fig 17: Variation of Current vs Torque

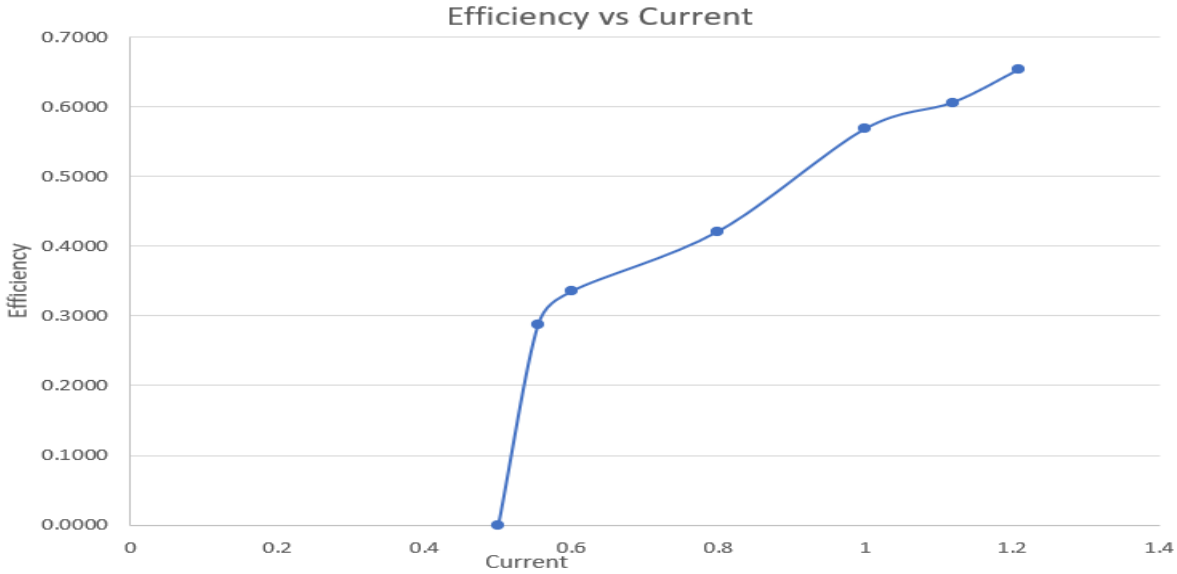


Fig 18: Efficiency vs Current

X. CONCLUSION

The design and fabrication of our proposed conversion of futile IC engine to an electromagnetic engine found to be successful as it showed an increment in efficiency along with reduction of harmful and toxic exhaust gases. The modification made by incorporating permanent magnet over the piston head on a scrap one-cylinder moped engine for a particular study and analysis led to the power production in every stroke by changing the polarity of electromagnet by reversing current direction. It was acknowledged that due to large number of turns, the force produced in the solenoid with very less current was sufficient enough for the linear moment for the piston. Moreover, with this arrangement, speed of the engine was found to be excellent and satisfactory considering the low power consumption. The use of proximity sensor was found to be successful as it eliminated the cam system with very high accuracy of sensing the position of flywheel and reverting the current direction. In addition to this, it was noticed that the coil got heated quickly. So, to solve this problem, a cooling mechanism or use of heat sinks can be employed for controlling the temperature of the coil. Also, it can be concluded that use of step-up boost converter module can increase the efficiency of the engine by boosting the input power to the solenoid. Thus, a good research, selection of materials, circuit analysis and component arrangements are very much necessary to increase the potency.

XI. ACKNOWLEDGMENT

This paper become a reality with the kind support and help of many individuals, we would like to extend our sincere thanks to all of them. First and foremost, we want to offer this endeavor to our GOD Almighty for the wisdom he bestowed upon us, the strength, peace of mind and good health in order to finish this research. We would like to express our gratitude towards our family for the encouragement which helped us in completion of this paper. We are highly indebted to Prof. Dr. N. Natarajan, Head of the Department, Department of Mechanical Engineering, Excel Engineering College and all the faculty members for their guidance and constant supervision as well as for providing necessary information regarding this research & also for their support in completing this endeavor.

We would like to express our special gratitude and thanks to our Project guide, V. Udhayakumar for imparting his knowledge and expertise in this study.

We would like to thank and appreciate our colleague Rakesh Kumar Shah, Pradeep Kandel, Ajay Kumar Yadav, Sumit Pandit and people who have willingly helped us out with their abilities.

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