

Exploring the Efficiency of Vortex Bladeless Turbine for Renewable Gyro-Energy Production

Mikael Andersson¹, Lars Johansson², Erik Nilsson^{*3}

¹Department of Mechanical Engineering, KTH Royal Institute of Technology, Stockholm, Sweden

²Department of Mechanical Engineering, University of Gothenburg, Sweden

³Department of Mechanical Engineering, Lund University, Sweden

ABSTRACT

Vortex-Bladeless is a Spanish SME whose objective is to develop a new concept of wind turbine without blades called Vortex or vorticity wind turbine. This design represents a new paradigm in wind energy and aims to eliminate or reduce many of the existing problems in conventional generators. The bladeless vortex turbine is one such concept that uses the principle of aero-elasticity and thereby the variations produced by it to generate electricity. Project work will include the design and development of a vortex wind bladeless turbine and a gyro-action based e-generator to be coupled to it to generate the electricity. Prototype development will be done using 3-D printing for the vortex turbine and the e-generator to make a scaled working model that will demonstrate electricity generation and testing will be done on the same to determine the effect of wind speed on , turbine speed , voltage , current and power generated by the model.

KEYWORDS: Vortex bladeless turbine, gyro torque, vortex shedding effect, wind.

I. INTRODUCTION

Vortex-Bladeless is an objective to develop a new concept of wind turbine without blades called Vortex or vortices wind turbine. The vortex design aims to eliminate or reduce many of the existing problems in conventional generators and represents a new paradigm of wind energy. It is morphologically simple and it is composed of a single structural component, so its manufacturing, transport, storage and installation have clear advantages. The new wind turbine design has no bearings, gears, etcetera, so the maintenance requirements could be drastically reduced and their lifespan is expected to be higher than traditional wind turbines. In the development of this new device, it is of prime importance to be able to test different geometrical configurations, operation conditions and to have energy production predictions.

II. MATERIALS AND METHODS

Material Required

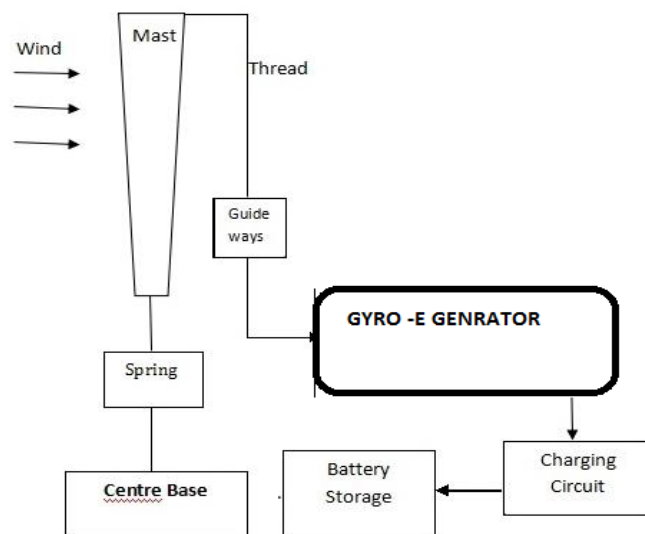
Material required for the vortex bladeless turbine is fiberglass and carbon fiber mast oscillates in the wind taking advantage of the vortex shedding effect. At the bottom of the mast a carbon fiber rod moves inside a linear alternator that generates the electricity, with no moving parts in contact. Vortex has a small carbon footprint, is noiseless, has low center of gravity and allows for small foundation dimensions, so more generators can be placed in an area, at twice the density of traditional turbines.

What is vortex?

- Vortex is a wind generator without blades. Instead of capturing energy via the rotational motion of a turbine, the Vortex takes advantage of what's known as vorticity, an aerodynamic effect that occurs when wind breaks against a solid structure. The Vortex structure starts to oscillate, and captures the energy that is produced.
- Vortex is just eliminating the blades. They have designed it to have no parts like all (no gears, linkages, etc.). This way they can make Vortex cheap and easy to maintain.
- Basically, they reduce the amount of raw materials used for manufacturing, which cuts the production costs and time to produce the equipment. Further, having no moving parts in contact means that there are really very few things that can break, which extends time between maintenance intervals and allows to have less down time. As a result, maintaining costs are low.

