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Generation of Clean Energy using Concept of Wind Belt

Review Paper on Wind Belt Technolgy

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Abstract- **The need of generating clean and green energy is increasing worldwide, various kinds of devices that generate green energy are being developed recently. The wind belt technology can prove to be an alternative to the complex and expensive wind mills. The conventional wind mills focus on 'rotation' whereas the new wind belt capitalizes on 'vibration'. It makes use of the 'Aero Elastic Flutter' in which air passing over a thin strip of material creates vibrations. These vibrations are used to convert into energy. The wind belt converts wind energy to electrical energy. As there are magnets placed over the thin membrane that vibrates along with the belt. The magnets move in the conducting coils that generate emf by the principle of electromagnetic induction. This device can prove to be a success in the market of renewable energy devices.**

Keywords: Vibration, Aero elastic Flutter

NOMENCLATURE

emf generated (mV)	E
number of turns of conducting coil	N
area of the belt or ribbon (m)	A
magnetic field intensity (Tesla)	B
frequency of vibration of the belt or ribbon	*f*
wind velocity (m/s)	v
length of belt or ribbon	L
thickness of belt or ribbon	b
relative magnetic field strength for given magnet material	Br
thickness of magnetic disc	D
radius of magnetic disc	E
distance between the pole and nearest conducting surface	z

INTRODUCTION

The Windbelt is a power generating device invented by Shawn Frayn in 2004 for converting wind power to electricity. It consists of a flexible polymer ribbon stretched between supports transverse to the wind direction, with magnets glued to it. When the wind blows across it, the ribbon vibrates due to aero elastic flutter, similar to the action of an Aeolia harp. The vibrating movement of the magnets induces current in nearby pick coils by electrostatic induction.

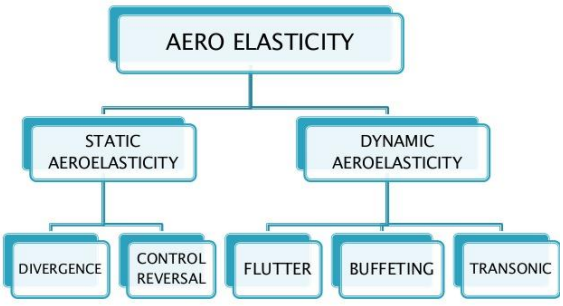
Types of aero elasticity:

Aero elastic flutter: Flutter is the dynamic stability of an elastic body in a fluid flow, caused by positive.

Feedback between the body's deflection and the force exerted by the flow.

Aero elastic buffeting: Buffeting is high-frequency instability, caused by airflow separation or shock wave oscillations from one object striking another. It is caused by a sudden impulse of load increasing. It is a random forced vibration.

Transonic aero elasticity: The flow is not linear in the transonic regulated system, dominated by moving shock waves.



Power generation using aero flutter:

Wind Belt Wind Power Generator is a device which works on the principle of aero elastic flutter as well as on mutual induction process between the magnet and the coils. In this device, we have arranged the magnet on thin belt, which starts to flutter on the basis of aero elastic flutter when held between

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passing air. This fluttering causes this magnet also to reciprocate between the two coils arranged one above the other having little space for magnet between them. This movement of magnets between the coils due to fluttering motion causes changes in field strength, which leads to the induction of current. As the wind speed increases, the voltage produced is increased. Also, due to the movable coil and magnet arrangement, the length for the flutter can be varied.

Problem Statement:

The conventional windmills have been in use since a long period of time; and also have been advantageous on a large scale. As for today, with the single windmill generating energy as much as 2 Megawatts, it is clear that all the wind energy has been used in large energy consumption requirements. However, it hasn't been possible to use a windmill in smaller applications having energy requirements of less than a Watt. Moreover, these huge energy generating machines are not portable by any means. Reducing the size of windmills reduces their efficiency of generating electricity.

Now a days, the world needs quick energy with ease of access at any place and at any time. We use many portable devices that work on portable energy storages. These energy storages need to be recharged timely for uninterrupted use. Our project claims to create a smaller sized portable device that can generate quick energy of less than a Watt. Moreover, the device uses clean energy (i.e. wind) and will be able to power small portable devices such as mobile phones, etc.

Objective:

This project is brief about conventional energy which is clean type energy and main motive of ours is to create an electricity from a wind flowing at very small speed.

This project is design in such a manner that it should work accurately in storms, it should acquire less space and most essential is it should be portable and also cheap.

