Design and Fabrication of Hybrid Exhaust Ventilator Turbine and Solar Tracking Mechanism Using RTC

Abhilash G[1], Ajay H R[2], Harish R[3]

[1, 2]Research Scholars, Department of Mechanical Engineering, SVCE, Bengaluru, Karnataka, India

[3]Assistant Professor, Department of Mechanical Engineering, SVCE, Bengaluru, Karnataka, India

Abstract: ***In recent era, the electrical energy is the driving force for the daily activities, energy generation is the most important and challenging task for the human being. Power generation using renewable energy resource is the important considerations to overcome the energy crisis. Power generation can be done with use of renewable and non-renewable energy sources. In recent years the interest has grown towards the alternative sources for energy conversion, due to limitation of non -renewable energy sources (conventional). This extensive need led human being to think of efficient conversion devices. We know that, at present rooftop ventilators are used for ventilation and will be rotating ideally. This paper deals about the hybrid turbine that can provide space ventilation as well as generate a useable amount of voltage and improving the power generation efficiency of the system by incorporating solar tracking mechanism based on Real Time Count.***

Keywords: Actuator, Renewable Resources, Rooftop Ventilator, RTC

1. Introduction

Nowadays, the world is talking about the green energy that can save the world from pollutions and green house effects.In viewing the energy crisis and the fast degradation ofthe natural environment, scientists have become increasingly interested in the renewable energy. Kinetics in nature, for example winds, water, ocean waves, can play a significant role in tomorrow's electricity production, but the constructions require adaptations to their media. However, there are some problems in the development of the clean energy power generator, such as high cost of construction, difficult maintenance, the power distribution and need to install in specific place etc. Therefore many countries now gradually begin to develop a small power station to improve such flaws.

The warm air in the enclosed space is lighter than cold air, so it goes upward towards roof and gets thrown out in atmosphere through roof ventilators. Then the fresh air enters through the natural vents like windows, doors or any opening and hence space ventilation takes place. There are two rotating principles of the ventilator. The first principle is the hydromechanics that the air current can flow from the high temperature area to the low temperature area to motivate blades to rotate. This air convector can both exhaust and ventilate spontaneously, when the indoor and outdoor temperature is different. The air can flow through the gap of the turbine blades from high temperature side to low temperature side; therefore a spontaneous ventilating phenomenon is formed [1]. In addition, when the turbine wheel revolves, the high temperature air will be discharged from the room, so the air density in the room can be reduced, then the cold air outdoor therefore enters the room to achieve the convection goal. Continuing this may achieve theeffect of ventilation and refrigeration at the same time. The second principle is the air convector. It relies on the breeze air to rotate its blades. Its structure is similar to that of a backward-curved fan [2, 3]. The curving direction of the blades is opposite to the direction of the rotation. For a centrifugal fan, the air flows in from the axial direction, but after pressurization it flows out from the blade's radius direction, which forms a spiral air current from the circumference direction. When a wind direction changes, the air convector does not have to change its structure just because of the change of the wind direction. Therefore, the wind power generation may reduce the design of complexity.Figure 1.1 the working of present roof top ventilators. This technology is popularly installed on the roofs in warehouses, workshops, industrial buildings and even residences. Roof ventilators are free moving. This rotation of the ventilator can be used to produce electricity. This idea can be related with wind turbines which produce electricity using a wind powered electric generator. Similarly, we can use an electric generator coupled to the roof ventilator to produce electricity.

