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Implementation of Maglev Turbine and Solar Energy for Generation of Electricity

[1]N.P.Bhiram, [2]Shivraj Panaskar, [3]Shivani Mane, [4]Aditya Nikam, [5]Vishwajit Nikam

[1]Professor, ISBM College of Engineering, Pune, Maharashtra, India
[2,3,4,5]Student, ISBM College of Engineering, Pune, Maharashtra, India

***Abstract* - Renewable energy is electricity supplied from sources such as wind power, solar power, geothermal energy, hydropower and biomass. Magnetic levitation (Maglev) technology combined with photovoltaic (PV) solar panels presents an innovative hybrid power generation system. The Maglev Vertical Axis Wind Turbine (VAWT) uses Neodymium (Nd-Fe-B) rare earth magnets to achieve frictionless levitation, enabling operation at wind speeds as low as 1.5 m/s. This paper presents the design, fabrication, and testing of a hybrid Maglev-Solar power generation system. The system generates electricity continuously: the maglev turbine operates during wind availability while the solar panel supplements during daylight. Testing results demonstrate that at 698 RPM, the maglev turbine generates 21.4 V, compared to 12.8 V at 278 RPM for a traditional windmill. The total system cost is estimated at ₹14,374.**

Keywords: Maglev turbine, VAWT, Solar PV, Renewable energy, Hybrid power generation, Magnetic levitation, Neodymium magnets.

I. INTRODUCTION

Combining latest Maglev technology with PV (Solar) panels gives the best of both worlds for greater independence from costly grid electricity bills. From apartments to street lighting, hybrid systems are starting to bring consistent power to areas worldwide. Maglev turbines are an ideal solution to the traditional wind turbine, which needs very high structures to allow room for massive blades.

Using Maglev technology in VAWTs (Vertical Axis Wind Turbines) means fewer moving parts, less maintenance, a smaller profile, and most importantly, very little wind required to start working due to the lack of friction. The smaller, more compact design of the VAWT makes it ideal for home use as the unit and blades stand upright.

Having magnetic levitation means the turbine's weight is frictionless in operation, allowing even a small breeze to turn it and produce power. The Maglev VAWT has a much smaller footprint. It is also quiet in comparison to normal turbines, doesn't create turbulence, and is safer as no massive windmill blades are rotating.

The Maglev uses latest Nd-Fe-B (Neodymium) rare earth magnets which are 10 times stronger than others, eliminating the need for any electromagnetic drive, making them friction-free and virtually maintenance-free.

1.1 Maglev-Solar Hybrid System

Wind turbines only work when there is wind, and solar only works when there is sun. Normally, lots of messy and expensive solar batteries are used to store energy when the sun goes down or the wind stops blowing. Due to the air/ground temperature difference, when the sun goes down ground wind instantly increases. So the hybrid system produces power day and night.

1.2 Objective

With populations increasing exponentially and natural resources being strained by increases in demand, it is more important than ever to invest in renewable energy. The by-product of fossil fuel consumption is carbon dioxide, a primary constituent leading to global warming. This project focuses on the utilization of wind energy as a renewable energy source. The aim is to design and implement a magnetically levitated vertical axis wind turbine system that has the ability to operate in both high and low speed conditions.

The design objectives of the project are:

1. Incorporation of more renewable energy to the power system.
2. Design of a new method of generating electricity using wind energy generated by moving vehicles on highways, or from home/college terraces and balconies.
3. Reduction of energy loss due to friction in bearings.
4. Design and development of a magnetically levitated wind turbine.
5. Development of a stand-alone system for providing power to highways, streetlamps, signals, and CCTV, etc.

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6. Combination of two natural power sources—wind and solar—to produce the desired output.
7. Creation of a low-cost device that middle class consumers, small scale industries, or societies can purchase

II. THEORY

2.1 Wind Power

Wind is known to be another form of solar energy because it comes about as a result of uneven heating of the atmosphere by the sun coupled with the abstract topography of the earth's surface. Wind power is the use of air flow through wind turbines to mechanically power generators for electricity. Wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation.

2.2 Solar Power

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics convert light into an electric current using the photovoltaic effect. The International Energy Agency projected that by 2050, solar photovoltaics and concentrated solar power would contribute about 16 and 11 percent, respectively, of worldwide electricity consumption.

