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Bladeless Turbines

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***Abstract*— Turbine that would provide a quite safe, simple andefficient alternative to our supposedly Bladed Turbine engine is the need of the hour. Bladeless WindPower Generation uses a radically new approach to capturing wind energy. The device captures theenergy 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. Once these forces are strong enough, the fixed structure starts oscillating. Instead of avoiding these aerodynamic instabilities the design maximizes the resulting oscillation and captures that energy. Naturally, the design of such device is completely different from a traditional turbine. This technology of the Bladeless Turbines puts it at a very low range of capital intensity. It also makes it highly competitive not only against generations of alternative or renewable energy, but even compared to conventional technologies. Bladeless turbines are also thereenest turbines with almost nil harmful effects on the environment. The bladeless turbine has a promisingfuture as a new power generation system.**

I.INTRODUCTION

. Today's ubiquitous three bladed designs are being evolved in many unexpected directions ; Bladeless Turbines are one such kind of technology.

The Bladeless Turbine uses a radicallynew approach to capturing the wind energy.ItharnessVorticity, the spinning motion of fluids or air. Its structure consists of an elastic rod of specific height,weight as well as material. Conversion of Oscillating motioninto Electrical output is the key concept of the turbine. Designed to reduce the visual and aural impact of conventional blade turbines , this new device takes advantage of the power contained in swirling vortices of air.

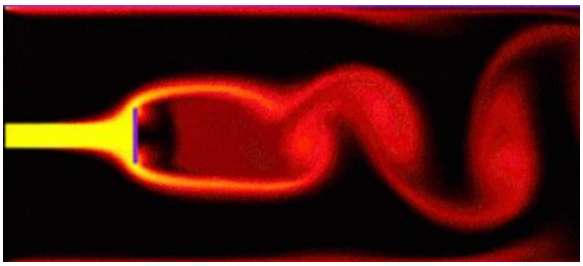
We've explored a number of bladeless wind-turbines before – the Solar Aero turbine being one (though, by definition, not really bladeless as it merely covered the spinning blades with a housing) and the Saphonian being another. The latter being more of a true bladeless "turbine," it still required hydraulic actuation of pistons to generate electricity, so its efficiency was probably not all that great (and, to be perfectly frank, it was not strictly a turbine either as it had no spinning parts).

The Vortex, on the other hand, is purported to take advantage of the swirling motion of wind and not direct force like the aforementioned units. This means that it can generate energy from the repeating pattern of vortices (known as the Kármán vortex street), which are generated as the air separates to pass by a blunt body, such as the Vortex structure itself.

II. IDEA OF VORTEX BLADELESS TURBINES

It all started back in 2002, when one of the founders first saw a video of the Tacoma Narrows Bridge swaying and oscillating in wind. The structure got caught up in aeroelastic coupling and collapsed under influence of the wind. This disaster is still a topic among engineers and scientists discussing the aeroelastic flutter and continues to motivate their research.

The idea grew into beautiful invention of structure when it was supported by one of the basic laws of Fluid mechanics. It was Karman Vorticity Effect.



Understanding the vibration: The Effect of Vortex Street
The Vortex Shedding was first described and mathematically formalized by Theodore von Kármán, the genius of aeronautics, in 1911. This effect is produced by instabilities on the boundary layer. Due to viscosity and the fact that the fluidhas to slow down its speed as long as passes the blunt body, interactions between different layers of the fluid close to the surface of the body embebed within the fluid induces, at the end, the generation of