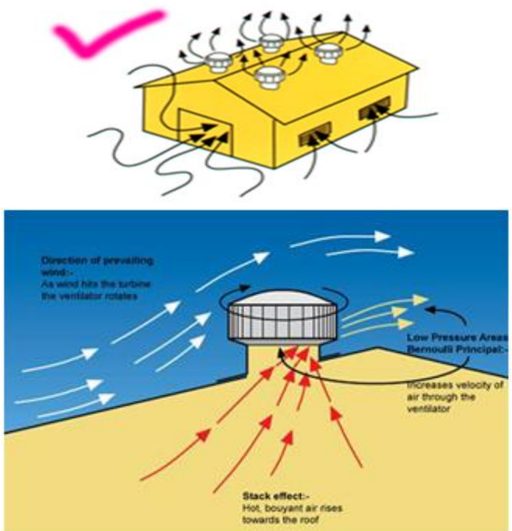


Figure 1.1: Function of Rooftop Ventilator

In the past, some electric generators driven by a roof ventilator have been developed. For example, Daut et al. have reported a new modification of the roof ventilator generator system by adding the extra fins to rooftop ventilator turbine in order to help it to spin faster and more efficiently. In this design, the rubber belting was attached to the moving object of the roof ventilator. The AC generator is connected to the belting area by using a small plastic wheel. When the wind blows on the fins and generates enough drag forces, the roof ventilator will rotate [4]. The plastic wheel of the AC generator and the moving roof ventilator will spin synchronously to generate electricity. However, the rubber belting has to rub against the wheel and will lead to friction that occurs at the belting/wheel interface causing energy loss and is hardly employed. Ming Chun Hsieh developed a small power generation system motivated by a coreless stator AFPM (Axial Flux Permanent Magnet) generator which is driven by the air ventilator. AFPM machines are generally regarded as ideally suited whenever low speed is required, such as in direct-drive applications [6]. Compared with other PM machine topologies, the AFPM designs have higher power densities. For a given magnet material and air-gap flux density, radial flux designs have higher rotor moment of inertia; the active weight of the AFPM machines is smaller. Furthermore the AFPM machines have many unique features. For being permanent magnet, they are usually more efficient. As field excitation losses are eliminated, reducing rotor loses significantly. Machine efficiency is thus greatly improved, and higher power density achieved. Also, AFPM machines have thin magnets, so they are smaller than radial flux counterparts. AFPM machine size and shape are important features in applications where space is limited, so compatibility is crucial. The noise and vibration they produce are less than those of conventional machines. Their air gaps are planar and easily adjustable. Also, direction of main air gap can be varied, so derivation of various discrete topologies is possible. These benefits give AFPM machines advantages over conventional machines in various applications [7]. But proper ventilation doesn't take place with this system as the space available for the air flow is very less.

To overcome these issues for the rooftop ventilator, a small hybrid power generation system was developed which uses stepper motor coupled with roof ventilator using a set of gears with gear ratio 1:5. Solar panel incorporated with solar tracking mechanism based on Real Time Count was placed above the roof ventilator for improving the power generation efficiency of the system.

2. Literature Review

Roof top ventilators has not only been utilized for purpose of ventilation instead scientists have incorporated in generating power using the ventilators.

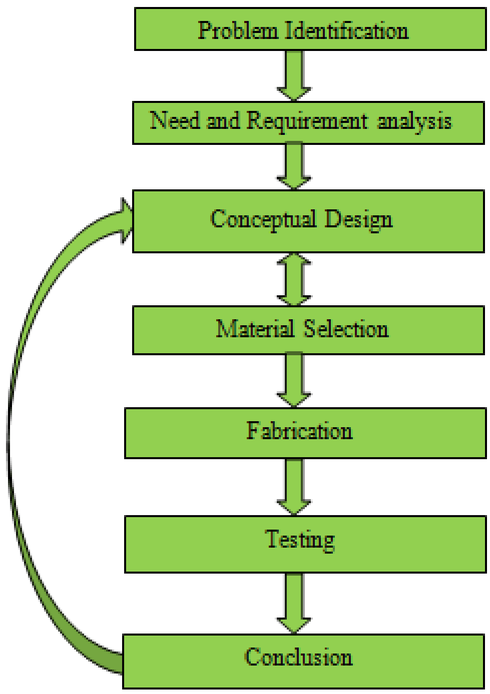
A. 'Electricity Generation Using Rooftop Ventilator' by, *Dr.S.V.Rode, Ganesh Damdhar, ChinmayGadhikar, VipulDhumale, MandarDeshpande, TejasRatnaparkhi, Department of Electronics & Telecommunication Engineering, Amravati University, Amravati, Maharashtra, India*

In Auditoriums, Theatres, work places, etc. there were number of peoples gather together, due to this warm atmosphere gets form. This warm air is lighter than cold air, so it goes upward towards roof and gets thrown out in atmosphere through roof ventilators. This warm air is a natural source provided by human being. The ventilator sucks the warm air in the building and throws it to the outside of the building, then the inside building temperature and humidity are not too high. We can convert this warm air into electrical energy using Rooftop Ventilators. By using this technique we can glow at least 5 watt bulb. This technology is popularly installed on the roofs in warehouses, workshops, industrial buildings and even residences.

