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STUDY ON ELECTROMAGNETIC BASED BRIDGE ENERGY HARVESTER USING BRIDGE'S VIBRATIONS AND AMBIENT WIND

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Abstract - In the world electricity generation is the many sources. Due to the wind energy is generate the small amount of voltage. In this harvestr utilizing bridge vibrations and ambient wind to harvest energy. faraday' s law of electromagnetic induction. The working principle, fabrication and characterization of the harvester is discussed. The harvester consists of a fixed wound coil, a permanent magnet, an airfoil, a cantilever beam and a Base support. The harvester is characterized both under ambient vibration and wind energies.

Key Words: airfoil, Ambient wind Bridge energy harvester, electromagnetic induction, vibration, linear generator, multimeter.

1. INTRODUCTION

Ease of miniaturization and minimal maintenance are among the advantages for replacing conventional batteries with vibratory energy harvesters in a wide of range of disciplinarian and applicable, from wireless communication sensors to medical implants. Energy harvesting from ambient wave field is a non-linear and maintaining free solution for health noticing of machines structures. The harvesting energy on bridges usually includes bridge's vibration and ambient force of wind. [1] Bridge structures is low frequency and low amplitude and wind induced vibrations. Short and medium spancel bridges vibrate with frequency. [2] However the basically arrangements of bridge's and vibrations are comparability more fixative with a more frequency range and acceleration levels highly. [3]In the world there are present the number of bridge's which is give to more frequency and acceleration. There is following are bridge's

a) New Astra (Sweden) bridge frequency is 1-40and acceleration is 0.01-3.79.

b) California, (USA)bridge frequency 10-20and acceleration 0.0002

c) Box grideris (Austin, USA) bridge frequency is 1- 15and acceleration 0.12.

[4] Electromagnetic and electrostatic energy harvesting. The bridge vibrations and wind can be used full for harvesting nonstoping supply of energy is small amount of voltage is generated which is useful to small electronic device charging purpose. [5] There is many types to generate the energy harvesting electromagnetic, piezoelectric, energy harvesting technologies. Advancementing in each of these are will be discussed, as well as the use of more than one technology to create hybrid harvesters. [6]Electromagnetic energy harvesters that use Faraday's law of induction as the underlying principle of operation. Using the fundamental idealise that a magnet moving inside a coil will induce a voltage.[7] Electromagnetic energy harvester comprised of a beam, coil, magnet and a base support. When the harvester is excited, the beam starts vibrating and the magnet attached to the beam also starts moving, and hence a changing magnetic flux is induced in the coil.[8]Electrostatic energy harvester is made of two conductive plates. The plates are separated by vacuum or air and electric charge is produced as a result of the plate's movement. When external vibration is applied to an electrostatic based energy harvester, the plates of charged capacitor separates and the mechanical energy is converted into electrical energy.

2. DEVICE ARCHITECTURE AND WORKING PRINCIPLE

The energy harvester's architecturally developes in this work is shown in Fig.1 the harvester comprised of a wound coil, a permanent cylindrical magnet, an airfoil and a cantilever beam. When the device is exposed to vibrations, the cantilever beam and the magnet attached to it starts moving due to which a changing magnetic flux density is experienced by the coil and an EMF is induced in the coil according to Faraday's law of electromagnetic induction. When the ambient wind

surge flows the airfoil, then the beam is up and down then it produces an upward lift force. The natural wind flow is always flow to the cantilever beam and magnet attached to the airfoil will start oscillating vertically, due to the magnet is up and down flux are produce and result an EMF will be produced in the coil and voltage is generate.

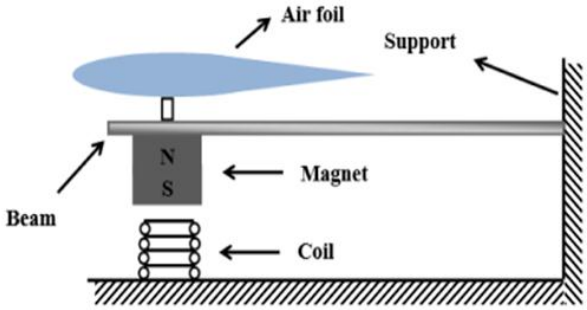

Fig-1: Architecture of Develop Energy Harvester

The fabrication of bridge energy harvester is shown in Fig.1. The basically support for the cantilever beam is produced airfoil. The cantilever beam connected the permanent magnet is fabricated from a galvanized. The fabricated airfoil is connected to the cantilever beam through a long bolt and a nut. The coil holder is fixed to the base through nut and bolts and the airfoil is mounted to the beam, a permanent magnet having strong magnetic field is attached to the beam.

