DOI: https://doi.org/10.46632/ese/1/1/9
Environmental Science and Engineering
Vol: 1(1), 2022
REST Publisher; ISBN: 978-81-956353-2-0
Website: http://restpublisher.com/book-series/environmental-science-and-engineering/

Design and Fabrication of Windmill by Using Maglev Technology

***K. Raghavendra Kasyap, Bhanu Prathap Reddy, Saikumar Ediga, Vamsi Mohan Rajoulu, KuppiReddy Jyosthna.**
MRR institute of technology and science, udayagiri, Nellore, Andhra Pradesh, India
*Corresponding author Email: raghavendrakasyap@gmail.com

Abstract. Renewable energy is electricity produces from sources, such as wind, solar, geothermal and various forms of biomass. The popularity of renewable energy has experienced with a significant upsurge in recent times due to the exhaustion of conventional power generation methods and increasing realization of its adverse effects on the environment. Bases on research, it is estimated that renewable sources might contribute about 20% – 50% to energy consumption in the latter part of the 21st century. Worldwide there is now over two hundred thousand wind turbines operating with a total name plate capacity of 432,000 MW as of end 2015.Unlike the traditional horizontal axis wind turbine, this design is levitated via Maglev (magnetic levitation) vertically on a rotor shaft. It serves as an efficient replacement for ball bearings used on the conventional wind turbine and is usually implemented with permanent magnets. This levitation will be used between the rotating shaft of the turbine blades and the base of the whole wind turbine system. It does not need to vast spaces required by more conventional wind turbines.
Keywords: VAWT, Magnetic Levitation, Wind Turbine, Magnet, Blades.

1. Introduction

Conventional wind mill having a maximum efficiency of 30% and energy efficient wind mill can operate in maximum efficiency of 45%. The remaining energy is mainly lost in friction. If the Same wind mill is operating at 50% of its maximum speed the efficiency becomes very low and the frictional loss gets increased compared to power generated. The drawback of wind mill is that it cannot be operated at its full capacity all the time. Moreover, due to friction there will be wear and tear in machines. Due to the wear and tear the performance of the machine will deteriorate and also Normal windmill can start its generation from wind speed of 3 m/s. With introduction of magnetic levitation to Vertical Axis Wind Turbine (VAWT), energy wasted in the form of friction can be saved and also windmill using magnetic levitation can start generation from wind speed at 1.5 m/s. Operation of windmill at lower speeds, increases the amount of energy harvested from the windmill. Power will then be generated with an axial flux generator, which incorporates the use of permanent magnets and a set of coils.

2. Design Considerations

- Wind speed
- Force
- Weight of the turbine
- Diameter of the blades
- Length of the blade
- Blade angle and also
- Shape of the blade.

3. Components

- DISCS
- SHAFT
- MAGNETS
- BLADES
- COPPER COILS etc.

4. Specifications for components

S. no	Name of the parts	No of parts	Outer diameter	Inner diameter	Length	Height	Thickness
01	DISC	02	300	25	__	__	5
02	MAGNETS	02	50	25	__	__	20
03	SHAFT	01	15	__	__	600	__
04	BLADES	03	195	142	100	400	5

Types of Turbines: Wind Turbines are divided into two classes: horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs).

5. Horizontal Axis Wind Turbines

Horizontal axis wind turbine can be visualized as conventional box fan, a set of blades connected to a shaft that is parallel to the ground; however, function of turbine is the opposite of a box fan. It normally consists of two to three blades connected to a shaft that is connected to a generator which will produce energy from shaft work. There are two main types of HAWTs, ones that face into wind and ones that face away from wind. Turbines that face into wind require a rudder or some other type of mechanism to be able to self-orientate to face incoming wind. Those that face away from the wind do not need this rudder to self-orientate, however they suffer from a vibration due to support tower blocking part of wind flow.

