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DESIGN AND DEVELOPMENT OF THE MAGLEV WHEEL FOR AUTOMOBILE APPLICATION

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Abstract— **The automobiles that run today uses internal combustion engines for producing power. This results in the emission of toxic gases which causes air and noise pollution. Also the efficiency of these engines are low as it uses various power transmission systems. The main objective was to eliminate the usage of fuels and this was achieved by using the concept of maglev which operated the wheel as a prime mover.**

This paper presents the design and development of a maglev wheel for use in a motor cycle. The techniques used for fabricating various parts of the wheel, such as the hub ring, hub side part, rim ring and rim side part, as well as for finding the number of electromagnets and neodymium magnets required, are described. Comparison of the obtained results, after the manufacturing of the wheel, with the specifications of the motorcycle used for bench marking confirmed the feasibility of the proposed wheel design. Operating a motorcycle with the wheel as its prime-mover and a frictionless drive resulted in the increased efficiency of the motorcycle and eliminated the consumption of fuel.

Index terms- - **Levitation, propulsion, guidance, efficiency, neodymium magnets.**

I. INTRODUCTION

India is investing most of its revenue in the refining and usage of crude oil. At present, around 735 million metric tonnes/ of crude oil is consumed annually by the country and about Rs.79 thousand crores of the country's revenue is expended for the import, maintenance and transportation of crude oil annually. The major portion of this oil is utilized in automobiles which is a major cause of air and noise pollution. Moreover, the fossil fuels are depleting and the whole world is in an urge for an alternative energy source. Also, in the global era, the technical difficulties like Ozone layer depletion and pollution are still prevailing. The above mentioned hazards cannot be cured altogether, but a step towards its reduction might weaken it.

Magnetism has been a part of the earth since the beginning of evolution. It is due to this magnetism that the earth revolves and rotates and thus creates things like gravity. Presently, it has been made into use for a number of applications. One of these applications is magnetic levitation. Magnetic levitation uses the concept of a magnets natural repulsion to poles of the same kind. It is a method by which an object is suspended with no support other than magnetic fields. Maglev is a system in which the vehicle runs levitated from the guideway by using electromagnetic forces between superconducting magnets on-board the vehicles and coils on the ground. Magnetic propulsion is the process by which motion is imparted to the magnet by alternating the polarity of corresponding magnets.

The earliest work was carried out by the Brookhaven National Laboratory, Massachusetts Institute of Technology, Ford, Stanford Research Institute, Boeing Aerospace Co., and the Garrett Corporation. In the United States, though, the work ended in 1975 with the termination of Federal Funding for high-speed ground transportation and research. It was at that time when the Japanese and German developers continued their research and therefore came out with the first test tracks. In 1990, a legislative action directed the U.S. Army Corps of Engineers to implement and prepare a plan for a National Maglev program. The Department of Transportation (DOT), Department of Energy (DOE), and the Army Corp developed what is known as the National Maglev Initiative which was a two year 25 million dollar program to assess the engineering, economic, environmental and safety aspects of Maglev.

In this paper, the design and construction of a maglev wheel for use in a motorcycle will be described, based on the theoretical evaluations carried out by considering a standard bike for bench marking purpose.

II. THEORETICAL EVALUATION

A. Bench-marking specifications:

Considering 'Hero Honda Splendor Plus' bike.

Fig.1 Hero Honda Splendor Plus bike

P_{max} = 6.1 kW
T_{max} = 8.05 N-m
N = 5000 rpm

B. Calculation of overall efficiency:

$$BP = \frac{2\pi NT}{60}$$

$$= \frac{2 \times \pi \times 5000 \times 8.05}{60}$$

= 4.214 kW

Considering 15% of transmission loss, the power available at the wheel is given by,

WP = 0.85 × BP
= 0.85 × 4.214

∴ WP = 3.58 kW = 4.8HP

The wheel used in the above bike is of 18 inch diameter.
Consider Transmission Ratio (t) = 3
Hence, the velocity of wheel is given by,

$$v_w = \frac{\pi \text{ D N}}{60}$$

∴ v_w = 143.633 km/hr

From the specification sheet, the mileage of the bike ranges from 65-75 km/L.