B. 'Generation of Electric Power using Turbo Ventilators' *by, Rushikesh Shinde, Vaibhav Lavhale, Ashwin Nair, Shubham Pawar, Ritesh Mahajan, Marathwada Mitra Mandal's Institute of Technology Lohgaon, SPPU, Pune-47, India*

In this world of depleting resources, renewable energy plays an important role. Wind energy is one of the major renewable energy sources. In this paper we intend to study and review various research papers on generating electricity from wind energy using turbo ventilators. This method is economical and feasible by applying various electrical and mechanical techniques. In this paper we also intend to improve the efficiency of the system by using various materials for the fabrication of turbo ventilators. We have reviewed the papers on this topic published by various authors. We have compared their designs and concluded into an efficient model by combining all the designs into one.

3. Methodology



4. Experimental Investigation

The research process of roof ventilator and solar tracking mechanism application for electricity generation are as below.

1. It all started with conceptual design. We prepared two conceptual design where one was an idea of inducing the solar cell in a transparent blade made of composite material. Through research we came to know that photovoltaic cells efficiency will be effected if is installed on a rotating machinery. Further the manufacturing cost for composite blade would cost more and they have less life time. In order to overcome these issues, we decided to place a solar panel above the turbine by incorporating tracking mechanism to it.
2. Prepared the CAD model and analysed the working of the model by simulating it. Once the design was finalized, 2D draft copies were prepared and used for fabricating purpose.

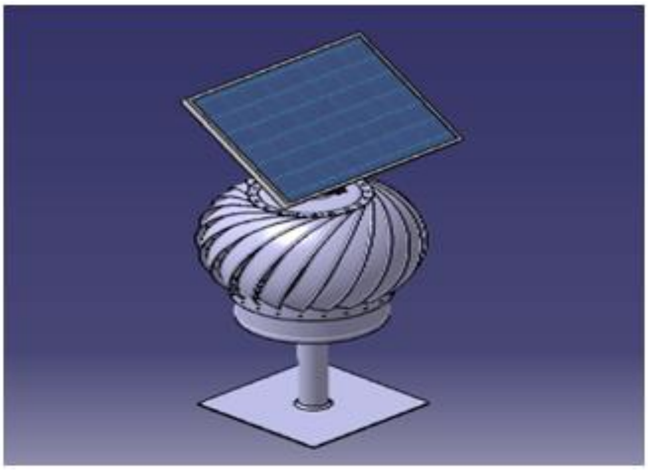


Figure 4.1: Conceptual Design

3. Material selection was done before going to fabrication. The best suited material depending upon the application was selected. Stainless Steel Sheet metal was selected as a blade material as it is high resistance to corrosion, less weight and high strength. Hallow shaft made of stainless steel material was used as a stationary shaft which provide support for both solar panel as well as ventilator.

4. Raw material used for turbine blade will look as shown in Figure 4.2

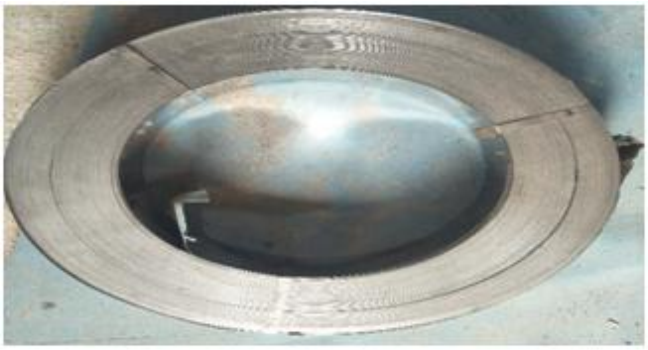


Figure 4.2: Raw Material for Blade

It was brought to required shape using die pressing surface stamping process. Die Pressing tool used is shown in figure 4.3