2.3 Magnetic Levitation

Also known as maglev, this phenomenon operates on the repulsion characteristics of permanent magnets. Using a pair of permanent magnets (neodymium magnets), the magnetic repulsion is strong enough to keep both magnets at a distance away from each other. This repulsion force can be used for suspension purposes and is strong enough to balance the weight of an object. In the designed prototype, the stator and rotor are separated in air using the principle of magnetic levitation.

The rotor is lifted a few centimeters in the air by the magnetic pull forces created by ring-type Neodymium magnets. As the rotor is floating in the air due to levitation, mechanical friction is totally eliminated. That makes rotation possible in very low wind speeds. The vertically oriented blades of the wind turbine are suspended in the air above the base of the machine by using permanent magnets, which produce magnetic force to lift the blades.

2.4 Dc-Ac Conversion / Battery Charging Unit

The output from the maglev windmill will be an alternating voltage. This output can be directly connected to a load or converted to DC and stored in a battery for later use. By varying the duty cycle of the pulse applied to the gate of the transistor for switching, converters can buck or boost the voltage. When accurate feedback is applied, the converter will not only transform a supply voltage to the desired output but also maintain it given a varying input.

III. HARDWARE DESCRIPTION

3.1 Neodymium Magnets

The Maglev system uses Nd-Fe-B Neodymium ring magnets with the following specifications:

- Dimensions: 40 mm OD × 20 mm ID × 10 mm thick
- Grade: N52
- Plating/Coating: Ni-Cu-Ni (Nickel)
- Magnetization Direction: Axial/Radial (Poles on Flat Ends)
- Max Operating Temp: 80°C (176°F)

3.2 Coils

An electromagnetic coil is an electrical conductor such as a wire in the shape of a coil, spiral, or helix. A current through any conductor creates a circular magnetic field around the conductor due to Ampere's law. The advantage of using the coil shape is that it increases the strength of the magnetic field produced by a given current. 26-gauge wires of 3050 turns each are used as coils for power generation. Four sets of such coils are used in the prototype, arranged in the periphery of the stator in alignment with the disc magnets.

3.3 Solar Panel

Specification of solar panel: Company – GOLDIGREEN, Model – GOLDI003PM, Rated Power – 3 W, Open Circuit Voltage – 10.8 V, Short Circuit Current – 0.39 A, Voltage at Maximum Power – 8.8 V, Current at Maximum Power – 0.35 A, Maximum System Voltage – 600 V.

IV. DESIGN OF MAGLEV TURBINE

The plate weight is 200 g and total weight of turbine with magnet is 1.3 kg.

4.1 Air Catchment Area

Area = w × h = 25 cm × 6 cm = 150 cm². The plate diameter of 30 cm was selected according to the magnet weight capacity. Ring magnet Grade N52 has an approximate

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weight capacity of 1.5 kg. Total turbine weight = 1.3 kg, leaving a factor of safety of 0.2 kg.

4.2 Blade Profile & Volume

Surface area = $2\pi r^2 + 2\pi rh = 2 \times 3.14 \times 15^2 + 2 \times 3.14 \times 15 \times 50 = 6{,}123\ cm^2$

Volume = $\pi r^2 h = 3.14 \times 15^2 \times 50 = 35{,}325\ cm^3$

V. CALCULATIONS

5.1 Power Generation (Faraday's Law)

$$V = -N\,(d\Phi/dt)$$

The voltage produced by each coil is calculated using Faraday's law of induction. The induced EMF is produced by a time-varying magnetic field.

5.2 Magnetic Flux

$$\Phi = BA\cos\theta \;\rightarrow\; \Phi B = \int B \cdot Da$$

5.3 Field Density Calculation

$$A\_surface = \pi/4 \times D^2 = \pi/4 \times 0.038^2 = 8.55 \times 10^{-4}\ m^2$$

$$Hl = H \times l = (875 \times 10^3) \times (0.019) = 16.66 \times 10^3\ A$$

$$\Phi = B \cdot A \cdot \cos\theta = 1.32 \times 8.55 \times 10^{-4} = 1.12 \times 10^{-3}\ Weber$$

5.4 Wind Power

$$P\ (kW) = 2.14 \times \rho \times A \times V^3 \times 10^{-3}$$

Where ρ = 1.22 kg/m³ (air density), A = swept area (m²), V = wind speed (m/s). The power harnessed from the wind cannot exceed 59% of the overall wind power (Betz limit).