Scope

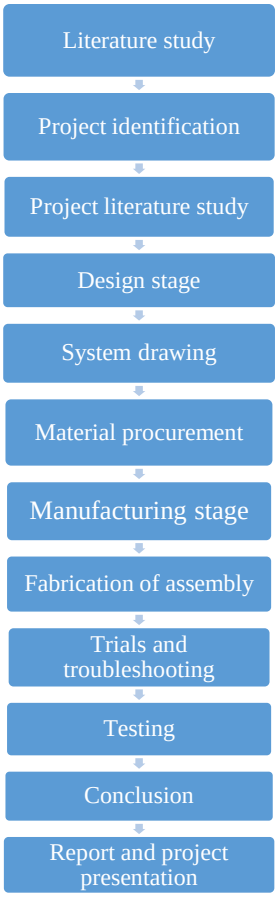
The scope would involve activities starting with, to decide the dimensions of belt. The material of belt, specifications of magnet, fluttering distance of belt is documented for further study and analysis. Device is built according to dimensions. Trials are taken using the device which is constructed and troubleshooting is done. Testing is done at different wind speeds.

Block Diagram:

1.4. Experimental Validation

Experimentation for our project will be carried out once a device prototype is ready and functioning. The experimentation includes measurement of the emf generated by the wind belt device at various air velocities. This includes maximum and minimum air velocities sustainable by the device. The recorded values then can be compared to the calculated theoretical values of emf to know about the total losses in practical device.

1.5. Methodology:



LITERATURE REVIEW

Power Generation from Aero elastic Flutter at Low Reynolds Number by

'Geoff Johnson, Lucas Harman, Tejus Goenka'

In this paper the purpose of author was to combine fluid mechanics and vibrations to create a device that generates electricity from wind energy. Author has also briefly discussed regarding vertical vibrations & torsional vibrations. At last author has concluded that Amplitude & frequency of its oscillation steadily decreased therefore belt experienced wear & due to this wear results in decreased in power generation.

CFD and Experimental Analysis of Vortex Shedding behind D-Shaped Cylinder by

'Chandrakant Mhalungekar, Swapnil Wadkar'

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In the above paper author has briefly discussed about the phenomenon of vortex shedding behind D-Shaped cylinder. Their objective was to reduce the drag using D-Shaped cylinder. They have also make a comparison between CFD simulation & experimental result of pressure distribution. At last author has concluded that in D-Shaped cylinder there fix flow separation point so there is wake steadiness as compared to circular cylinder as circular cylinder has wake unsteadiness.

Low Cost Energy Production using Fluttering Wind Belt by

'Akhilesh Mishra, Supriya Sharma, khushal Shendre, Jainesh Pandya, Dhiren Patel'

All the authors of this paper are from Alpha College of Engineering & Technology, Gujarat.

They have discussed the details regarding the device called wind belt wind power generation. Authors have also discussed regarding working & construction of this device. They have also discussed about magnetic properties & coil properties of the device.

Altering Wind Belt Design for Better Efficiency by

'Jagan C, Amarnath Bose'

This paper has discussed harnessing energy by the belt vibrations due to wind. They have also discussed regarding generation of EMF in this paper. They have also given the formula of generating the EMF in this research paper.

Electricity Generation Using Wind Belt Technology by

'Shubham Kanhe, Ms. Shital Kurhade, Prof. Akansha Khaparkar'

In this paper author has focused on conversion of energy wave into electrical energy. They have also discussed the advantages of wind belt i.e. the design of wind belt in very simple, cost is less, and no gears bearing are present. Authors have also discussed the incident of Tacoma narrow bridge which collapsed due to strong wind in 1940.

Urban Integration of Aero elastic Belt for Low Energy Wind Harvesting by

'Angelo Aquino, John Calautit, Ben Hughes'

The aim of author in this paper is to study & investigate the potential of integrating the aero elastic belt using Computational Fluid Dynamics (CFD) simulations. Authors have discussed that effect of various external conditions such wind speed, wind direction, positioning, sizing on the performance of aero elastic belt.

Low Cost Energy Production using Wind Belt Technology by

'Dr. P. Balaguru, B. Vignesh Raj, B.E. Vignesh'

In this research paper author has discussed that wind belt uses even the lightest of the winds for vibrating the membrane. They have also said in a recent experiment that a prototype of wind belt was found to be ten to thirty times more efficient than micro turbines. Also as the constructing a wind belt is cheap, it can be an excellent alternative especially in rural areas where kerosene is used for lesser amount of power. They have also given the cost of project in this paper which is very less.