Figure 4.3: Die Pressing Tool

The shape of blade after die pressing is as shown in figure 4.4

Figure 4.4: Blade after Die Pressing

Groove like structure was created on the blades so that impact of the wind on blades can be increased. This was achieved by passing the die pressed blades through rolling press. The tool used for this operation is shown in figure 4.5

Figure 4.5: Rolling Press Tool

Bearings were place in betweena coupling as shown in figure 4.6 and they were assembled the base of rotating turbine using a metal strip and rivets.

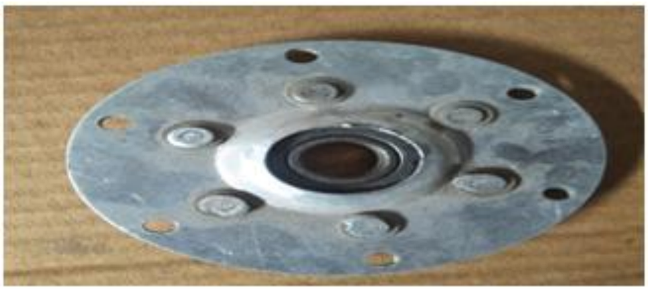


Figure 4.6: Bearing with couples

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Turbine consists of 20 blades and each bladesare joined using rivets. The blades were further joined to the circular plate at top and circular ring at bottom. The rivet and rivet gun used is shown in figure 4.7

Figure 4.7: Rivet (left) and Rivet Gun (right)

Hallow shaft and base of the model is machined according to the designed Draft shown below in figure 4.8. Small grooves are made at a certain dimensions where Circlip is assembled in a groove and it holds the bearing and bearing with couples in return holds the turbine.

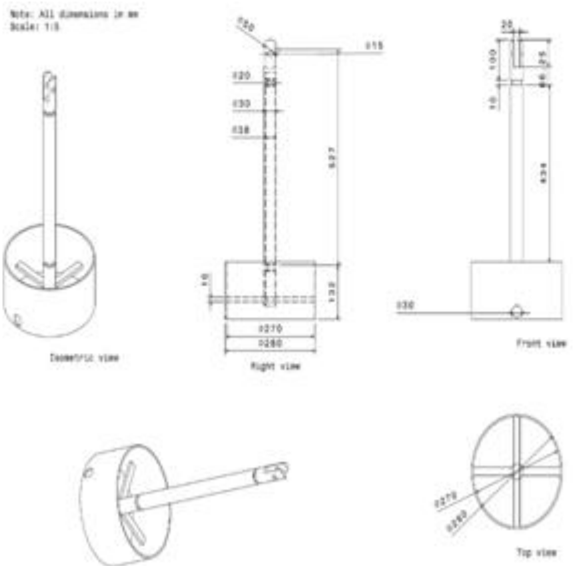


Figure 4.8: Hallow Shaft and Base for Turbine

Gear has been screwed to the couple present at the bottom of the turbine and 1:4 gear ratio has been maintained for power generation through wind energy. Figure 4.9 shows the placement of gear to the turbine. Complete turbine assembly is shown in fig 4.10.

Figure 4.9: Gear Placement

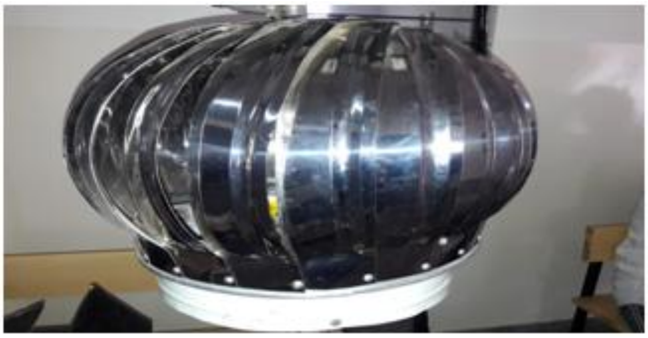


Figure 4.10: Turbine Assembly

5. Electrical Components place a major role in this project. We have used 12v Stepper motor as a generator. For solar tracking actuation we have used 12v Motor driven linear actuator with a stroke length of 90mm. solar tracking mechanism designed is based on Real Time Count (RTC). The circuit board is shown in figure 4.10 and the components used and there functions are as below:-

