# Energy Harvesting by Turbo Ventilator

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***Abstract*— Wind is a renewable and non-polluting form of energy. Technological advancements have been made to harvest wind energy, most common of which is generation of electricity by using turbines. This paper discusses energy extraction from an application of Vertical Axis Wind Turbine (VAWT) i.e. a Turbo Ventilator. The ideology is of harvesting energy in the form of electricity by using an alternator and piezoelectric transducers. The construction consists of rotating internal shaft connected to alternator, external shaft with movable sleeve on which governor is mounted and piezoelectric transducer with pressure induction plate. The alternator will produce electricity by the rotation of the shaft whereas the pressure applied on piezoelectric transducers will induce an emf. Project focuses on checking the feasibility of energy generation using piezoelectric transducers, satisfactory results of which will help develop a VAWT employing such a system to produce more electricity.**

***Keywords*— Renewable energy, Turbo Ventilator, Alternator, Governor, Piezoelectric Transducer.**

## I. INTRODUCTION

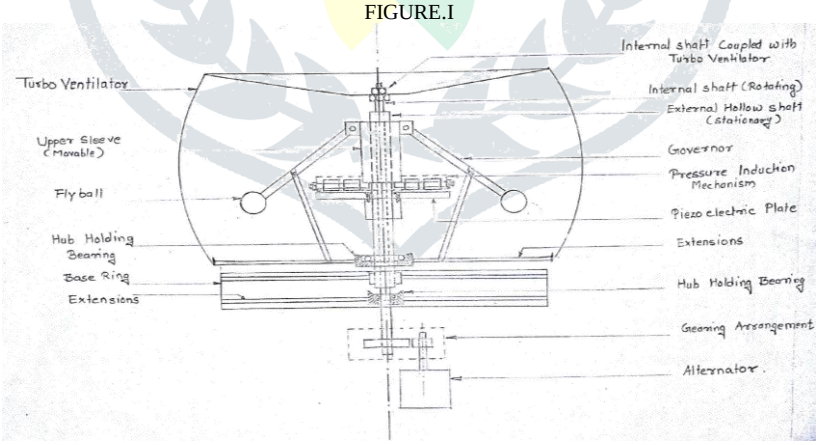
We know that there are two types of energy resources used for generation of electricity. These are Renewable Energy sources and Non Renewable Energy sources. The Solar, Wind, Water, Tidal energy can play important role in production of electricity without affecting on environment. But the some problems arises in the production power generation like, high construction cost, difficulties in maintenance, space for plant installation and power distribution. Therefore in India, government has to develop small power stations to improve such problems. One of the ways to develop such type of small power station is effective use of Roof top ventilator to generate electricity. Roof top ventilator is name of mechanical equipment that runs on wind to provide fresh air in the industrial sheds without running cost. It does not consume any power units and no power connection is required.
The highly efficient roof top ventilator is naturally powered by wind and helps in keeping the machine shops and industries with fresh air. The workers not just can enjoy the benefits of the better air ventilation in the house, but also have extra electricity supply for small load appliances like radio, mobile phone charger, etc. The main component of the system is Generator. It will convert the kinetic energy of turbo
Ventilator into the electricity.

## II. Objectives

1. To extract energy without hampering the ventilation capacity of the turbo ventilator.
2. To design and manufacture a light weight and sensitive governor to induce pressure on the piezoelectric transducer.
3. To couple a generator to the rotating shaft of the turbo ventilator to produce electric output.
4. To perform experiments at different wind speed to find the corresponding electrical outputs.

## III. Drawing and Explanation

FIGURE.I




Detailed Drawing

Following are the main components

1. Turbo ventilator
2. Governor
3. Pressure induction plate
4. Piezoelectric transducer
5. Alternator

1. Turbo Ventilator-

Ventilators driven by natural convection do not require an external prime mover and all the necessary work is carried out by the natural convection, thus the absolute efficiency of this system is substantially high. When it comes to roof top ventilators, they have several advantages which include that they do not need to be powered by electricity, they are located such that they exhaust the hottest air first, they do not cause any harm what so ever to the environment, they tend to save a lot of money because there is no operating cost plus they are maintenance free. There are different sizes of wind turbo ventilators that range from 14″ to 36. The main structure of the rooftop ventilator comes from the ventilation turbine, as bought off the shelf. Fulfilling the goal of an easily installed system, the all modifications to the turbine are superficial to or surrounded by the visible exterior of the turbine.


FIG.2 Turbo Ventilator

2. Governor-

A four link inverted governor mechanism is used to convert the rotation of the ventilator to pressure. As the speed of ventilator increases, the centrifugal force on the fly balls increases as well. The upper sleeve being movable, will apply pressure on the piezoelectric transducers.

