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Design and Fabrication of Vortex Bladeless Windmill

K.sunil Kumar[1], P. Amirthalingam, [2] N.K Karthikeyan[3], S. Arun[4]
[1, 2, 3, 4,] *Assistant professor in Mechanical department Department of Mechanical Engineering Veltech, Avadi, Chennai-India*

Abstract: The Vortex, a bladeless wind turbine that looks like a giant rolled joint shooting into the sky. The Vortex has the same goals as conventional wind turbines: To turn breezes into kinetic energy that can be used as electricity. But it goes about it in an entirely different way. Instead of capturing energy via the circular motion of a propeller, the Vortex takes advantage of what's known as vorticity an aerodynamic effect that produces a pattern of spinning vortices, According to Vortex, the devices can be used to generate more power in less space. Because not only is the wind wake narrower than a traditional turbine. but installing them closer together can actually be beneficial to the technology based on wind tunnel testing.
Keywords- Bladeless Windmill, Vortex Induced Vibrations, Vortex Shedding, Renewable Energy Sources.

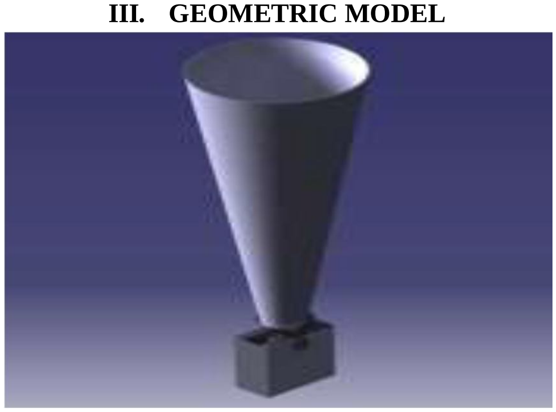
I. INTRODUCTION

Bladeless windmill uses a radically new approach to capturing wind energy. 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 by passes a fixed structure, its flow changes and generates a cyclical pattern of vortices [1]. Once these forces are strong enough, the fixed structure starts oscillating, may enter into resonance with the lateral forces of the wind, and even collapse. Instead of avoiding these aerodynamic instabilities, this technology maximizes the resulting oscillation and captures that energy. Naturally, the design of such a device is completely different from a traditional turbine. Instead of the usual tower, nacelle, and blades, the device has a fixed mast, a power generator, and a hollow, lightweight, and semi-rigid fiberglass cylinder on top [5].Its makers boast the fact that there are no gears, bolts, or mechanically moving parts, which they say makes the Vortex cheaper to manufacture and maintain. Based on field testing, the Mini ultimately captures 30 percent less than conventional wind turbines, but that shortcoming is compensated by the fact that you can put double the Vortex turbines into the same space as a propeller turbine.

II. OBJECTIVES

To avoid those aerodynamic instabilities, this technology maximizes the resulting oscillation and captures the energy. Naturally, the design of such a device is completely different from a traditional turbine. Instead of the usual tower, nacelle, and blades, the device has a fixed mast, a power generator, and a hollow, lightweight, and semi-rigid fiberglass cylinder on top.

III. GEOMETRIC MODEL



In continuum mechanics the vorticity is a pseudo vector field that describes the local spinning motion of a continuum near some point (the tendency of something to rotate).
Conceptually, vorticity could be determined by marking the part of continuum in a small neighborhood of the point in question, and watching their relative displacements as they move along the flow. The vortices vector would be twice the mean velocity

vector of those particles relative to their center of mass, oriented according to the right-hand rule. This quantity must not be confused with the angular velocity of the particles relative to some other point. More precisely, the vorticity is a pseudo vector field ω→, defined as the curl (rotational) of the flow velocity u→ vector. The definition can be expressed by the vector analysis formula:

$$W = \blacktriangledown \times U$$

where∇ is the del operator. The vorticity of a two-dimensional flow is always perpendicular to the plane of the flow, and therefore can be considered a scalar field

IV.NEODYMIUM MAGNETS

A neodymium magnet (also known as NdFeB, NIB or Neo magnet), the most widely used[1] type of rare-earth magnet, is a permanent magnet made from an alloy of neodymium, iron and boron to form the

Nd2Fe14B tetragonal crystalline structure.[2] Developed in 1982 by General Motors and Sumitomo Special Metals, neodymium magnets are the strongest type of permanent magnet commercially available.[2][3] They have replaced other types of magnets in the many applications in modern products that require strong permanent magnets, such as motors in cordless tools, hard disk drives and magnetic fasteners .Sintered Nd-magnets are prepared by the raw materials being melted in a furnace, cast into a mold and cooled to form ingots. The ingots are pulverized and milled; the powder is then sintered into dense blocks. The blocks are then heat-treated, cut to shape, surface treated and magnetized.