3. AIRFOIL OF PROTOTYPE

An airfoil-shaped body moved through a fluid produces an aerodynamic force. The component of this force perpendicular to the direction of motion is called lift. The component parallel to the direction of motion is called drag. Subsonic flight airfoils have a characteristic shape with a rounded leading edge, followed by a sharp trailing edge, often with a symmetric curvature of upper and lower surfaces. Foils of similar function designed with water as the working fluid are called hydrofoils.

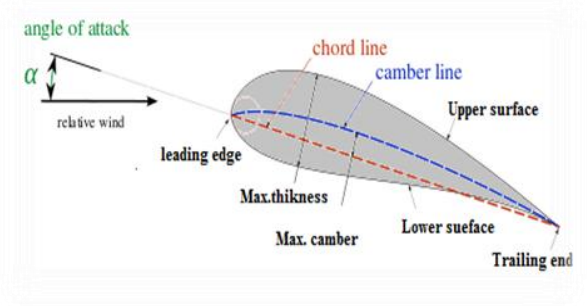

Fig.2: Airfoil Shape Parameters

The lift on an airfoil is primarily the result of its angle of attack and shape. When oriented at a suitable angle, the airfoil deflects the oncoming air, resulting in a force on the airfoil in the direction opposite to the deflection. This force is known as aerodynamic force and can be resolved into two components lift and drag. Chord Line is the Straight line drawn from the leading edge to the trailing edge. Chord Length is the Curved line from the leading edge to the trailing edge, which is equidistant between the upper and lower surfaces of the airfoil. Maximum Camber is the Maximum distance between the chord line and the mean camber line. Maximum Thickness is the Maximum distance between the upper and lower surfaces of the airfoil normal to the chord line. Angle of Attack is the Angle between the chord line and the stream wise flow direction.

4. EXPERIMENTATION AND RESULT

By using the experimental setup shown in Fig.3, the developed prototype has been characterized inside the laboratory. The setup consisted of a 12 V, DC power supply , a power amplifier, oscilloscope, function generator, digital multimeter, vibration shaker and an accelerometer, Moreover, a variable speed electrical motor and fan arrangement, PVC pipe is used to produce surges of high speed air.

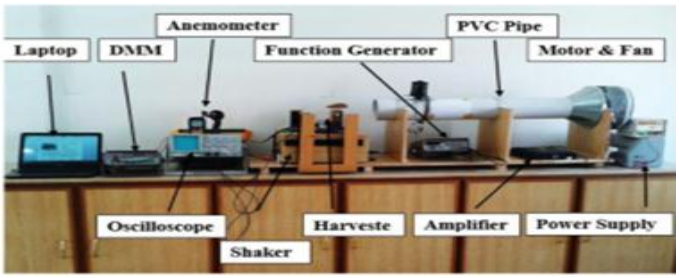

Fig-3: Experimental setup

The harvester is placed on a wooden block which is tightly fixed to the shaker's table and an accelerometer is attached to the block in order to monitor the acceleration levels to which the device is subjected. The harvester output voltage signals and the readings from the accelerometer are analyzed and measured with the oscilloscope and multimeter.

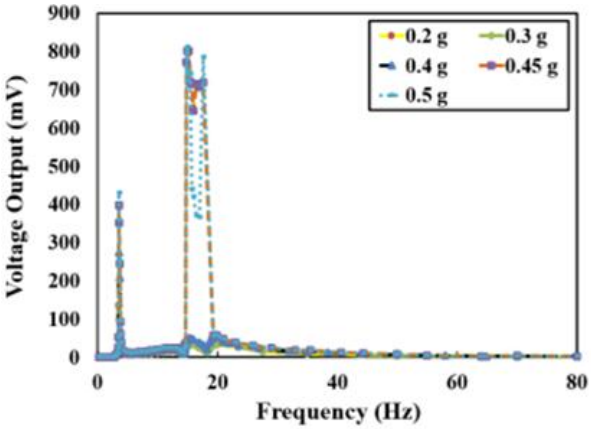

Fig-4: Characteristic of Voltage & Frequency

In the above fig. 4 is the characteristic of the voltage and frequency. Voltage of the harvester to maximum with respective to frequency at different acceleration levels. The acceleration level to which the harvester is exposed increased the output voltage increases and higher voltage levels were observed at these acceleration levels.

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