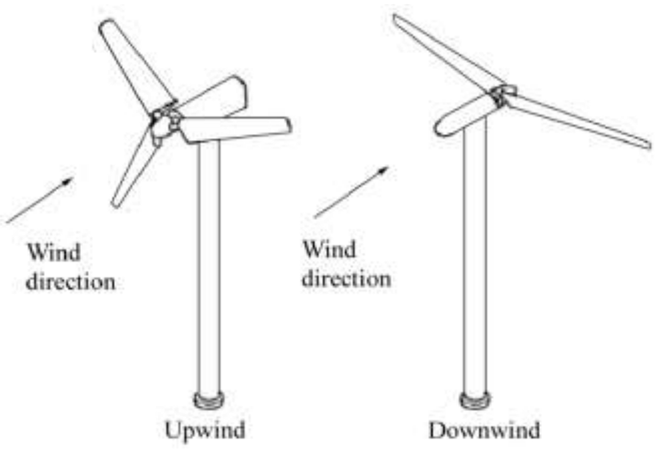


FIGURE 1. Horizontal axis wind Turbine

6. Vertical Axis Wind Turbines

Vertical axis wind turbines operate on same principle of converting rotational movement due to wind into shaft work, which is then converted into electricity through the use of a generator. VAWTs contain a shaft that is perpendicular to ground. Unlike the HAWTs, the VAWTs can catch the wind regardless of the position that they are facing, which can lead to them being more versatile. Also, VAWTs are able to function in more irregular wind patterns than HAWTs are able to. There are two primary blade designs that are used for VAWTs that operate on different principles: the S avonius type and the Darrieus type.

Savories Turbine Type: Finnish engineer Sigurd Savories invented the Savonius model. Savonius type blade design uses aerodynamic drag from wind to rotate the blades and produce power. Savonius type blades are rugged and simplistic. This can reduce costs since they are easier to manufacture, need less maintenance, and can last longer in harsher environments. However, they are roughly half as efficient as other lift type such as the Darrieus designs.

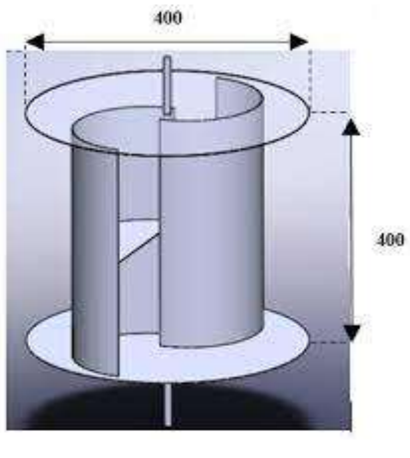


FIGURE 2: Savonius Turbine

Darrieus Turbine Type: French aeronautical engineer, Georges Darrieus invented this turbine. Darrieus type blades use lift forces from wind to rotate the blades. The blades have an airfoil shape, and instead of being oriented horizontally as they would be on an airplane, they are oriented vertically. The air that travels along the outside of the curve must travel at a greater speed than the air on the inside of the blade. This creates an area of lower pressure on the outside of the blade, and therefore a net force on the blade to the outside. By controlling the angle of the blade, this net force causes the blade to rotate.

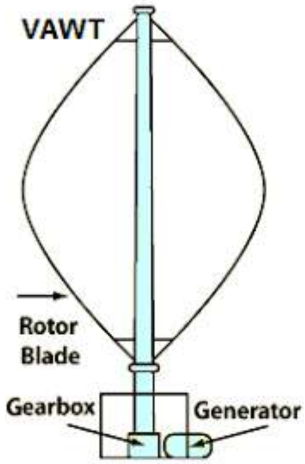


FIGURE 3: Darrieus Turbine

7. System Modelling

Wind Power Generation: When the air strike the blade of the turbine, due to the action of repulsive force of the magnet the rotation of the blade increase resulting in rotation of the shaft. Hence induced emf is generated in the generator. Output of turbine is AC power. The bearing arrangement is totally replaced by the neodymium magnet which gives high repulsive force. With the help of this force small amount of air pressure gives maximum rotation which results in large power generation.

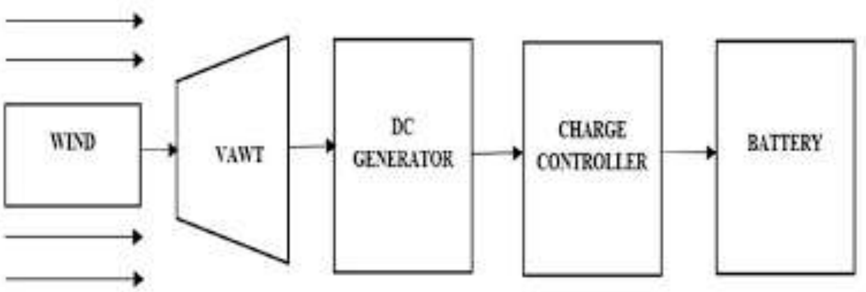


FIGURE 4. Block diagram of wind power generation

8. Magnetic Suspension (Levitation)

Principle : Magnetic levitation can be explained as technology which suspends or levitates an object with the help of magnetic forces for getting support without any contact and low friction during motion. Due to absence of mechanical contact in the magnetic bearing, advantages of no wear and tear, suitability for long-term use in any environment, absence of mechanical friction, low noise, less amount of power loss and absence of lubrication or sealing can be achieved. Therefore, this technology is beneficial for high-speed applications to satisfy the objective of eliminating mechanical problems power loss.