V. MAGNETIC PROPERTIES OF NEODYMIUM MAGNETS

Neodymium magnets have higher remanence, much higher coercivity and energy product, but often lower Curie temperature than other types. Neodymium is alloyed with terbium and dysprosium in order to preserve its magnetic properties at high temperatures[15]. The table below compares the magnetic performance of neodymium magnets with other types of permanent magnets.

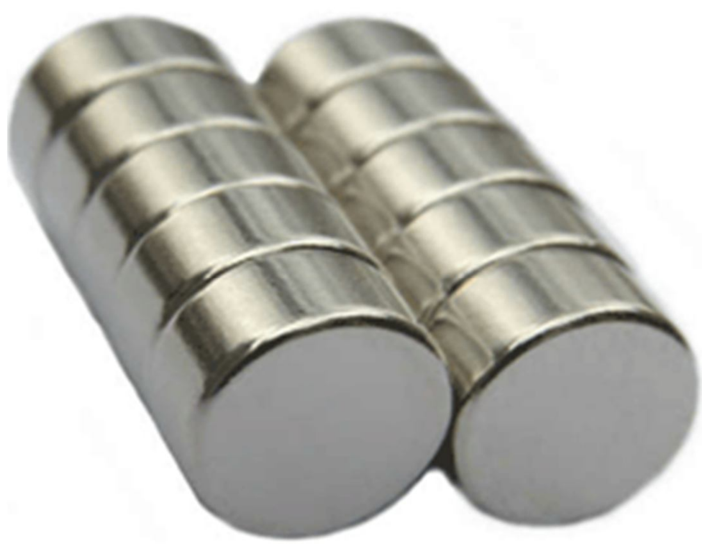


Fig 3 Super strong cylinder magnet 25x20mm Rare earth neodymium N5

VI. CORROSION PROPERTIES

Sintered Nd2Fe14B tends to be vulnerable to corrosion, especially long grain boundaries of a sintered magnet. This type of corrosion can cause serious deterioration, including crumbling of a magnet into a powder of small magnetic particles, or spalling of a surface layer.

This vulnerability is addressed in many commercial products by adding a protective coating to prevent exposure to the atmosphere. Nickel plating or two-layered copper-nickel plating are the standard methods, although plating with other metals.

Table 1 Properties Of Neodymium Magnets

Magnet	Br (T)	Hci (k A/m)	BHmax (kJ /m3)	TC (° C)	TC (° F)
Nd2Fe14B (sintered)	1.0–1.4	750–2000	200–440	310–400	590–752
Nd2Fe14B(bonded)	0.6–0.7	600–1200	60–100	310–400	590–752
SmCo5 (sintered)	0.8–1.1	600–2000	120–200	720	1328
Sm(Co, Fe, Cu, Zr)7 (sintered)	0.9–1.15	450–1300	150–240	800	1472
Alnico (sintered)	0.6–1.4	275	10–88	700–860	1292–1580

Table 2 Mechanical and physical properties of neodymium magnets.

Property	Neodymium	Sm-Co
Remanence (T)	1–1.3	0.82–1.16
Coercivity (MA/m)	0.875–1.99	0.493–1.59
Relative permeability	1.05	1.05
Temperature coefficient of remanence (%/K)	−0.12	−0.03
Temperature coefficient of coercivity (%/K)	−0.55..–0.65	−0.15..–0.30
Curie temperature (°C)	320	800
Density (g/cm3)	7.3–7.5	8.2–8.4
CTE, magnetizing direction (1/K)	5.2×10−6	5.2×10−6
CTE, normal to magnetizing direction (1/K)	−0.8×10−6	11×10−6
Flexural strength (N/mm2)	250	150
Compressive strength (N/mm2)	1100	800

VII. TESTING STAGE

Demonstrate the feasibility of the technology, Vortex tested dozens of prototypes in wind tunnel, and Vortex Bladeless is currently optimizing the field tests to complete the small-scale Equipment The first Vortex products will be focused on small-scale production. The first will be 100W, 3m (9.8 ft.) high and weigh less than 10 kg (22 lb). This system has been designed to bring energy to off-grid locations and matching it with solar panels. This is a cost-effective solution for homes with existing solar installations and where having a non-expensive wind device will help to store the energy produced while the solar is not producing. It will also work for communities where having energycouldbe a matter of life.

VIII. CONCLUSION

Finally, Vortex is silent, since it oscillates 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.Since there is 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.

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