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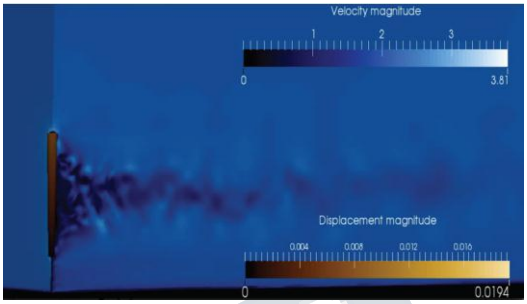
vortices, conclusively creating vortices all along the studied structure. It has to be pointed out that, speed, viscosity and density as well as size of the body have to be in perfect conditions. Those vortices, as told above, generate forces on any object immersed in a flowthat fulfills the conditions to create vortices.In the real world, when the fluid bypasses the object, and it achieves the conditionsto it, it generates a cyclical pattern of vortices all along the structure, which canbecome an engineering challenge for any vertical cylindrical structures, such astowers, masts and chimneys. Within these conditions, it may start vibrating,entering into resonance with the lateral forces of the wind (vortices), andultimately, collapse. One of such examples is the breakdown of three coolingtowers at Ferry bridge power station in 1965. However, it is possible that the same forces can be harnessed to produce energy, that's the idea behind Vortex. When a semi-rigid structure enters into a horizontallaminar airflow, it begins to vibrate under the influence of the lateral forcesgenerated by the vortex street. When the frequency of vortex shedding itself in theatmosphere matches the natural frequency of the structure, it enters intoresonance, maximizing the amplitude of vibration and hence, the powergeneration capability we are interested in. The natural frequencies of any objecthave specific values that depend on its mechanical properties, and would onlyenter in resonance and vibrate on narrow bandwidth of frequency that means, inour case, a narrow bandwidth of wind speeds.

However, Vortex successfully adapts its natural frequency to resonate with the frequencies of wind vortex generation within a wider wind speed range, widerthan what mechanical properties of the rod tell.The natural frequency of vibration depends on the body mass, and the stiffness.Therefore, the design of the Vortex generator is critical. The parameters, such asthe diameter of the structure, height, total mass, are all designed to achievemaximum performance to the average observed wind speeds.

Vortex goes further to maximize the output from a given wind by modifying the stiffness. The top of the rod has a magnetic confinement system that increases theapparent stiffness of the system according to their degree of flexion.This system, at the end, allows Vortex to widen the wind speed at which it isgenerating energy. as the wind speed intensifies, the magnetic force of repulsiongoes up, which reduces the distance between the rod and the magnet. As a result,the oscillation and the potential of generated energy increases to the maximum.With that, Vortex can automatically vary rigidity and "synchronize " with theincoming wind speed, in order to stay in resonance without any mechanical ormanual interference.



III.CONVENTIONAL TURBINES

Wind power has become a legitimate source of energy over the past few decades as larger, more efficient turbine designs have produced ever increasing amounts of power. But even though the industry saw a record $99.5 billion global investment in 2014, turbine growth may be reaching its limits. Transportation is increasingly challenging because of the size of the components: individual blades and tower sections often require specialized trucks and straight, wide roads. Today's wind turbines are also incredibly top heavy. Generators and gearboxes sitting on support towers 100 meters oû the ground can weigh more than 100 tons. As the weight and height of turbines increase, the materials costs of wider, stronger support towers, as well as Sustainable Energy Bladeless Wind Turbines May Offer More Form Than Function Startup Vortex Bladeless makes a turbine that looks intriguing, but it may not solve wind power's challenges. by Phil McKenna May 27, 2015 Wind could supply almost 20 percent of the total global energy market by 2030, up from 3 percent today the cost of maintaining components housed so far from the ground, are cutting into the efficiency benefits of larger turbines. The alternative energy industry has repeatedly tried to solve these issues to no avail. But the latest entry promises a radically different type of wind turbine: a bladeless cylinder that oscillates or vibrates.

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IV.ADVANTAGES OF BLADELESS TURBINES

Vortex doesn't just eliminate the blades. It hasbeen deliberately designed to have no parts in contact at all (no gears, linkages, etc). This way it makes Vortex cheap and easy to maintain. Basically, the amount of raw materials used for manufacturing is reduced, 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. Finally, Vortex is silent, since itoscillates at a frequency that doesn't produce audible noise (it is below 20 Hz) . It is also safer for birds that often suffer from collision with blades. Comparing Vortex with the same height of a conventional wind turbine, Vortex currently takes up as much as 30 % of the area of a conventional generator, with maximum amplitude around a diameter at the top. It can capture around 40% of the wind power contained in the air (Betz Limit- 59.3%), which is a more than reasonable capacity. To sweep the same area Vortex needs to be higher than a conventional wind turbine.

Nevertheless, the bottom line is that the Vortex operating principle allows to:

• Remain in operation for a longer period of time. Early calculations estimates up to 86 % increase over a classic onshore facility. `The self-synchronization system allows to capture a wider range of wind speeds, starting from 2-3m/s.

• Eliminate, thanks to its design, the need to constantly adjust the installation for the best angle of the wind, with the consequent energy savings.