Use of Magnetic Levitation in Wind Turbine: In recent years, due to rapid growth in the use of material for designing permanent magnet, the magnetic suspension using permanent magnets are approaching towards wind turbine application leading to reduction in the cost as well as stringency of wind power. Due to use of magnetic levitation concept the advantages marked below has obtained:

1. Reduction in starting wind speed, Due to elimination of friction the power output is increased for the same value of wind speed. Hence reduction in starting speed is obtained.
2. Due to utilization of magnetic levitation, design of the conventional wind turbine rotor has largely been affected. The use of conventional bearings is based upon careful lubrication for greater service life and higher

reliability. With the reduction in operational cost as well as maintenance cost of the bearings reduction in the downtime of turbine is achieved improving the overhaul efficiency.

9. Construction of Prototype

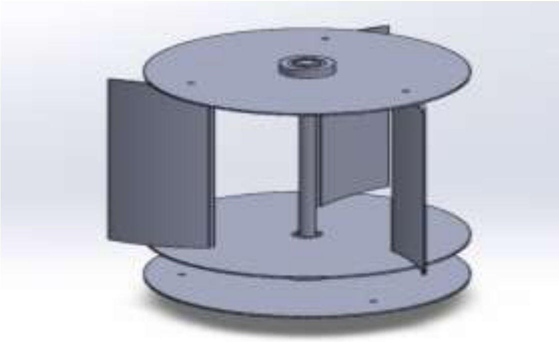
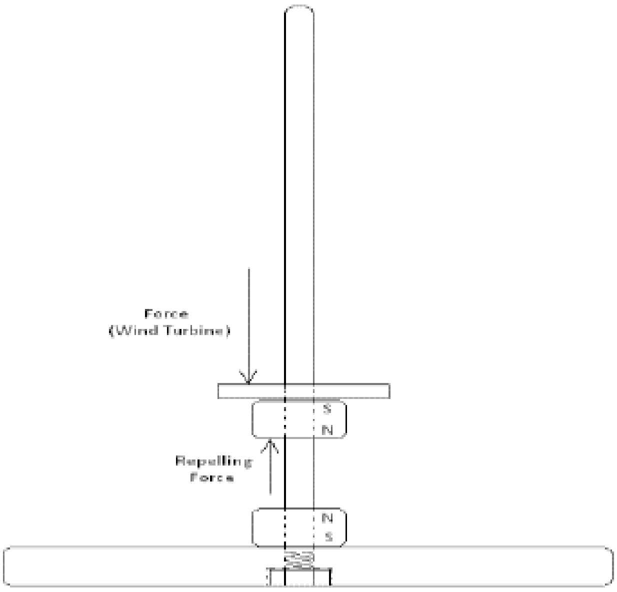


FIGURE 5. Design of maglev wind turbine

Magnet Selection: In every wind turbine and generator you will find one or more incredibly strong magnets. Simplified, the rotating shaft of a wind turbine is connected to one or more strong magnets, usually neodymium magnets, these magnets turn relative to an assembly of coiled wire, generating voltage in the coil.

Magnet Placement: Two ring shaped neodymium (NdFeB) magnets are arranged at middle of shaft by which necessary suspension between stator and rotor is obtained. Similarly disc magnets having parameters 10 mm in diameter and 4 mm height are placed as one North Pole and one South Pole one after the other, along the rotor circumference of 40 cm diameter. These magnets supply the useful flux which is utilized for the power generation.



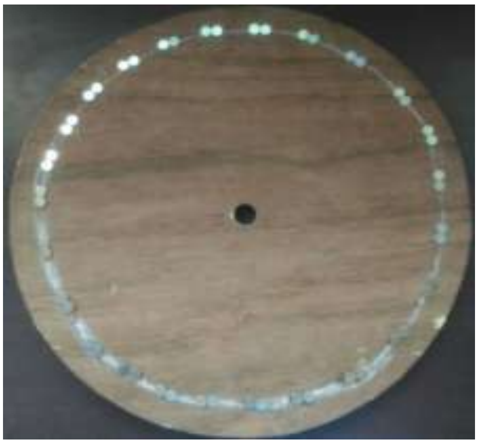
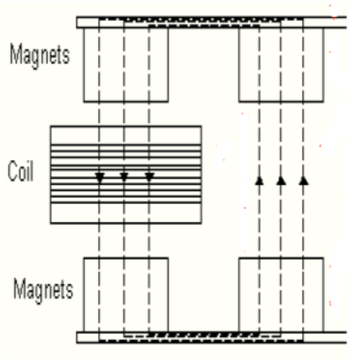