Considering Mileage = 65 km/litre

$$\text{Volumetric Fuel usage} = \frac{Velocity\ of\ Wheel}{Mileage}$$

= 2.21 litres/hr
= 6.13×10^{-4} litres/sec

The fuel used for operating the bike is petrol.
Density of petrol = 0.711 kg/litre
Hence, the mass flow rate of fuel consumed is given by,

m_f = density of fuel × volumetric fuel usage
= $0.711 \times 6.13 \times 10^{-4}$

∴ m_f = 4.364×10^{-4} kg/sec

We know, Calorific Value of fuel (CV) is 44000 kJ/kg.
Energy associated with fuel = CV × m_f
= 19.2016 kW

$$\text{Overall Efficiency} = \frac{Wheel\ Brake\ Power\ (= 3.48\ kW)}{Energy\ Associated\ with\ Fuel}$$

= 18.64 %

C. Calculation for neodymium magnets:

Clearance between the magnets on rim and on hub = 0.16 *inch* = 4 *mm*

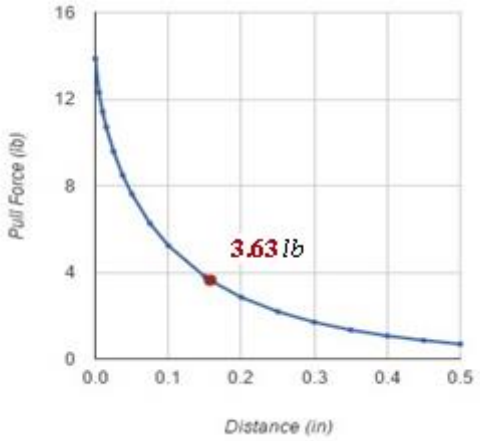

Fig.2 Graph of pull force vs distance

Repelling force (R) = 3.63 *lbf* = 1.65 *kgf*
Considering,
Mass of vehicle (m_v) = 100 kg
Mass of driver (m_d) = 80 kg
Total mass = 180 kg
Mass on each wheel = 90 kg
Therefore,
Number of magnets required = 90/1.65
= 54.54 ≈ 55 *magnets*

This is possible only for flat surface.

Now, for curved surface,
∴Let, N = Number of magnets contributing to levitation.

$$\therefore \text{Repelling force (R')} = 1.65 \times 2 \times \sum_{i=1}^{i=N} \sin\left(\frac{180}{N} \times x\right)$$

$$\therefore 1.65 \times 2 \times \sum_{i=1}^{i=N} \sin\left(\frac{180}{N} \times x\right) = 90$$

∴ N = 30

Total magnets required = 4 × 30
on hub and rim = 120 magnets

D. Calculation of electromagnets:

Voltage (V) = 12 V dc
Rated power consumed = 36 W
Pulling force = 10 lbf = 4.54 kgf
Diameter of hub = 206.569 mm
Radius of hub = 206.569/2 = 103.28 mm
Hence the torque produced per electromagnet is given by,
Torque per electromagnet = 4.54 × 9.81 × 0.10328
= 4.599 N-m

Assume, the corresponding pulling occurs at 75^0 to the normal surface.

∴Torque per electromagnet = 4.599 × $\sin 75^0$
= 4.443 N-m

We know that,
Torque provided by engine = 8.05 N – m
Hence the total torque applied on the wheel is given by,
Total torque = rated torque x transmission ratio

= 8.05 x 3
= 24.15 N-m
Electromagnets required = 24.15/4.443
= 5.43
= 6 electromagnets per surface
Since, for propulsion we use BLDC circuit:
No. of electromagnets = 6 3 = 18 electromagnets