Working of vortex bladeless turbine with gyro e-generator

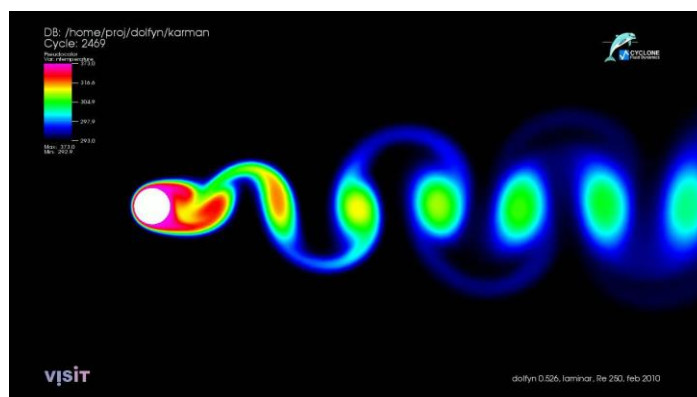
The main principle behind bladeless wind generator is the conversion of linear oscillation of mast to rotational motion. As the mast is subjected to wind energy, it tends to oscillate due to the vortices formed around the structure of the mast, which can be converted to rotational force to generate electricity. In the bladeless wind system configuration, the mast is fixed with respect to the ground and the rib structure at the top of the mast comprising of thread arrangement is used for pulling the threads attached to it. Energy is obtained by continuously oscillation of the mast the vibrations from the wind turbine are given to e-gyro generator. Gyro Torque is a new type of infinitely variable transmission system based on gyroscopic reaction. Gyro Torque is capable of large speed ratios, without the need to utilize gears for generating electricity from wind and wave power resources. The infinitely variable nature of gyro Torque means that more power from wind and wave sources can be captured and controlled to generate electricity at reduced costs. By not transmitting the peaks and troughs of wind gusts gyro Torque avoids severe mechanical and electrical loading from the turbine onto other parts of the system including the generator.



Block Diagram Representation of Bladeless Power Generation Scheme

Vortices and Vortex Shedding Effect:

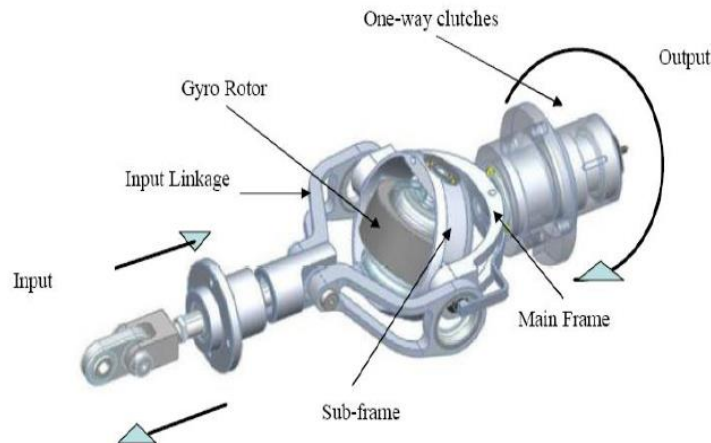
Vortex shedding is an oscillating flow that takes place when a fluid such as air or water flows past and bluffs (As opposed to streamlined body at curtained velocities, depending on shape and size of the body. In this vortices are created at the back of body and detach periodically from either side of body. Vortex shedding behind a circular cylinder. In this animation, the flows on two sides of a cylinder are shown in different colors, to show that the vortices from the two sides alternate.



Vorticity and Vortex Shedding Effect

Gyro Torque™ Technology:

- Static: In the static type, the input torque is transmitted to the output by a ratio called a speed ratio, meaning that input is directly linked to the output via some form of physical constraint such as gears or belts.
- Kinetic: In the kinetic type, this does not occur; rather power transmission torque is generated within the transmission. This means that the input and output can move independently of each other with no physical constraint. Gyro Torque belongs to kinetic type.



