# The Development of a New Type of Wind-Solar Driven Natural Turbine Ventilator Working on the Principle of Eddy Current

**Himanshu B Patel[1] Sanket N Bhavsar[2]**
[1]Student, M.E. Mechatronics
[2]Professor & Head, Mechatronics Dept
[1, 2] G H Patel College of Engg. & Technology, Anand, Gujarat

**Abstract:**— *this paper presents an eco-friendly modification to existing turbine ventilators for operation at low or zero wind speed by harnessing solar energy. Although solar powered turbine ventilators have already been proposed, they employ fans which require changes in the fundamental structures of the turbine ventilators and they cannot be implemented on existing installed turbine ventilators. This paper aims to minimize the modification, which consists of a miniature motor, powered by a 12 volt-10 watt solar panel, attached above the turbo vent using an L-shaped frame. In the new design an aluminium plate is fixed to the rotor of the motor and another iron plate is fixed to the top of the turbo ventilator. Thirteen magnets are fixed to this iron plate. Parameters like C.F.M. (cubic flow per minute or volumetric flow rate), RPM of turbine ventilator and radiation of solar panel have been measured for comparison. At the end of experimentation turbine ventilator was observed rotating at 13 RPM even at zero outer wind speed. It may be considered as a significant research contribution.*

**Keywords:-** Eddy Current, Solar energy, Turbine Ventilator

## I. Introduction

Turbine ventilator is a simple and affordable device which is driven by natural wind force and is preferable to air conditioning systems which are associated with high energy consumption and global warming[3]. This device was originally patented by Meadows in 1929 and is also known as a rotary ventilator or a wind-driven air extractor. It is observed as one type of roof ventilator. Its definition has been outlined by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (1999) as 'a heat escape port located high in a building and properly enclosed for weather tightness with the primary motive forces being stack effect and wind induction'[1]. A conventional turbine ventilator does not use any electricity to rotate. Here outdoor wind force is found to be a major force because it spins constantly the blades and creates centrifugal forces in the turbine, which in turn extracts air from the building. In the absence of wind, the turbine ventilator functions due to stack effect and extracts hot and stale air out from the building if there is enough indoor-outdoor temperature differential. The turbine ventilator can be classified as wind-assisted stack ventilation or wind-stack driven ventilation by Allard (1998). It can maximize both wind-induced and stack effect to extract hot and stale air from the building. Mainly, the device consists of a waterproof frame which is mounted by a number of vertical vanes in a spherical or cylindrical array and a base duct which is connected by a shaft and bearings. Edmonds of Australia was the first company which commercialized it in 1931 for the purpose of industrial ventilation. The device now is widely used and has become a familiar ventilation feature used in various types of buildings serving commercial, residential, institutional, industrial and storage functions. It has been found to be effective even in the lightest wind conditions as low as 1.5m/s (Edmonds 2007).

On the other hand, some researchers studied the impact of combining the turbine ventilator with the extractor fan. The results showed that it is effective to increase ventilation rate in the buildings and achieving sufficient air change rate (ACH) for the hygienic need in the industries ventilation system [5]. Some of the researchers discovered that the integration of turbine ventilator with solar-powered battery operated inner fan is successful to increase ventilation rate without consuming any paid energy [3]. Their experimental study found that the solar powered turbine ventilator is significant to improve ventilation. Although wind-solar hybrid ventilators already exist specifically for use at zero or low wind speeds, they are expensive and cannot be used where simple turbine ventilators have been installed. In this design solar panel of 10watt, 12 volts is used which consumes 50% less power than solar power extractor designs [5]. Some researcher produces electricity from turbine ventilator [6]. New wind-solar hybrid turbine ventilator provides a low cost universal solution. Several papers were referred and it is observed that the experimental and analytical work (related to design and performance) carried out on the various aspects of different existing rooftop turbine ventilators [1, 4]. This paper is going to make a modification which will enable existing turbine ventilators to operate in less or zero wind conditions. It has been successfully demonstrated in this paper that an existing simple turbine ventilator can be modified with a design, which is based on the principle of eddy current generated through the use of a solar powered motor. The Wind-Solar hybrid turbine ventilator which has been newly developed provides a low cost solution.