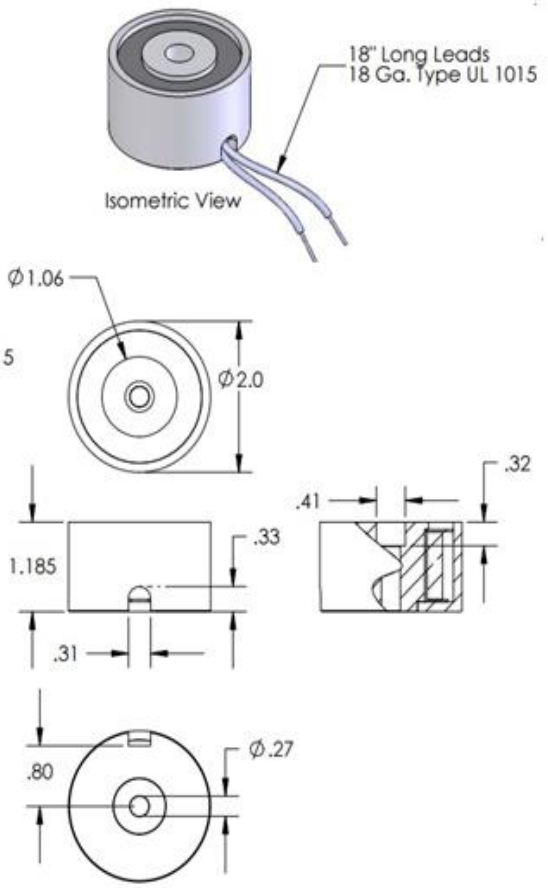

Fig.3 Design of electromagnet

III. Modelling of Prototype

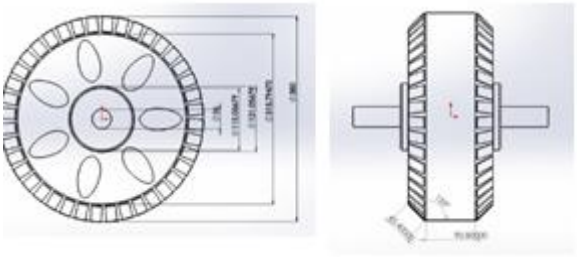

Fig.4 Design of wheel hub

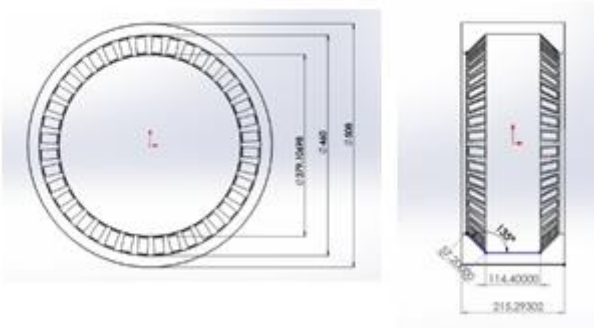

Fig.5 Design of wheel rim

The material used is aluminium alloy steel because of its less density, high strength and easy weldability.

