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Electromagnetic Engines: A Review

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Abstract

The global trade sector has been working toward ending its dependence on oil. Nevertheless, the demand for fuel continues to increase, and we can expect a scarcity of fossil fuels due to their constantly growing consumption in coming years. As an alternative to existing fuel combustion engines, the present research develops electromagnetic engines. In order to develop an electromagnet engine, it was necessary to analyze different probabilities and calculate the magnetic flux produced by the magnet to deal with the power output of the engine as well as the force required to move the piston. The combined electromagnetic model for motors and rectifiers is presented using the finite element model for the motor and the physical model for the rectifier, then validated with prototype-test results. A mathematical model for linear motors is presented using electromagnetic simulation. This is followed by an analysis of electromagnetic losses during the standard cycle. The linear motor system can be used to convert mechanical into electrical energy with 86.3% efficiency, which corresponds to the requirement of portable free-piston engine generators when the reciprocating frequency is 50 Hz and the reciprocating stroke is 36 mm.

Keywords: Electromagnet; Emissions; Engine Efficiency; Engine Performance

1. Introduction

For a long time, humankind has invented many new technologies that will help reduce the efforts for daily needs. The engine is one of the inventions humans have relied on heavily for a long time. Conventional IC engines have a problem that they require fuel for combustion, and when this fuel is burned, pollution is released. Another concern is that people tend to use gasoline propelled vehicles. However, electric cars have been available in the market for some time but are not very popular because of their high cost and lower durability. The growing demand for fuel and the depletion of fuel reserves have made us look for alternate engine systems. The electromagnetic engine is a new, clean, green, and renewable energy. It does not burn any fossil fuels or produce any exhaust. The need for fossil fuels has amplified, and in the near future, a lack of fossil fuels is expected due to the endlessly growing consumption. The present work focuses on developing electromagnetic engines as an alternate for the

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existing fuel combustion engines. Various probabilities were carried out in producing an electromagnetic motor. A need for a unique form engine was required to increase travel in a very cost-effective way. Therefore, there was an urgent requirement to develop a substitute engine that was entirely ecofriendly and easy to maintain. The electromagnetic engine can substitute as an alternative engine. It works altogether on battery current, thus controlling the pollution enormously.

Working Principle

In electromagnetic engines, magnetism is fundamental to their operation. Two poles make up a magnet: a north pole and a south pole. A magnet exerts forces on another magnet, and this is a class of physical phenomenon. A magnet's poles repel one another when like poles are brought together by the principle of magnetism. However, unlike poles, they attract when brought together. Similarly, electromagnets and permanent magnets work in the same way. We can create force between the piston head and cylinder head by modifying them into magnets.

Advantages There are many advantages of the electromagnetic engine. However, this paper will discuss three benefits: [1] far more environment-friendly, secondly, less energy required, and lastly, a quieter engine. Starting with the most crucial advantage, environment friendliness, car engines in our day and age cause a heavy amount of pollution by emitting greenhouse gasses such as Carbon monoxide, nitrogen oxides, and hydrocarbons. In turn, pollution causes global warming, and electromagnetic engines would help with the pollution since it does not need fuel to burn, which means it won't emit greenhouse gasses. And the second advantage is less energy requirement. The fossil fuel we use for today's car engines are limited, and the current electric engines consume heavy amounts of energy. However, when it comesto the electromagnetic engine, it mainly focuses on magnetic power while the electrical part is igniting the engine and general power usages, like lights and air conditioning. Current cars have loud engines, so one of the benefits of the electromagnetic machine is it being tranquil, so using it in the city is not going to be a problem. Nevertheless, the electromagnetic engine still needs much development, but from what we are currently seeing, electromagnetic engines might be the future of car engines.

Disadvantages Of the few disadvantages is the high initial cost, and the harder to produce manufacturing technology. The electromagnet and permanent magnet in the cylinder can be very costly. The engine is not as flexible as the normal IC engine. The main power source is the battery but mainly the rotation of the cylinders is from the permanent magnet. The size of the battery will increase and it will consume a lot of space. They heat up very fast and due to this heat generation loss of electrical energy is high. A continuous power supply requires maintaining the constant magnetic field. To get the strong magnetic field, a large number of coiling of copper wire is required which in turn, requires large space, and using a large amount of copper wires results in a higher magnetic flux, as well as cost. So, the electromagnets are unfit for small spaces.

Design Mechanism

The design is simple and straight forward, it has multiple different elements [2], but it mainly focuses on the permanent magnet in the piston. The other elements are the cylinder, connecting rod, flywheel, the battery, and the magnet above the piston that allows it to move up and down.

Cylinder Block The design has focused on the magnets, thus choosing the material for the cylinder, ferrous materials would hinder the movement of the magnets, concluding that the best material for the cylinder is Aluminum [3]. Using Aluminum and Magnets in the engine makes the engine significantly lighter, resulting in providing more stability and movement of the pistons as well as making it easily manufacturable. The Piston within the cylinder does not produce high temperatures, which means that no further heat transfer is needed.

Piston The piston is a metal piece that goes up and down the cylinder. In each cylinder, there is a piston, it connects to the connecting rod, and it rotates with the help of the counter weights. Electromagnetic pistons have many similarities with the normal IC engine pistons, in both engines, the piston is connected to the connecting rod, to the crankshaft, then to the flywheel [3]. As the electromagnetic piston has a permanent magnet that has a flat end, the crank shaft case has a strong magnet that allows the permanent magnet to repel from the permanent magnet, and continuously move up and down the crankshaft with less power.

