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Design and Development of Savonius Vertical Axis Wind Turbine for Electricity Generation through High Pressure Wind Produced by Railway Trains Running in India

Devansh Nigam, Mayank Chauhan , Ram Jaiswal , Saurav Gabhane

Deptt. of Mech. Engg.Yeshwantrao Chavan College Of Engineering,Nagpur
Deptt. of Mech. Engg.Yeshwantrao Chavan College Of Engineering,Nagpur
Deptt. Of Mech. Engg, Yeshwantrao Chavan College Of Engineering,Nagpur
Deptt. of Mech. Engg.Yeshwantrao Chavan College Of Engineering,Nagpur

Abstract

India has the largest railway infrastructure in Asia and second in the world.That is 115,000 km followed by a route of 67,386km. 22,550 trains run in India every day and the average speed of trains in India is above 50 kmph which produces high pressure wind in large amounts. This wind energy goes waste in the current scenario. Using VAWT this source of energy production can be utilized. Pressurized air produced by the railway hits the blade of the vertical axis wind turbine and produces torque resulting in the rotation of the turbine in the desired direction. Shaft of the turbine is connected to the gear mechanism next to the generator. Using assembly of VAWT we produce large torque and equivalent power. This model of Vertical Axis Wind Turbine can be used for the production of power which may be used to fulfill the power requirements for railways and to cut the expense in power generation for the railways generator. Using assembly of VAWT we produce large torque and equivalent power.

In addition to that
India also has a very large highway network and by implementing the same model for highway side we can produce power in large amounts that can be used for commercial uses.

Keywords: VAWT, Renewable energy, Natural resources, Harnessed, Railway tracks

1. Introduction

Demand for electricity is increasing day by day and our dependence on conventional sources of energy is increasing but many countries in the world face the problem of shortage of conventional sources and hazardous effects of using this source like global warming, carbon emission etc. To avoid this dependence on this source we need to work in the field of green energy. There are many renewable energy sources, one of them is wind energy. This energy source is clean energy and available in large amounts but until now this source is underrated and no model is invented that can utilize this energy hence we are planning to implement VAWT that uses wind energy to produce electricity. Vertical axis wind turbine is suitable to operate at low wind speed as well as at high speed wind, VAWT is easy to install and maintenance is also cheap this feature makes

VAWT as our first preference over the HAWT .Working efficiency of VAWT can easily increase by analyzing forces and making some changes in shape of blade and thus VAWT gives optimum performance. As railway passes it start to gain momentum and in any instant of point pressure drop occurs and wind start to flow from high pressure to low this flow of wind is used to produce drag force and rotate blade of turbine and thus kinetic energy in the form of wind is converted into mechanical energy and then by using generator mechanical energy gets converted to electrical energy .creating frame consist of large number of VAWT throughout the highway or train route we can produce large torque that torque may be used to produce electricity in large amount that can be used for commercial uses and to eliminate dependence on conventional energy sources .Depending upon requirement of power frame structure can be easily modified. We are going to propose the model of VAWT which is realistic, effective and flexible.

2. Proposed Model

Vertical axis wind turbines can be developed in two ways: Savonius and Darrieus. The Savonius type turbine is the easiest wind turbine which has a lower cut in wind speed. Its structure comprises two half cylindrical shapes attached with a central shaft in such a manner that it forms an 'S' shape. Alternatively there can be three blades around the shaft. The central shaft is solid and is parallel to an axis of rotor. Here high velocity wind is utilized as a source of energy, this wind when coming in contact with blades produces the gust. In turn this wind energy is converted into mechanical energy. Shaft is connected to the generator thus one can store electrical energy generated in batteries which can further be used for various purposes.This turbine produces work irrespective of the wind direction. At a time one blade acts as advancing blade while other acts as returning blade. Whenever there is more importance of power reliability than the efficiency of a turbine, a Savonius type turbine is preferred. This type of turbine possesses distinctiveness in its rotor design as well as in torque production.

3. Material Used

Selection of material for various components is done by considering various aspects like durability, cost, feasibility, strength, requirements of specific components etc. In this model various kind of materials are used for different components some of them are listed below:

1. **Shaft**: Material for the shaft must be selected in such a manner, which possesses good weldability and can be structured with ease, thus 304 stainless steel is preferred here. It has an excessive resistance to corrosion and heat, and gives good results to hardening by cold working. Its composition includes eighteen percent chromium and eight percent nickel, even at a higher temperature of 1,600°F, it shows good oxidation resistance. This 304 stainless steel matches ASTM A276 properties.

2. **Aluminum Sheet**: Type-sheets 1050A grade; available sizes: 1/2inch, 3/4inch, 1inch, 2inch and 3inch; condition-new; features includes-annealed, pickled, polished, cold drawn; brand-aesteiron; pipe length available-3 meter, 6 meter, 9 meter, 18 meter, customized; aluminum sheet (2mm thickness is considered as studied from 3 research paper that minimum thickness is 1.56mm and 3mm becomes very thick so we consider the standard 2mm.