IV. Final Maglev Wheel Prototype

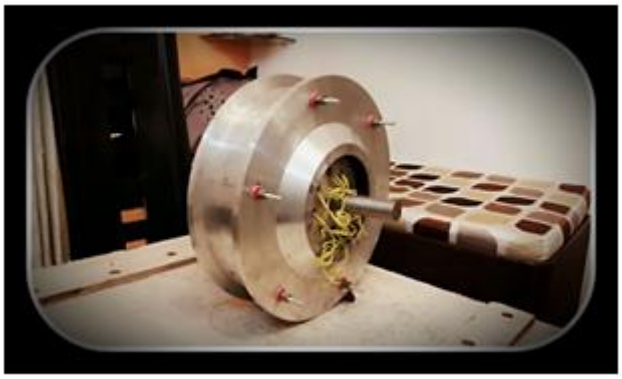

Fig.6 Final Maglev Wheel prototype

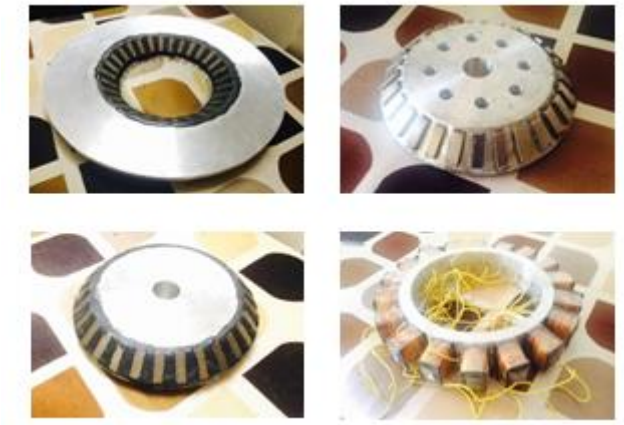

Fig.7 Parts of the Maglev Wheel prototype

The hub and rim side parts are made out of a single cubical block to reduce the cost of the wheel. First, the rim side part was splitted from the block by using profile cutting method and then gas cutting. The rim part was then machined by turning operation on lathe machine.

The electromagnets were manufactured by preparing a die of the required size for it and then by produced injection moulding. In order to increase the heat dissipation, it was then covered by glass taping.

V. RESULT

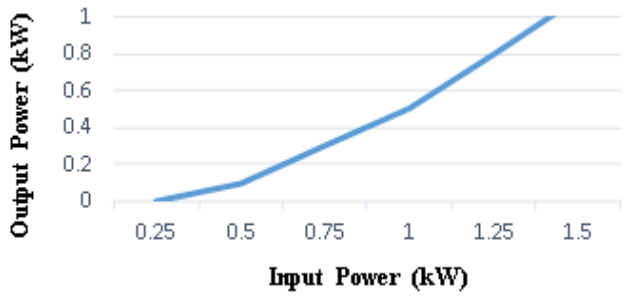

Fig.8 Graph of output power vs input power

The efficiency at the rated current can thereby be calculated as:

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power}}$$

$$\therefore \quad \text{Efficiency} = \frac{0.78}{1.2} = 0.65 = 65\%$$

VI. CONCLUSION

The Design and Development of the Maglev Wheel has been successfully carried out. The maglev wheel prototype was able to fulfil the pre-mentioned objectives. The hub successfully levitated on the rim at a clearance of 5 mm. The wheel is able to produce considerable torque for the motion of motorcycle.

The result showed the following conditions:

1. By increasing the number of electromagnets, the torque obtained increases, thereby increasing the output power. Thus the overall efficiency of the bike increases.
2. Since there is no use of any combustible fuel, there is no emission of toxic gases and this bike can be said to be eco-friendly.
3. Since there is no friction these maglev wheel can reach high speeds.
4. Since this maglev wheel does not touch the track and it has no motor/engine it makes very less noise.
5. It requires very little maintenance because there is no contact between the parts which will result in less wear and tear.
6. The magnets alignment can be changed to the helical form in order to improve the tendency of levitation.
7. The bike can travel at a very high velocity with less power consumption.

Thus the Maglev Wheel promotes Green Technology and can be termed as an “Eco-friendly bike”.

VII. REFERENCES

1) Website:

- http://www.elektrobike-online.com/news/e-bikes-und-pedelecs/lightweight-velocite-das-100km-h-bike-mit-transrapid-technologie.1262586.410636.htm#5
- http://www.carbofibretec.de/en/references
- http://www.totalmotorcycle.com/future.htm
- http://www.google.com/patents/EP2210807A1?cl=en

2) Patent:

- Sanyo Electric Co. Ltd., EP2436592A1, Apr 4, 2012, ‘Electric bicycle hub unit, and electric bicycle including the hub’.
- Lan Lee, WO2012164354A1, Jun 22, 2011, ‘Electricity generating bicycle wheel assemblies’.
- Ziping Wang, EP20080784030, Publication, EP2210807 A1, “Magnetic levitation magneto-electric bicycle wheel hub”, July 28, 2010.

3) Bibliography:

- The Magnetic Levitation Train: A Technology ahead of its Time? – Jens Hillebrand
- Maglev Trains – Springer
- Design Data Book of Engineers – Kalaikathir Achchagam