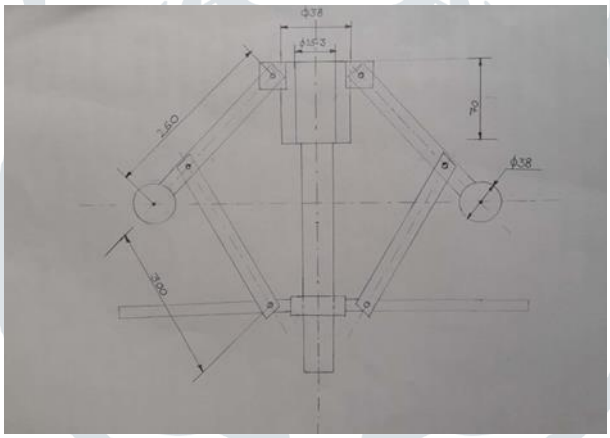


FIG.3 Construction of Governor

Specification-
1. Length of arm = 260 mm
2. Weight of fly ball =240 kg (Stainless Steel)
3. Diameter of fly ball = 38 mm

Calculations-

Force = Centrifugal Force = Fc

r = 250 mm N = 80 rpm

$$fc = 2mr\omega^2$$

$= 2 * m* 0.25*(2*\pi*80/60)^2$

Fc = 35* m

Considering, m=200gms

Fc = 7N

Diameter of ball

$$\rho = \frac{m}{(\frac{4}{3} * \pi * r3)}$$

$$r = \left(\frac{0.0477}{\rho}\right)^{1/3}$$

Considering , ρ =7770 kg/m$^3$

3. Pressure Induction Plate-

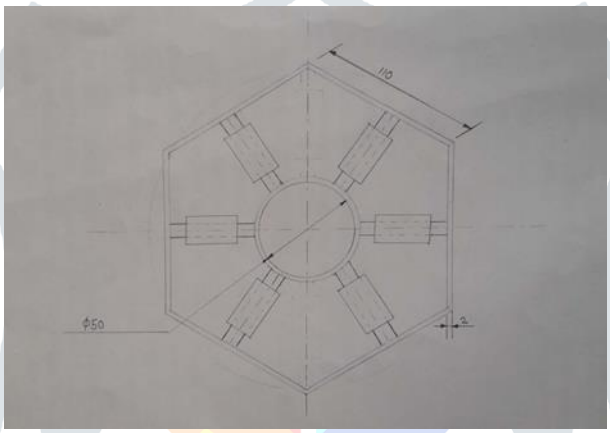


FIG.4 Construction of Induction plate

4.Piezoelectric transducer-

A piezoelectric transducer is a device that transforms one type of energy to another by taking advantage of the piezoelectric properties of certain crystals or other materials. When a piezoelectric material is subjected to stress or force, it generates an electrical potential or voltage proportional to the magnitude of the force. This makes this type of transducer ideal as a converter of mechanical energy or force into electric potential.

FIG.5 Piezoelectric Material

Piezoelectric material- Lead Zirconate Titanate (10 NOS)

5. Alternator-

The roof ventilator by adding three phase synchronous generator for voltage generating. The results of the generator performance are at the no-load speed 100 rpm, the generator voltage could be induced 52.3 V. At on-load, the generator could be supplied the load with the real power 1.15W. For the results after install the generator in the ventilator on the roof of a building to charge the 12V battery, and the minimum wind speed for enough charging to battery is at 20 rpm.

Induced voltage from generator is directly proportional to the speed of roof ventilator. In case of Practical installation on the roof, voltage is induced lower than the measurement in laboratory because of wind changing.

A small power generation system motivated by a coreless stator AFPM (Axial Flux Permanent Magnet) generator which is driven by the rooftop ventilator. The ac voltage is rectified to dc voltage and finally charged to the 12 V 5 Ahr batteries for household appliances. Based on the experiments, the results of the output voltage can achieve 103 V with no-load and 20 V on 100 Ω resistive loads at the speed of 200 rpm. For the results after installing the generator on the roof of a building to charge the 12 V batteries, the minimum wind speed for enough charging to battery is at 10 rpm.

## IV. Construction

The turbo ventilator used is of curved vane type with the base ring diameter of 24 inches. It consists of two parts- the rotating dome and a stationary base ring. A 15 mm diameter shaft threaded at one end is fastened to the top of the rotating dome; hence the rotation of the ventilator will cause the shaft to rotate as well. A bearing is mounted at the other end of the shaft. The bearing is placed inside a hub. The hub and the base ring are connected by using extensions which makes the outer race of the bearing stationary. Just below the bearing a gear is mounted on the shaft which is then meshed with the gear on shaft of the generator.