3. **Spur Gear**: Materials utilized in plastic gears are, mostly, engineering plastics like MC Nylon and polyacetal (POM) which is essentially polyamide resin. Various characteristics of plastic gears include being non-rusting, low noise during operation, lightweight, large production and low cost enabled by injection molding, and being able to operate without lubrication by mating with metal gears. Apart from these advantages, lower strength, ability to keep heat, various dimensional changes with backlash compared to metal, etc. are some of the points requiring caution. There are various reasons like temperature alteration, moisture absorption rate, resistance to chemicals.

4. **Steel Pipe**: MS square steel pipes are used for various purposes. These MS square steel pipes are manufactured by high grade mild steel which possesses highly break resistance. Their flawless finish adds up their popularity. Some of the features are: anti rust, high construction, high tensile strength.

4. Results and Discussion

The Vertical Axis Wind Turbine works on precept of changing the kinetic power of the wind into mechanical power. The Power in the wind may be calculated via way of means of the use of the standards of kinematics.

Kinetic Energy (K.E) = ½ x mass x (wind velocity)^2

$= \frac{1}{2} mv^2$ .... Eq^n (1)

The Energy transferred to the rotor with the aid of using the wind, relies on the air density (ρ), the swept vicinity of the rotor (A) and wind velocity (v)

Amount of air passing is given by :

$(m) = \rho \times A \times v$ .... Eq^n (2)

putting equation (2) in equation (1) , we had got

Available Wind Power (P_{wind}) = $\frac{1}{2} \times \rho \times A \times v^3$ watts.

VAWT are at best about half as efficient therefore, the actual power generated is the wind power multiplied by a coefficient of performance (Cp). According to Betz's law , no turbine can seize greater than 16/27 i.e. 59.3% of the kinetic electricity in wind. There is handiest 45% of energy is transformed into beneficial work, a few energy is might also additionally lose in equipment box, transmission, bearings etc. The maximum value for the power coefficient (Cp) is called the Betz limit i.e. Cp = 0.59

Power coefficient is given by $Cp = P_{wind} /(0.5 \times \rho \times A \times v^3)$

The maximum power coefficient, Cp for Savonius rotor is 0.45. Hence, the Cp value used in this project is 0.45 and the power output, P with considering the power efficiency is :

$P_{wind} = 0.45 \times 0.5 \times \rho \times A \times v^3$

Swept area (A) = D x h = 1.12 x 0.56 = 0.62 m^2.

We are considering normal speed of Express or Superfast trains moving with 120km/hr that produces the wind drag of (2.5-5.6) m/s as per the data referred from a research paper.

$P_{wind} = 0.45 \times 0.5 \times 1.2 \times 0.62 \times 5.6 \times 5.6 \times 5.6 = 29.34$ watts.

5. Conclusions

The VAWT is designed and fabricated in one of these manner that the it is able to capable of seize wind from all of the direction, power developed from the project is 29W for a velocity of 5.6 m/s, the performance of VAWT may be growth through converting the dimensions and form of the blade, the theoretical and experimental end result is varying due to the fact in theoretical calculation we consider the wind is hitting all of the turbine blades, which is not possible practically.

Our effort and the consequences received are very recommended that vertical axis wind power conversions are potential and probably very make contributions to the manufacturing of the easy renewable strength from the wind even below low perfect sitting conditions. With the concept of a highway, it's going to electricity up avenue lights. In maximum cities, highways are a quicker direction for day by day to go back and forth and in want of consistent mild weather makes this a completely green manner to supply clean energy.

References

1. Power Generation on Highway by using Vertical Axis Wind Turbine & Solar System by Prof. Sachin Y. Sayais and others, available on May,2018

2. Modified Savonius wind turbine for harvesting wind energy from trains moving in tunnels by Rajagopal Vinod Bethi and others, available online 10 December

3. Analysis of Vertical Axis Windmill Turbine for Electricity Generation on Highways Kiran Nakil‡*, Akshay Tekale ‡, Pratush Sambhus‡ and R.S. Patil

4. Al-Kayiem, H. H., Bhayo, B. A., & Assadi, M. (2016). Comparative critique on the design parameters and their effect on the performance of S-rotors. Renewable Energy, 99, 1306-1317

5. Blackwell, B. F., Sheldahl, R. E., & Feltz, L. V. (1978). Wind tunnel performance data for two- and three-bucket Savonius rotors. Journal of Energy, 2(3), 160-164

6. Menet, J. L. (2004). A double-step Savonius rotor for local production of electricity: a design study. Renewable energy, 29(11), 1843-1862

7. DESIGN AND CONSTRUCTION OF SAVONIUS ROTOR Mirsad Hyder Shah

8. Design & Analysis of Savonius VAWT for 50W Rated Power output Mr.R.M.Khandagale 1, Mr.B.G.Marlapalle

9. Experimental Comparison Study for Savonius Wind Turbine of Two & Three Blades At Low Wind Speed Mohammed Hadi Ali

10. INDIAN RAILWAYS SCHEDULE OF DIMENSIONS 1676mm Gauge (BG) Revised 2004

11. A Savonius Wind Turbine with Electric Generator Model and Test Yogendra Kumar Yadav