Electricity Generation by Wind Injection System

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Abstract— Wind Energy Generation system has exist around thousands of years. An innovative concept in wind energy generation is described which significantly performs like traditional wind turbines having same aerodynamic characteristics but different wind speed and different design, that delivers significantly higher output, at reduction in overall cost. Its 1st innovational feature is the elimination of tower-mounted turbines which are costly, inefficient, and harmful for living beings. Succeeding and vital innovative feature of new system is that it captures wind flow through all direction from the intake and thereby there is no need for a passive or active yaw control mechanism for the system. Third, it accelerates the flow of wind at interval of Venturi section, later on it expands and free into the surrounding through a diffuser section. It is seen that it is possible to capture, accelerate and concentrate the wind. The system increased wind velocities result in significant improvement in the power output.

Keywords: aerodynamic, yaw control, venturi, diffuser

I. INTRODUCTION

A new concept was established of utilizing a low wind speed for electric generation. [1] The following system consists of five main parts:

1) In-take with Direction Guide Blades
2) Double Nested Cone
3) Wind Concentrator
4) Venturi and Power Generation Section
5) Diffuser

The flow velocity in a free stream is directed by the intake section due to its geometrical feature and fades into double nested cone where the wind is directed towards a particular end. Later the wind is concentrate due to reducing the cross section at the venturi section, where wind is naturally accelerated. In venture section wind turbine are placed for power generation. And next the air is allowed to environment by the diffuser safely. The magnification of wind velocity is defined in terms of speed ratio. Speed ratio is the ratio of average velocity of wind at the venture section to the free stream wind speed.

Key features are as follows:

1) Separation of intake and wind turbine, so that the turbine can be installed as per the requirement and environmental conditions.
2) By the installation of wind turbine at ground reduces the overall installation and maintenance cost.
3) Separation allows designing the system for higher speed ratio.
4) Smaller blades result saving of material, manufacturing and transmission cost.
5) There is no need of yaw control as the system is Omni-directional system.

The new model can overcome the problems faced in traditional wind power generation such as:

1) High cut in speed.
2) Distance from grid.
3) Turbine Reliability.
4) Noise impact and shadow flicker.
5) Impact on living being such as animals, birds etc.
6) Reduced land used.

The objectives of present work are:

– To understand the physics of flow of fluid inside the model.
– Check the efficiency of the system under various wind flow velocity.
– Check the Omni-directional property of the system.
– Try and modify the model by using different configurations to improve the efficiency

II. MODEL DESCRIPTION

The advance and multiple wind turbine innovative technology system which captures concentrate and accelerate the wind flow. [2] This new innovative technology increased the flow rate of wind and generates more power than traditional wind power generation system. The generated energy is affordable, abundant, safe and clean. The fundamental innovation of the multiple wind turbine system is that it eliminates tower mounted turbines. In this system the available mass flow rate at second and third wind turbine is smaller than the first in a venturi duct. The wind velocity drops at the end of first turbine then after it enter into second and then third turbine. As in case of second and third turbine could not generate more power at lower rating speed. Then the stream of kinetic energy is used to drive the generator which installed at ground level safely.

III. WIND DELIVERY SYSTEM

As per the five key parts of model are mention above the scientific principle i.e. Bernoulli's principle is used while designing the respective model. The principle can be applied to various types of fluid flow. [2]

A. Bernoulli's Principle

Bernoulli's principle states that at increase in the speed of a fluid occurs simultaneously with decrease in pressure or a decrease in fluid potential.

$$\frac{P}{\rho g} + \frac{V^2}{2g} + z = \text{Constant}$$

B. Calculations

Let the Bernoulli's Equation is,

$$P_{a1} - P_{a2} = \frac{1}{2} \times \rho \times (V_1 - V_2)$$

And by continuity equation [2]

$$A_1 V_2 = A_2 V_2$$

For finding the Cross Section Area, [2]

$$A = \frac{\pi}{4} \times D$$

For finding the Density, [2]

$$\rho = P_a \times N(R \times T)$$

Where,

P_a- Atmospheric Pressure

N-Number of Moles

R-Universal Gas Constant
T-Temperature
For finding the Power, [2]

$$P = \frac{1}{2} \times \rho \times A \times V^3$$

Where,
A- Area of Cross Section
V-Volume
Total Theoretical Power for Multiple Turbines is,

$$P_1 + P_2 + P_3 + \cdots . + P_N = P_T \quad [2]$$

C. Advantage

1) Required Low Cut-in Wind Speed

The new model will generate power at about 20% less wind speed than traditional turbine required. Hence the innovative model can be placed on low wind speed sites. [3]

2) Requirement of Land is Less

Thanks to its smaller size and its high performance, and these wind generation model use solely a fraction of a land area usually required for the operation of traditional wind park. The model is design is such a way that it is less influenced by the vortex and wake effects that are caused by the massive turbine blades rotation. These aerodynamic effects impose turbine spacing constraints on traditional wind parks, and cause them to take up much more space. The model doesn't face such problems as it has no rotating blades on top of tower. [3]

3) Reduce Noise Impact and Shadow flicker

Traditional winds turbines produce aerodynamic noise by the rotation of the blades, which can produce create annoyance and interference within the quality of life of nearby residents. It is noted that the damaging frequency range of the traditional turbine is below the hearing frequency of human ear, i.e., below 20 HZ. Low frequency noises and vibrations are difficult to measure and noise experts still struggling to deal with such issues. The model considerably reduces low frequency noise nuisance created by traditional wind parks and eliminates entirely the shadow flicker issue.

4) Less Impact on Habitants

Traditional wind farms represent a risk to birds because of collision with the rotating blades, interferences with migrations, and reduction or loss of habitat. Thanks to the innovative model for its structure that the rotating blades are placed in venturi section which is in closed structure, nearer to ground and its smaller land use, contributes to significantly reduce the negative impact on birds. [3]

5) Increase Turbine Reliability

Because of structure turbine and generator are safely placed at ground level; reliability will increase since they are not subjected to harsh environmental conditions. For example,
Bearings, shafts, blades, and gears are not exposed to climatic issues like temperature variation, humidity, airborne debris, and excessive winds conditions. Our enclosed turbine-generator system will reduced downtime, and result in more effective maintenance programs.

6) Aviation & Military Radar

Traditional wind farms can cause electro-magnetic interferences on aviation and military radars, and as a result cannot be installed in sites where such interference would occur. The model structure is like that it do not interfere with aviation and military radars, and can therefore be installed in areas inaccessible to traditional wind farms.

Fig. 1: Small Model of Innovative Wind Energy Plant

IV. CONCLUSION

It was shown that the new concept can be designed to capture, concentrate and accelerate the wind flow by using Omni-directional intake. The system has low sensitivity with respect to the wind direction. The model eliminates the need for self-alignment with the wind because its intake is Omni-directional and all rotating parts are on the ground which simplifies the operation and maintenance.

V. FUTURE WORK

More work can be done in relation to the profile used to model a duct. The significance of improving the geometry of the ducted wind turbine to improve the inlet and outlet conditions is immense. There can be studies related to using an airfoil design for the nozzle, diffuser to reduce the flow separation at the walls of the structure and improving performance. In this study, the basic aspects of flow can be answered, such as, forces acting on a duct etc. Future work can be done to also identify the possible flow separation due to viscous effects in the duct.

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