• Avoid any limitations associated with the "shadow effect", the disturbance of the downstream wind current, which is why wind turbines need to beinstalled at a certain distances from each other.

ITS GREENER…

Though a more rigorous analysis needs to be done, it appears that Vortex also has a number of environmental upsides to traditional wind power. The Vortex aims to be a "greener " wind alternative.The impact on the bird population is expected to be much smaller, because Vortex doesn't require the same type or magnitude of movement as the traditional wind turbine, allowing for higher visibility. With the oscillation frequency of the equipment below 20Hz, the impact sound level is nonexistent, opening the possibility to make the future wind farms completely silent.

V.DESIGN OF BLADELESS TURBINE

Basically, Vortex Bladeless consists of a conical cylinder anchored vertically to theground by an elastic rod. The cylinder oscillates in the wind, which then generates electricity through a linear alternator system. The outer conical shaped device, the so-called mast, is designed to be largely rigid. Its shape is specially designed to generate the forces needed to make the system oscillate remaining anchored to the bottom rod. The top of the mast has been developed to optimize its performance. The structure is built using carbon and/or glass fiber reinforced resins, very common materials used in conventional wind turbines industry.

Inside the device there is a rod, which connect the mast to the ground at its bottom part (end). It is built with carbon fiber, which we think it should have the best performance to the fatigue, having also excellent mechanical properties for the best behavior of the Vortex.Based on aerolastic phenomena called Vortex Induced Vibration, the device captures the energy from the wind. As Von Karman stated, for particular cases of speed, density, and viscosity of a fluid, and particular shapes (lenghts) of a blunt body immersed in the mentioned fluid, downstream of that body, it can be generated swirls, vortices and hairpins that induce forces in the structure. Once these forces are strong enough, the body starts to oscillate. Thus, the whole system enters into resonance with the lateral forces of the wind. This is also known as Vortex Induced Vibrations.

Civil engineering and architectural design usually run away from this. It has beenalways considered as a problem. However, instead of avoiding these aerodynamic instabilities, our technology maximizes the resulting oscillation and captures that energy. Based on these principles, and bearing in mind some other physical phenomena's, such as Hellmann's law, finite bodies' aerodynamics, turbulence regions, etc., we use computational models that help us to develop and improve the efficiency of Vortex.

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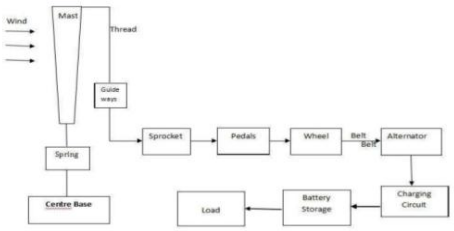
CONSTRUCUTION OF VORTEX TURBINE



VI. WORKING

The main principle behind this project 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 mast utilizes wind power to pull the threads along with the chain attached to the sprockets which drive the shaft which intern rotates the alternator to generate power.During the oscillation of the mast, the mast tries to oscillate in any direction depending on the wind direction. The rib structure at the top of the mast is attached with six threads to absorb the energy from the wind. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence three sprockets are available in the shaft out of which one of the sprockets always is always in motion during the oscillation of the mast. The arrangement of the threads on the mast is such that the power is generated on all direction of oscillation of the mast. Each of the threads is joined with the chain which drives the sprocket attached to the shaft to generate the maximum amount of power. The thread joined with the chain is fixed with a spring mechanism, during the oscillation of the mast one of the six threads is pulled which make the chain to drive the sprocket on the shaft. After the maximum oscillation on one side is reached, the mastreturns to its initial position and then continues the oscillation on the other side where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft. Such operation has been developed and tested through numerical simulations, considering a quite accurate model, which takes into account the aerodynamic characteristics of the mast and the strength of the threads, and employing self-tuning magnetic coupling system to maximize the net generated energy. So that it can operate in a wider range of wind speeds and also withstand the high wind velocities. This system allows maximizing the oscillation amplitudes when wind intensifies.When the wind strikes the mast, it starts to oscillate due to the vortices formed around the structure and suspension spring placed at the bottom of the mast. The energy absorbed by the spring during the oscillation of the mast contributes to the increase in the amplitude of the oscillations. The rib structure with the sixthread arrangement at the top of the mast is attached to the bottom chain drives through the guide ways which helps the mast to oscillate in any direction of the wind. During the back and forth oscillation of the mast, one of the six threads is pulled from the rib structure of the mast depending upon the direction of the wind. The thread being pulled due to the oscillation of the mast is connected to chain which drive the sprocket on the shaft. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence t three sprockets are available in the shaft out of which one of the sprockets always is always in motion during the oscillation of the mast. The thread mechanism is provided with guide ways and pulleys for maximum transfer of the pulling force from the oscillation to the sprockets of the shaft. It also helps to increase the tensile strength of the threads which is necessary to increase the conversion efficiency to the maximum extent. The shaft driven by the sprockets arrangement rotates only in clockwise