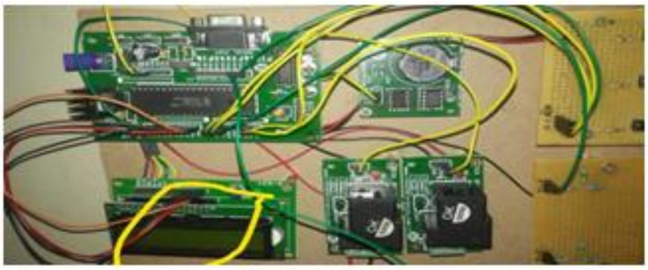


Figure 4.11: Circuit Board

PIC16F877A: The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an LCD display port, 2 comparator, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial peripheral Interface or the 2-wire inter-integrated circuit (I2C) bus and a Universal Asynchronous Receiver Transmitter (USART).These features make it advanced level A/D applications.

DS1307: The DS1307 serial real-time clock (RTC) is a low-power, full binary coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially through an I2C, bidirectional bus. The clock/ calendar provides seconds, minutes, hours, day, month, and year information.

Relay: A relay is a switching device as it works to isolate or change the state of an electric circuit from one state to another.

LCD: A liquid-crystal display is a flat-panel or the other electronically modulated optical device that the light-modulating properties of liquid crystal.LCDs are available to display present words, digits, and seven-segments display.

Motor Driven Linear Actuator: A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor.In motor driven linear actuator the rotation of the motor can be hold at any position with any feedback to it.

6. Software requirements are as follows:-

MPLAB X IDE: The MPLAB X IDE is the new graphical, integrated debugging tool set for all of Microchips' more than 8 bit,16 bit and 32 bit MCUs and digital signal controller,and memory devices.

Programming language: Embedded C Language

Proteus Design Software: The Proteus Design Suite is a software tool suite used for electronic design automation even only software itself the output can be checked by the software and also electronic prints for manufacturing printed circuit boards.

7. Implementation of solar tracking mechanism:-

- Place the solar panel on the shaft of actuator.
- The DS1307 real clock is initial set the data and restarted so the function stats to continues the data we have set.
- Sun rises at east and falls in west. So single axis tracking mechanism could be efficient. The program is done according to RTC. We have used 3-stroke actuation where from 6am-11am 30^0 towards east, 11am-2pm 180^0, 2pm-6pm 30^0 towards west and after 6pm solar panel will be angled to its initial position i.e towards east. Through RTC the controller gets time count and according to the program written, the controller sends the single to actuator through relay at a particular interval of time and actuator performs the required actuation.

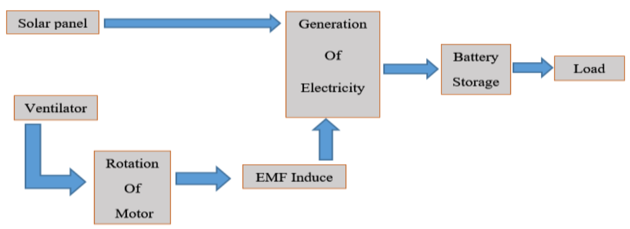


Figure 4.12: Block Diagram of the System

5. Results

The system has been tested at different locations and performance of the system was measured. We observed that the results obtained was practically well enough.

1. The results of roof ventilator with stepper motor comparing to the wind speed stated that the roof ventilator will create the electric voltage at wind speed 0.5 m/s. At the maximum speed at 4 m/s, the roof ventilator can create 4.9 volt of DC voltage. The results of average of DC voltage at the wind speed are shown in Table 1.