Connecting Rod A connecting rod in the electromagnetic engine is the exact same in the IC engine, no modification is needed since the material is cast iron and won't affect the magnetic field. Usually, the connecting rod converts the motion of the piston from a linear motion to a circular motion, rotating in the crank shaft and moving the flywheel. Electromagnetic engines have the same priceable flywheel as the IC engine. The flywheel moves at a steady pace, converting kinetic energy to mechanical rotational iron, it is a great material for energy storage, and braking systems. Efficiency of the flywheel is determined by the material and maximum energy stored per unit weight.

Battery According to [3], a 12V (SMF/VRLA) rechargeable battery can be used in the engine to power the electromagnet; this battery can be chosen carefully because it lasts longer and is rechargeable from the energy from the moving electromagnet. A car's starter motor requires a current of typically 200A to 400A, and one cell has a nominal output of 2.1 volts, but lead-acid batteries are usually used in an arrangement of three for a 6-volt battery and six for a 12-volt battery. That shows why it is recommended to use a lead-acid 12V battery to power up the engine.

Electromagnetic Coil An electromagnetic coil is a copper wire that is wired across the holder's surface and it is used to produce a magnetic field with the help of electricity from the battery [4]. The electric current passes through the wire thereby creating a magnetic field; the more wires that are used, the stronger is the resulting magnetic flux.

Relay A relay is a switch that is operated by electricity and allows current to pass through its coil. As a result, a magnetic field is created that attracts the lever and changes the contacts on the switch [3]. A relay allows one circuit to switch to a second circuit, which can be completely separate from the first circuit. Neither circuit is electrically connected to the other, but both are mechanically connected.

Results and Discussion

In the paper we discussed the importance of the electromagnetic engine and how it will benefit the environment.

These are one of the few things the engine has an edge in over the IC engine:

• It is light weight since most of the engine components were eliminated;
• It has a dual engine bay, that produces more power with less energy;
• Having a cheaper material used in making the engine will exponentially drop the initial cost, since the engine doesn't produce as much heat as the IC engine, we can replace the material with aluminum;
• Most parts of the engine are taken from the IC engine which will make things easier;
• Having a lighter engine will give a chance to make the car more comfortable and luxurious.

2. Conclusion

Electromagnetic engines have several advantages over internal combustion engines. Their greatest benefit is that they do not use fuel. As a result, there is minimal to no pollution, which is very desirable in today's world. There is only a small amount of heat generated in the cylinder due to no combustion, therefore, no cooling system is required [5]. The use of magnetic energy requires an air filter, fuel tank, supply system, fuel filter, fuel injector, fuel pump, valves, etc. All of which can be eliminated, by simplifying the engine's design. In addition, we can reduce the engine's weight by using materials like aluminum, titanium, etc. Transmission systems from IC engines can be used in electromagnetic engines, resulting in less noise when the engine runs. An electromagnet prototype uses the property that it changes its polarity when the current direction changes. Magnets attached to the piston are attracted or repellent depending on the variation in polarity. By using a relay and timer, the engine's output will be limited [6]. In order to gain more power on each stroke, an Electronic Control Unit can be used in the engine instead. The output of the engine will also be improved by inserting more permanent magnets in series with the piston. It is possible to modify the engine to produce more power and increase its efficiency so that it can be used in commercial vehicles and in other applications with only slight modifications to its design. The dual electromagnetic engine uses the battery completely for its operation. The usage of rechargeable battery helps in charging the battery following discharging, which results in smooth running, and enhanced driver comfort.

Competing Interests

The author(s) declare no competing interests.

3. References

[1] Kant,, R.,Kumar, S., Sai Tarun B. V. "Design of Electromagnetic Valve for IC Engine", IJASEAT: Int. J. of Advances in Science, Engineering and Technology, **8(3),** 21-27 (2020).

[2] Hu, Y., Xu, Z., Yang, L., & Liu, L. "Electromagnetic loss analysis of a linear motor system designed for a free-piston engine generator". Retrieved May 16, 2022, from https://www.mdpi.com/2079-9292/9/4/621 (2020).

[3] Eapen, A. J., Varughese, A. E., Arun T.P., Athul T.N. "Electromagnetic Engine", IJRET: Int. J. of Research in Engineering and Technology, **3(6),** 31-35 (2014).

[4] Sampreeth, S. J., Shruthi, V., Ravi, K., D'souza, R. T., Ganesh, V. N. "Dual Electromagnetic Engine", IJRET: Int. J. of Research in Engineering and Technology, **7(8),** 1123-1133 (2020).

[5] Adarsha, H., Kaushik, V., Prasad, K. S. H., Sharma, S. C. "Development Of Electromagnetic Engine For Future Transport Applications", IJMPERD: Int. J. of Mechanical and Production Engineering Research and Development, **7(2),** 145-154 (2017).

[6] Rawal, A., Parmar, D. S., & Pawar, M. "A review on: Working & Fabrication of electromagnetic reciprocating engine". Available at SSRN: https://ssrn.com/abstract=3703570 or https://dx.doi.org/10.2139/ssrn.3703570 (2020)