VI. MATERIAL SELECTION

The materials were selected for different components as follows:

1. Stand: Cast Iron (Carbon 2.1–4.5 wt%, Si 1–3 wt%) – low shrinkage, good fluidity and castability.
2. Shaft: Grade 304 Stainless Steel – good corrosion resistance with formability and weldability.
3. Stator: Plywood – baked at 140°C and 1.9 MPa for structural integrity.
4. Rotor Plates: Medium-Density Fibreboard (MDF) – engineered wood product, smooth surface, lightweight.
5. Rotor Blades: Aluminium Sheet – lightweight, strong, corrosion-resistant, ductile, and malleable.

VII. COST ESTIMATION

Table 1: Presents the raw material and standard parts cost estimation for the prototype:

Sr No	Part Name	Material	Qty	Cost (₹)
1	Frame	MS	25 kg	3,000
2	MDF	Wood	1 set	1,000
3	Shaft (Dia 19.75 mm)	Steel	1 No	200
4	Coil	Copper	4 Nos	600
5	Solar Panel	Std	1 No	2,000
6	Battery	Std	1 No	800
7	Aluminium Sheet	Std	1 No	200
8	Electrical Components & Wire	Std	–	100
9	Ring Magnet	Std	2 Nos	2,000
10	Disc Magnet	Std	8 Nos	2,424
11	Screw, Nut, Bolt	Std	1 Dozen	50
12	Other Expenses	–	–	2,000
			Total	14,374

VIII. FABRICATION

8.1 Stand Fabrication

The base stand is fabricated from MS rectangular pipes. Cutting processes include hacksaws, band saws, and circular saws. TIG (Tungsten Inert Gas) welding is used for joining high-strength parts.

Base stand specifications: Base square side = 500 mm, vertical pipe height = 500 mm, vertical pipe diameter = 40 mm, central base plate = 170 mm × 128 mm.

8.2 Rotor Fabrication

The rotor plates (upper, middle, lower) are cut in circular shape using a band saw. Aluminium sheet is used for the turbine blades, bent manually as per the design. Two ring-type NdFeB magnets (Grade N-42, OD 40 mm, ID 20 mm, thickness 10 mm) are placed at the centre of the shaft for required levitation. Eight disc magnets (20 mm diameter, 6 mm thickness) are arranged as alternate poles along the periphery of the rotor plate. Araldite adhesive is used to fix the magnets. The angular distance between two magnets is 45°, equal to the distance between two coils.

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Rotor plate specifications: Diameter = 400 mm, central hole = 20 mm. Blade height (lower half + upper half) = 250 mm each.

IX. RESULTS AND DISCUSSIONS

Table II presents solar panel voltage measurements at different times of day:

Table II: Testing of Solar Panel

Sr. No.	Time (hrs.)	Voltage (V)
1	9 am	8.5
2	1 pm	10.2
3	4 pm	9.8
4	6 pm	6.2
5	7 pm	2.8

Table III presents maglev turbine voltage at varying RPM:

Table III: Testing of Maglev Turbine

Sr. No.	Rotation (RPM)	Voltage (V)
1	64	3.7
2	130.7	8.9
3	232	13.4
4	303	14.6
5	698	21.4

Table IV compares Maglev with a Traditional Wind Turbine:

Table IV: Comparison of Maglev vs. Traditional Wind Turbine

Sr. No.	Maglev RPM	Maglev V (V)	Trad. RPM	Trad. V (V)
1	64	3.7	51	2.2
2	130.7	8.9	89	4.0
3	232	13.4	126	5.6
4	303	14.6	231	10.7
5	698	20.4	278	12.8

X. CONCLUSION

From this study, the following conclusions are drawn:

1. The magnetic levitation turbine is very useful in renewable energy generation.
2. The hybrid system is non-polluted, less noisy, and of simple construction.
3. Hybridisation of solar and maglev gives continuity in energy generation in any season.
4. A homeowner would be able to extract free clean energy, reducing utility costs.
5. At 698 RPM, the Maglev turbine generates 21.4 V, compared to 12.8 V at 278 RPM for a traditional windmill demonstrating significantly better performance.
6. The total system was built at a cost of ₹14,374, making it viable for middle-class consumers.
7. The Maglev wind turbine designed is ideal for bridge tops to generate electricity for street lights and commercial use.

XI. FUTURE SCOPE

1. Maglev can make rapid transits more energy efficient and environment friendly.
2. The technology is expected to create new opportunities in low-speed areas with starting speed as low as 1.5 m/s.
3. Increasing the coil and magnet arrangement will generate more electricity.
4. In the future, small villages may each have a small power generating unit of 500 W for basic appliances with negligible maintenance.
5. The system can be installed on every street light with day-night controllers for industrial use.

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