Gyro e-generator

It consists of a gyroscopic rotor that is held in an inner ring (sub-frame), the latter being free to pivot in an outer ring (main-frame). The mainframe is free to rotate in transmission housing. The sub-frame is connected to the input mechanism by linkage (off-set pin), which pivot the sub-frame in the mainframe. The mainframe, the sub-frame and the linkage rotate together under the influence of gyroscopic reaction. The mainframe is connected to output (rotating shaft) and the transmission housing via one-way clutch. Ability to decouple and control the transmission with minimal effort for maintenance purposes and variable operation. Ability to operate two or more gyro Torque units in parallel if required to achieve high transmission capacity.

Types of vortex bladeless turbine:

- Vortex Atlantis: 3 meters height and 100W generation capacity, working along with solar panels, mainly to bring energy to an off grid locations.
- Vortex Mini: 13 meters height and 4 kW generation capacities, mainly for small-scale/residential wind.
- Vortex Grand: 150 meters height and 1MW generation capacity, capable of generating electricity for 400 houses.

III. RESULTS AND DISCUSSION

The result shoe that the vortex bladeless turbine is Installation cost and maintenance cost low compared to blade wind mill, It produces less noise compared to blade wind mill, It occupies less area. High efficient power is generated. the generation of electricity is made possible by the small structure of bladeless turbine. This project will satisfy the need of continuous generation of electricity. The overall project uses less space area hence highly economical for the rural electrification of India.

IV. CONCLUSION

The bladeless wind generation system configuration has been considered and the obtained results appear to be very encouraging, even though they are based on simulations and model taken from the literature, which certainly can give only approximate description of involved dynamics. Tapping the wind for renewable energy using new approaches is gaining momentum in the recent years. The purpose of this paper is to provide some fundamental results on the bladeless wind system and serve as stepping stones for the future development of bladeless wind power generating system. The forces that is beneficial or useful to generate power in bladeless are different from those in conventional horizontal axial wind turbines. Our device captures the energy of vorticity, an aerodynamic effect that has plagued structural engineers and architects for ages (vortex shedding effect). As the wind bypasses a fixed structure, its flow changes and generates a

cyclical pattern of vortices. Overall the project has been a success with all of the project requirements achieved. As the wind energy is powerful and consistent, the usage of conventional wind turbine for utilizing the wind energy in lesser area.

V. ACKNOWLEDGEMENTS

This thesis is the result of several exchanges: technical, scientific and personal. First, I am deeply grateful with my advisors Bagade sir. Orientation and support, that I received during these years were fundamental for my research. I also feel grateful for the privilege of knowing and collaborating with many other people in Siddhivinayak Technical Campus, who became friends over the last three years in Mechanical Engg. Diploma. Finally, I thank to my parents, for their love and support.

VI. REFERENCES

- [1] 'J. C. Cajas, G. Houzeaux, D.J. Yáñez, M. Mier-Torrecilla' "Shape Project Vortex Bladeless: Parallel Multi-Code Coupling For Fluid-Structure Interaction In Wind Energy Generation" Barcelona Supercomputing Center- Centro Nacional De Supercomputación, Spain Vortex Bladeless S.L., Spain
- [2] 'Abhijit Mane, Manoj Kharade, Pravin Sonkambale Shubham Tapase, Sachin S. Kudte' "Design & Analysis Of Vortex Bladeless Turbine With Gyro E-Generator" B.E Mechanical Students G.S.M.Coe Balewadi Pune Assistant Professor G.S.M.Coe Balewadi Pune, 1-2 April 2017
- [3] 'H.Mueller-Vahl, G. Pechlivanoglou, C.N. Nayeri, And C.O. Paschereit' "Vortex Generators For Wind Turbine Blades: A Combined Wind Tunnel And Wind Turbine Parametric Study". In Proceedings Of Asme Igti Turbo Expo 2012 Asme/Igti June 11 -15, 2012, Copenhagen, Denmark. Asme, 2012.
- [4] 'G. Pechlivanoglou, S. Fuehr, C.N. Nayeri, And C.O. Paschereit'. "The Effect Of Distributed Roughness On The Power Performance Of Wind Turbines". In Proceedings Of Asme Igti Turbo Expo 2010 Asme/Igti June 14 -18, 2010, Glasgow, Scotland, Uk. Asme, 2010.