## II. Design and Modification

The experiments were carried out to simulate practical situations. As shown in figure 1, turbine ventilator of 27 inch diameter was used with number of vanes equal to 42. The turbine was placed on top of a cylinder-iron stand and that whole system was placed on top of the building of M/s. Supernova Pvt. Ltd. Total height of cylinder-iron stand was 52.5 inch. Size of cylinder was 36 inch × 60 inch (height × diameter). The size of iron stands was fixed to 16.5 inch × 16.5 inch (height × length). Air enters into the model through an inlet of 3 inch diameter hole at the bottom of cylinder where anemometer is placed to measure the air velocity passing through the turbine ventilator

Fig. 1: Experiment setup

Measuring parameters are inner wind velocity, outside wind velocity, C.F.M (cubic flow per minute or volumetric flow rate) and R.P.M of turbine ventilator. The field study is divided into two major experiments representing two different ventilation strategies.

1) Wind-driven turbine ventilator
2) Wind-Solar hybrid Turbine ventilator.

## III. Wind-driven turbine ventilator

Experiments were carried out on different days corresponding with different weather conditions. The data of ambient wind velocity and inside cylinder wind velocity were measured through anemometer (meter/second), at a height of 52.5 inch above the ground floor level (20 foot) at G.D.C.E of Anand city at latitude 22.3degree, Gujarat. First measured parameters were outer wind speed and inner wind speed. Based on data of inner wind speed, C.F.M. (volumetric flow rate) was calculated using following equations.

Area of cylindrical duct (Ac) = $\pi r^2$

Volumetric flow rate (C.F.M) = $Vt \times Ac$

Here Vt = Turbine velocity

Ac = Area of cylinder duct

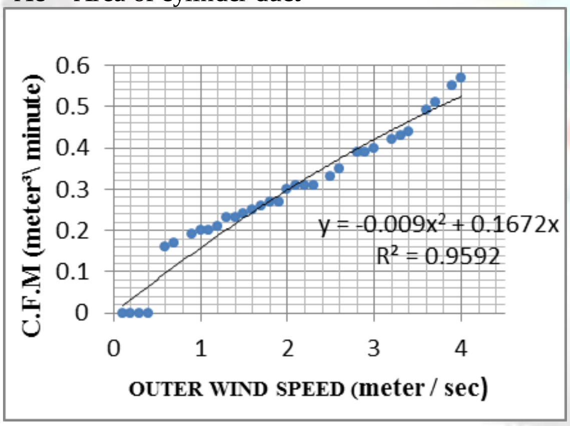


Fig. 2 Outer wind speed Vs. C.F.M

From the study, it was observed in the graph (figure 2) that at zero wind speed and low wind speed C.F.M is zero. Here tread line is polynomial and $R^2$ value is 0.95.

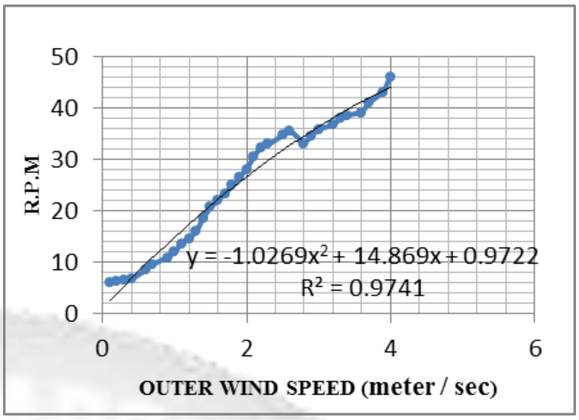


Fig. 3: Outer wind speed Vs. R.P.M

In figure 3 tread line is polynomial and $R^2$ value is 0.97. At zero outer wind speed RPM is zero and even low wind speed cannot get enough RPM, which rotate turbine ventilator. Some amount of jumping in the reading was observed in the graphs (figure 2, figure 3) due to sudden acceleration of ambient wind, gusting, torque breaking etc. Volumetric flow rate depends upon RPM of turbine ventilator, so by increasing RPM of the turbine ventilator, the volumetric flow rate can be increased. Following graph has been generated for comparison of RPM and volumetric flow rate [4].

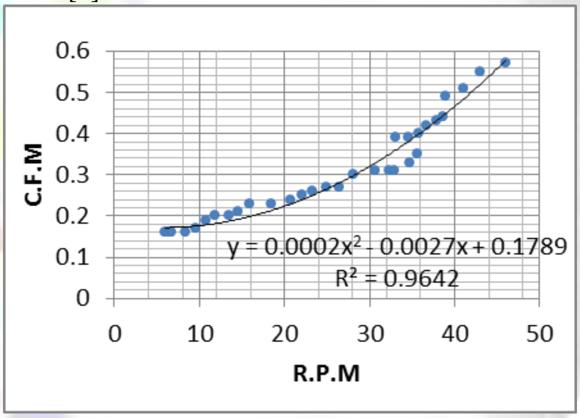


Fig. 4: R.P.M. Vs. C.F.M

## IV. Wind-Solar hybrid turbine ventilator

The modification consists of a miniature motor, powered by a 12 volt-10 watt solar panel, fixed with the L-shaped iron frame. An aluminium plate is fixed with the motor shaft.