Analysis of Vortex Shedding in A Various Body Shapes by

'Nazihah Binti Mohd Noor'

This paper consists of vortex shedding, Von Karman Vortex Street, vortex shedding frequency, Reynolds number, flow velocity, pressure loss, drag and lift force and bluff body. Author have also investigated the effect of bluff body shape on the pressure loss, drag force, flow velocity and lift force in the time response. In this research paper author has briefly discussed about Flow around Circular Cylinder, Flow around Rectangular & Flow around Equilateral Triangle.

An Overview of Neodymium Magnets over Normal Magnets for the Generation of Energy by

'Prof. Parag G Shewane, Abhishek Singh, Mayuri Gite, Amit Narkhede'

In this paper author ha briefly discussed about Neodymium Magnets. Author has also discussed about Grades, Properties, and Advantages of Neodymium Magnets. Author has also compared between hematite & neodymium magnets.

CALCULATIONS

After studying the WINDBELT concept, it is necessary to know the output generated from the project. It is clear from the study that the output generated is electrical energy in the form of emf. In order to calculate the emf produced by the device we need to use the basic formula used in study of electromagnetic induction. The formula for emf is as given below,

$$E = 2\pi N f AB \qquad [1]$$

While calculating the emf generated it is important to make some assumptions. Following assumptions were considered to calculate the generated emf from the wind belt device:

Avg. air velocity = 3m/s [5]

No. of turns of conducting coil = 100

Displacement of belt during fluttering= 0.02m

Also the belt dimensions are to be taken into consideration. According to the proposed design of wind belt device, following are the dimensions of the belt:

Length of belt = 0.918m

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Width of belt = 0.04m

Thickness of belt = 0.0003m

Magnets are mounted on the flat surface of fluttering belt that are supposed to reciprocate in between cylindrically wound conducting coils. These magnets are selected of a proper material having low weight and higher magnetic field strength. Also the design of magnets should be proper so as to produce maximum desired output. The dimensions of magnet discs to be placed on the belt are as follows:

Thickness of disc = 0.005m

Radius of disc = 0.04m

Distance between the pole and closest conducting surface = 0.004m

The relative magnetic flux range for N35 magnets = 1.17 to 1.21 Tesla

Firstly, calculating the flutter frequency,

$f = \frac{v}{d}$ [1]

$f = \frac{3}{0.02}$

f = 150 Hz

According to the belt dimensions, the area of belt surface directly in contact with the air flow is

A = L x b

A = 0.918 x 0.0003

A = 0.0002754m^2

Having considered neodymium magnets of N35 grade, the avg. relative magnetic field strength

Br = $\frac{1.17+1.21}{2}$

Br = 1.19 Tesla

Now, calculating the actual magnetic field strength for given magnetic disc,

B = $\frac{Br}{2}\left(\frac{D+z}{\sqrt{R^2+(D+z)^2}} - \frac{z}{\sqrt{R^2+z^2}}\right)$ [4]

B = $\frac{1.19}{2}\left(\frac{0.005+0.004}{\sqrt{0.04^2+(0.005+0.004)^2}} - \frac{0.004}{\sqrt{0.04^2+0.004^2}}\right)$

B = 0.201 Tesla

Finally, calculating the emf generated using the first formula

E = 2πNfAB [1]

E = 2π x 100 x 150 x 0.0002754 x 0.201

E = 5.217V

This is the calculated output in volts.

EXPERIMENTAL VALIDATION

Experimentation for our project will be carried out once a device prototype is ready and functioning. The experimentation includes measurement of the emf generated by the wind belt device at various air velocities. This includes maximum and minimum air velocities sustainable by the device. The recorded values then can be compared to the calculated theoretical values of emf to know about the total losses in practical device.

CONCLUDING REMARK AND SCOPE FOR FUTHRE WORK

Till now we have concluded that; the output (i.e. voltage) can be obtained by considering certain dimensions of the wind belt device. We have a clear view to start manufacturing of our device and obtain the experimental validation for our project. Also, the study of wind belt concept gave us the opportunity to develop an eco-friendly and clean energy producing device.

The scope in future would involve activities as to decide the actual dimensions of belt, the material of belt, specifications of magnet, fluttering distance of belt so as to get the optimum output from the device and increase its efficiency. It will also include the observations of output for different wind speed

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