Table 1: The average voltage from generator at different levels of wind speed

Wind Speed (m/s)	DC voltage (V)
0.6	0.2
2.1	1.3
2.8	1.8
3.4	3.1
4.5	4.9
5.1	5.7

2. The results of solar panel with and without tracking mechanismiscompared with respect to time (test performed on 21-03-19) and is shown in Chart 1.

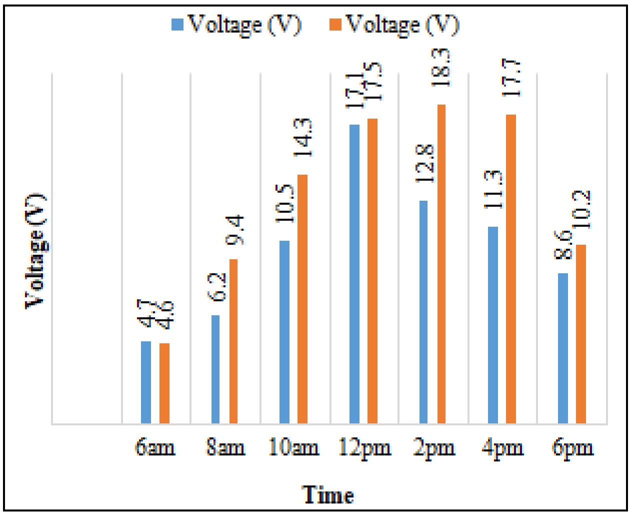
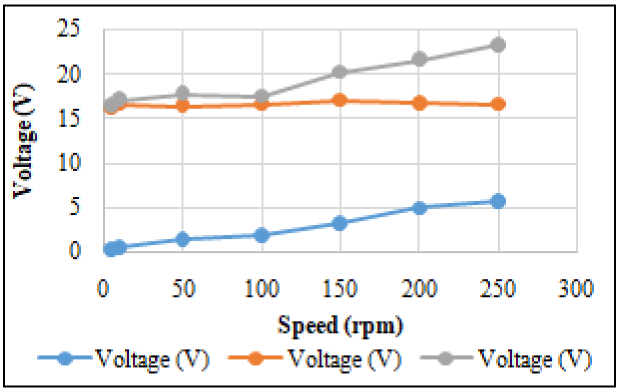


Chart 1: Comparison of voltage generated from solar panel with and without tracking mechanism

3. The voltage generated from wind energy by the system at different turbine rotational speed, voltage generated from solar energy during the test and the output of the system when both voltage generated from wind and solar energy connected in series is shown in Graph 1.



Graph 1: Output Performance of the combined system

6. Conclusion

Present scenario of the power generation needs improvement due to the fact that there is energy crisis which needs some sort of upgrading to be done.We can start of by utilizing the Hybrid ventilator turbine which is able to make use of two different renewable energy resource to generate power and also provide proper ventilation. This systems can bring new wave of ideas. This system was able to provide best output at higher speed and when it's sunny from both the sources as well as provide ideal ventilation. Solar tracking mechanism provides higher efficiency in terms of power generation.The presence of Solar panel did not affect the ventilation, this made the system ideal for the current market trends to be utilized and also can be used as secondary source of power in time of emergency.

Many industry plants/workshops contains roof ventilators in large number. They can be replaced by this hybrid system which provides not only efficient ventilation but also can provide electricity required for lighting the entire plant.

7. Scope of Future Work

The turbine blades can be slightly modified such that the impact area of wind can be increased. This change will increase the rotating speed of the turbine at lower wind speed and provide more effective ventilation.

This system can find its application for powering street lights and road side power generation by replacing the curved blade with straight blades as shown in figure 7.1. Instead of using only turbine we can replace it by hybrid system with straight blades turbine and hence the efficiency can be increased. This system can also be used as small power generating system in remote area and hill stations where conventional power transportation is very difficult.

Figure 7.1: Turbine used for powering street lights

The efficiency of the solar tracking mechanism can be further increased by changing single axis tracking mechanism to double axis tracking mechanism. This can be achieved by slight modification in solar panel frame design and by using another actuator for actuation purpose.

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