### *A. Working Principle of Modified Design*

When the motor receives power from the solar panel (12 Volt 10 watt), it rotates the aluminium plate attached to it. On other hand, 13 magnets are placed on the top cover of the turbine. Magnet has its own magnetic field so, when aluminium disk cut that magnetic field eddy current is produced in the aluminium disk. The eddy current has its own magnetic field. Hence, the eddy current magnet field and Neodymium magnet's magnetic field create clutching effect due to opposite polarity, which causes turbine ventilator to rotate.

Fig. 5: (a) New wind solar driven natural turbine ventilator

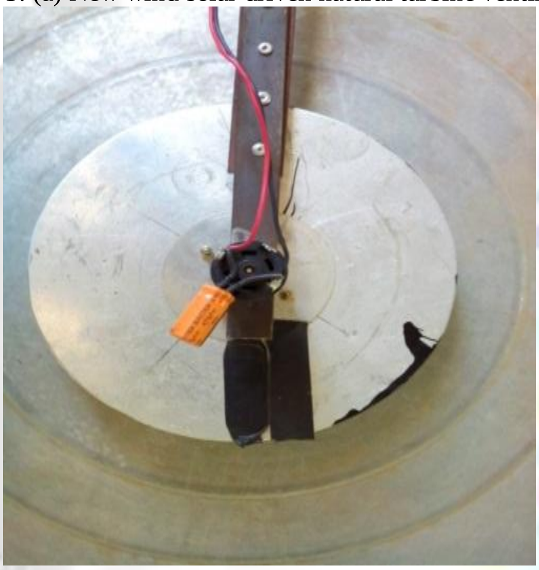

Fig. 5:(b) New wind solar driven natural turbine ventilator

## V. Result and Discussion

Initially Power was given to the motor of 6 volt, 5 watt solar panel but enough current and power could not be achieved. Afterwards the rating of solar panel was increased by parallel connection of two 6 volt, 5 watt solar panel for making power of 6 volt, 10 watt. Still it was not working. At last the power rating was increased to 12 volt, 10 watt solar panel. This solar panel was fixed at an angle 22.3 degree, which is latitude of Anand city. All readings were taken at time interval of 60 minute in morning and every 30 minute at after noon. Experiments were performed in three phase.

### *A. Solar plate at fixed angle (22.3 degree)*

In this experiment, entire set up (turbine ventilator) was placed inside plastic cabin and solar plate was fixed at fix angle of 22.3 degree of south face. During experiment it was tried to make this cabin air free. And all reading is taken at no wind speed.

### *B. Solar plate in tracking mode*

In this experiment, solar plate was in tracking mode according to the direction of maximum solar radiation. Tracking of solar plate was done manually. Solar plate was set in the direction of solar track in a way that maximum voltage and ampere can be got. Again same procedure has to be repeated as mentation in solar plate at fix angle. According to that R.P.M has been measured.

### *C. Solar plate in tracking mode and turbine ventilator in open atmospheric area.*

In this experiment, turbine ventilator was placed outside of plastic cabin in open atmospheric area. And ventilator was rotated by solar power and also with the wind velocity. Due to the combined effect (wind and solar power both) the RPM of turbine was increased. Here RPM readings were taken at every 5 minute interval because initial torque requirement to rotate the turbine ventilator is high. After 3 minutes it rotated with minimum 13 RPM. During experiment it is also observed that at no wind speed turbine ventilator rotated at 13 RPM due to modified design. Compared to the three types of experiments this one seemed to be a better solution. As Shown in the figure 6 (for new wind solar driven natural turbine ventilator), $R^2$ value was increased compared to figure 2(wind turbine ventilator). Moreover, it has also been observed that at zero outer wind speed CFM is non zero. In a same way figure 7 also shows non zero RPM at zero outer wind speed. At last, figure 8 represents an improvement in the initial value of RPM and CFM when outer wind speed is zero in comparison with the existing Mbient turbine ventilator.