FIGURE 6. Arrangement of magnets

10. Coil Design and Arrangement

To design the definite number of turns per coil is difficult. If the more turns are wound it increase the emf generated from each coil but increase the size of every coil. For minimizing the size, wire having higher gauge can be used. If the diameter of wire is small low amount of current flows leading to heating of wire because of the increased resistance of wire which another difficult task. While designing generator for given application, fact must be known that the problem attached with large coil size is the problem field density. The increase in coil height increases gap between two magnets leading to reduction in magnetic flux. Hence necessary voltage and current must be balanced.



The Coil placement is organized on the stator circumference exactly under the disc magnets placed on rotor. Each coil is kept in series to get maximum output voltage. The wire used to design the turns of one coil is of 24 gauge having 100 turns. 15 sets of coils are arranged in series connection in the prototype. The coil arrangement is shown in figure.

FIGURE 7. Arrangement of coils

Blade Design: Savonius type blade design is used because they are rugged and simplistic reducing cost. The manufacture is easier, less maintenance, and durable in harsher environments. This design was obtained from aluminum sheet and due to the flexible nature of the metal sheet, desired shape was obtained. The blade was designed for height of 400mm.

11. Conclusion

The concept of vertical axis wind turbine using magnetic levitation successfully worked. Comparing with traditionalhorizontal wind turbines, single Maglev turbine having large capacity gives more output. The turbine efficiency is improved by utilization of magnets helping to spin with fast speed with negligible friction as it cancels out the stress on the shaft of the turbine. This modern design of turbine gives more power output with higher efficiency compared to conventional wind turbine. For avoiding the vibration of the rotor, shaft was used. The blades of the maglev wind turbine are designed to sweep enough wind to generate power. The VAWT with Maglev is used over the conventional horizontal axis wind turbine as the efficiency is increased around 30% and at the same time the operational cost has been reduced by 45% over the ordinary wind turbine. Apart from these the reduction of vibrations by 30% is also a major factor for choosing this over the conventional turbine. The most proficient use for the Vertical axis Maglev wind turbine

(VAMWT) can be found in the countryside. The system can be installed on the top of the houses, so that the house can be supplied with Green & Cheap energy with regular or uninterruptible supply.

Reference

[1]. Aravind CV, RajparthibanR, Rajprasad R, WongYV," A Novel Magnetic Levitation Assisted Vertical Axis Wind Turbine- Design Procedure and Analysis." 2012 IEEE 8th International Colloquium on Signal Processing and Its Applications.

[2]. ChandulalGuguloth, A.T Gapat, D.C Shende, S.P More, A.G Dandekar. Power Generation using Maglev Win Turbine.(NCMTEE-2K17).

[3]. Krishna, M.H., Dasore, A., Rajak, U., Konijeti, R., Verma, T.N. (2022). Thermo-Economic Optimization of Spiral Plate HX by Means of Gradient and Gradient-Free Algorithm. In: Verma, P., Samuel, O.D., Verma, T.N., Dwivedi, G. (eds) Advancement in Materials, Manufacturing and Energ Engineering, Vol. II. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-16-8341-1_48

[4]. Dasore, A., Konijeti, R., Tarun, P. N. V., &Puppala, N. (2020). A novel empirical model for drying of root vegetables in thin-layers. International Journal of Scientific & Technology Research, 9(1), 2639-42.

[5]. Fegade, Vishal, Krishnakumar Gupta, M. Ramachandran, S. Madhu, C. Sathiyaraj, R. Kurinji< alar, and M. Amudha. " A study on various fire retardant additives used for fire reinforced polymeric composites." In *AIP Conference Proceedings*, vol. 2393, no. 1, p. 020107. AIP Publishing LLC, 2022.

[6]. Deepa, N., Asmat Parveen, Anjum Khurshid, M. Ramachandran, C. Sathiyaraj, and C. Vimala. "A study on issues and preventive measures taken to control Covid-19." In *AIP Conference Proceedings*, vol. 2393, no. 1, p. 020226. AIP Publishing LLC, 2022.

[7]. Shaik Mullan Karishma, Upendra Rajak, B. Kiran Naik, Abhishek Dasore, Ramakrishna Konijeti, (2022), Performance and emission characteristics assessment of compression ignition engine fuelled with the blends of novel antioxidant catechol-daok biodiesel, Energy, Volume 245, 2022, 123304.