Another hollow shaft is mounted on the solid internal shaft. The design requirements are such that the external hollow shaft must remain stationary. For that a bearing and hub is mounted on it at its lower end. Arms are welded to the hub and screwed to the bottom part of the rotating dome. This will make the outer race of bearing to rotate thus keeping the inner race stationary. To ensure rigidity the hollow shaft is fixed to base ring by using extensions. To the top part of the hollow stationary shaft a freely rotating sleeve is mounted. Two arms are symmetrically connected on the sleeve by using half threaded bolts and a locknut. At the end of arms steel balls are welded, these arms are hinged midway by two other arms which are further connected to the extensions given to bearing placed on the hollow shaft. This will lead to rotation of sleeve, arms and the fly balls. This construction is similar to that of the governor. A hub is tightly secured on the hollow shaft just below the sleeve. A rigid plate on which piezoelectric transducers are adhered is screwed on the top of this hub. To induce pressure on the transducers a pressure induction mechanism is used which is connected to the bottom most part of the sleeve. Small pieces of rollers inserted in a rod threaded at one end and welded to the bottom of the sleeve at the other end are used. An array of six such rods is made to induce the pressure. The electric connections of the piezoelectric transducers are taken through the slot milled on the hollow shaft which will not hinder the rotation of parts. Hence, the construction consists of a Turbo Ventilator, Governor, Piezoelectric Transducer, Pressure Induction Mechanism and an Alternator.

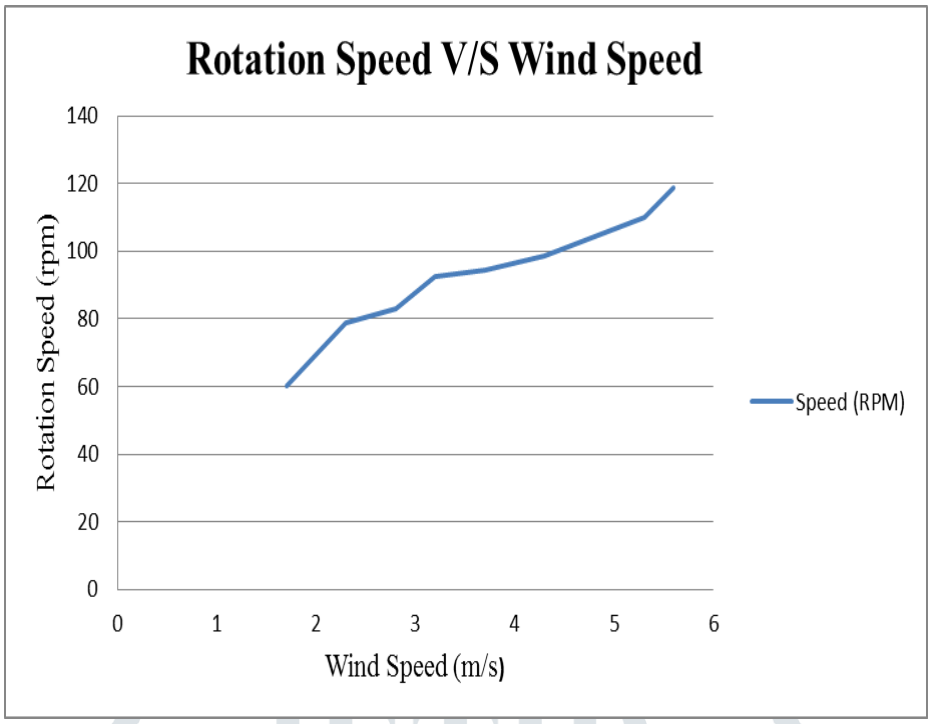
## V. Working

The impact of flowing wind on the vanes of turbo ventilator causes its rotation which rotates the internal shaft. The generator is driven by the gear mounted at the end of the shaft. The extensions given to the bearing of the hollow shaft will rotate as well intern rotating the fly balls of the governor. As the fly balls rotate, centrifugal force acts on them, which pushes those outwards? By the virtue of its construction, the sleeve tends to move down. The pressure induction mechanism attached to the sleeve rests on the piezoelectric plate. This applies pressure on the piezoelectric transducer. As the sleeve and pressure plate rotate, an intermittent contact is developed between the rollers and the piezoelectric transducers. The intermittent pressure applied on the transducer shifts its charges and thus equivalent emf is produced.

## VI. Experimentation

Turbo Ventilator Readings (Without Modification)

| Sr.no | Wind speed(m/s) (Anemometer) | Speed(rpm) (Tachometer) |
|---|---|---|
| 1. | 1.7 | 60 |
| 2. | 2.3 | 78.8 |
| 3. | 2.8 | 83 |
| 4. | 3.2 | 92.6 |
| 5. | 3.7 | 94.2 |
| 6. | 4.3 | 98.5 |
| 7. | 5.3 | 110 |
| 8. | 5.6 | 118.6 |

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