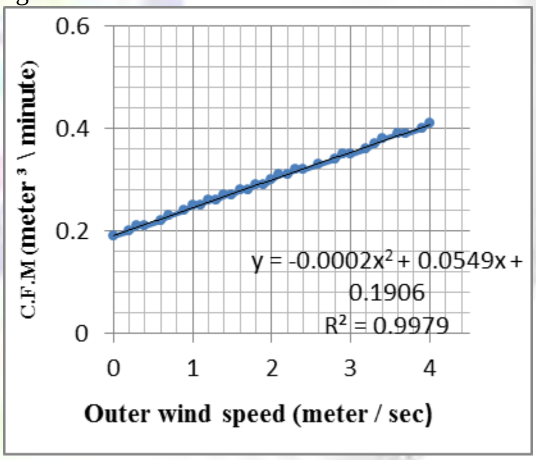


Fig: 6: Outer wind speed Vs. C.F.M

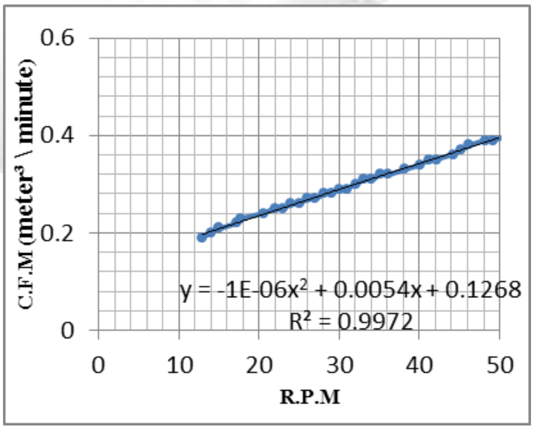


Fig. 7: Outer wind speed Vs. R.P.M

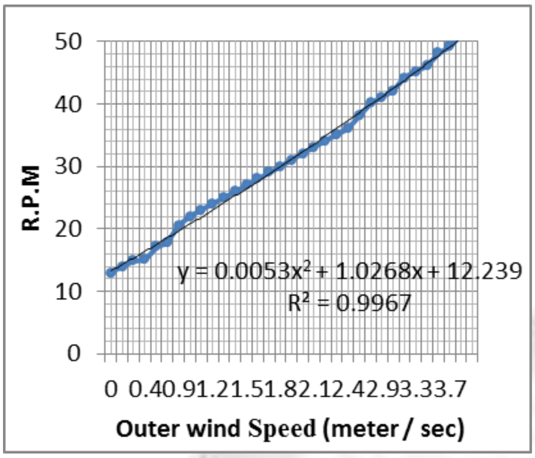


Fig. 8: R.P.M. Vs. C.F.M

## VI. Conclusion

In this pater after applying modified design of ventilator, Mbient turbo ventilators (a leading available brand) was compared with the modified wind-solar hybrid Mbient turbine ventilators. Parameter like CFM (cubic flow per minute) and RPM of turbine ventilator were measured experimentally for evaluation. Relationships like outer wind speed Vs CFM, outer wind speed Vs RPM, and RPM Vs CFM were compared between existing turbine ventilator and modified turbine ventilator. Result showed that the RPM were increased in modified turbine ventilator upto 13 RPM at zero outer wind speed with the use of solar panel with 12 Volt-10 Watt rating. As it a use of natural resource, it may be considered as a significant research contribution.

## Acknowledgement

The research presented in this paper was supported by M/s. Supernova Pvt. Ltd. Company, Vallabh Vidhaya Nagar, Anand, Gujarat, India. Authors are thankful to Mr. Shreelal Jha, for providing all financial support to carry out this research work.

## VII. References

[1] Mazran Ismail1 & Abdul Malek Abdul Rahman " Rooftop Turbine Ventilator: A Review and Update", Journal of Sustainable Development, vol. 5, no. 5, May 2012.

[2] Lai,C. M. "Prototype development of the rooftop turbine ventilator powered by hybrid wind and photovoltaic." Energy Building, vol. 38(3), no. 174–180, March 2006.

[3] Lai, C. M. "Experiments on the ventilation efficiency of turbine ventilator used for building and factory ventilation".Energy Building vol. 35, no. 927-932. 2003.

[4] Ahmed, N.A. "Wind-Solar Driven Natural Electric Hybrid Ventilators", Wind Power, InTech, ISBN: 978-953-7619-81-7, 2010.

[5] Mazran Ismail , Abdul Malek Abdul Rahman , Mohd.Rodzi Ismail "Field study on the ventilation performance of the hybrid turbine ventilator (htv)", International Journal on Design and Manufacturing Technologies, vol.3, no.2, July 2009.

[6] Ming Chun Hsieh1, David King Jair2, Huann Ming Choun " The Development of a New Type Rooftop Ventilator Turbine" Engineering, scientific research 2013, vol. 5, no. 16-20, July 2013.