direction and restricts the rotation of the shaft in the opposite direction which otherwise may cause the threads to be pulled which may disrupt the oscillation of the mast and bring it to a halt. This shaft is welded with two bicycle pedal at the end spaced 180 degrees apart and the flywheel is provided with four counter weights 90 degrees apart, the arrangement of the pedal and the counterweight helps to increase the rotation of the flywheel. As the power is generated in the half cycle of the oscillation of the mast

the shaft is subjected to a jerk motion rather than a smooth motion. Such arrangement of pedal and the counterweight helps in the smooth rotation of the flywheel trying to achieve perpetual motion. The power wheel is connected to the alternator via belt drive which increases the rotation of the alternator with a ratio of 1:10 when the shaft is in the motion. The belt drive eliminates the gear system thereby reducing the maintenance. The maximum oscillation on one side is reached with the thread pulled to maximum extent, at which the maximum energy is absorbed from the wind. After which the mast returns to

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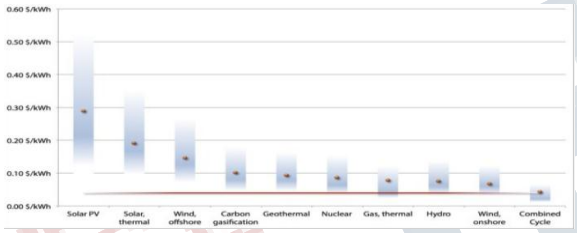
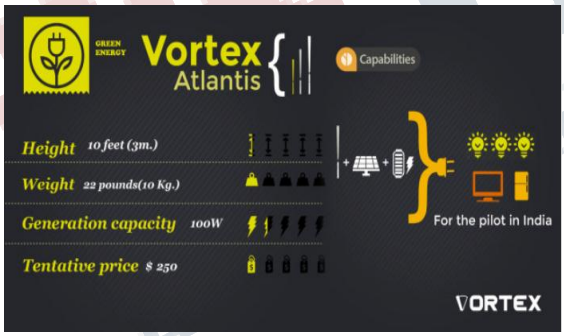
initial position and continues the oscillation at other end where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft. Since the power output of the alternator is AC. It is rectified using a rectifier circuit, filtered and regulated using a regulating circuit to 12V. The output DC Voltage obtained via the dual output of the regulation circuit charges the battery.

VII. SENARIO OF BLADELESS TURBINE IN INDIA

India is one of the largest market for many products in the world. It's the same scenario in case of bladeless turbines. Not only are Indians responsive to energy generators apart from the conventional ones ,but they are also taking measures to implement it at the grass root level.Vortex Atlantis(the founder of vortex bladeless turbines) are manufacturing a customised bladeless turbines suitable for Indian households also considering the Indian weather conditions.





VIII. CONCLUSION

Tapping the Bladeless Wind Power Generation 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. The 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 and cost is not possible. Hence bladeless wind energy helps us to achieve these criteria. This project has three main advantages: Utilizing less area, Generation of high power, Economical. In summary, the generation of electricity is made possible by the small structure of bladeless turbine. High efficient power is generated. This project will satisfy the need of continuous generation of electricity.

REFERENCES

• Mr.David Suriol CEO of VortexBladeless shared his views about the cutting edgetechnology they are working on; personally by email.(dsuriol@vortexbladeless.com). He also provided actual data of latest perspectives about the company

• www.indigogo.com which helped to know basic fundamentals about the subject.

• Vortex General Info Presentation 2017 given by CEO himself was of maximum use.

• Papers and Journal Publishings about Wind Energy using Bladeless Turbines were also used. Papers by IJICTRD as well as MIT Technology Review helped a lot.

• Wikipedia : Vortex Effect

• Patents about Bladeless Turbines and papers Published.

• Vortex bladeless Turbines Official Site