ISSN 2395-1621

DESIGN AND DEVELOPMENT OF SMART WIND GENERATOR

Mahesh S. Chaudhari, Vaibhav S. Badgujar, Amol B. Deore, Ashutosh R. Patil,
Mr.S.S. Shingare

mahesh13298@gmail.com, vaibhavbadgujar1997@gmai

Department of Electrical Engineering
All India Shri Shivaji Memorial Society's Institute of Information Technology, Pune, India

ABSTRACT

Fast consumption of the fossil fuels hasraised environmental concern and led to considerable interest in non-conventional sources of energy. Renewable Energy generated through sources such as wind, solar, hydroelectric, geothermal etc is the future of power generation in world. On the other hand, wind energy is available in enormous amount in environment, so there is need to focus on generating the electricity from wind. Our team have put efforts to design a prototype of wind turbine which has air-core generator and an electronic circuit which can control the output of the generator by activating and deactivating the stator coils by sensing the wind speed. This System is more efficient than existing as it does not have the gear box as the conventional wind turbine has, so various losses are reduced. Our Smart Generator can generate the electricity when the velocity of air is as less as 2m/s. Arduino Uno (AVR238) is Used in the circuit with six relays which helps to activate and deactivate the stator coils according to wind speed as the relays are connected to the output of generator. For our generator to generate the electricity a Savonius type of Vertical axis Wind Turbine (VAWT's)is used.

ARTICLE INFO

Article History

Received: 8th March 2020

Received in revised form :

8th March 2020

Accepted: 10th March 2020

Published online :

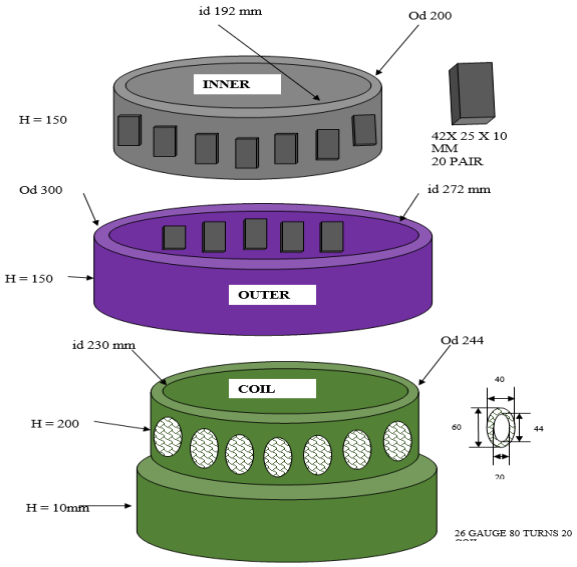
11th March 2020

I. INTRODUCTION

Michal Faraday has discovered that potential difference is generated between the ends of an electrical conductor that moves perpendicular to magnetic field. This is very important discovery done by faraday which has led us to design many electrical equipment that can generate electricity.All countries around the world are using mostly the conventional sources for generation of energy and they arenoxious to environment. Non-conventional energy sources can be utilized efficiently if given proper attention and time to develop machines which can use them to generate energy. Also, it helps to reduce pollution and other detrimentaleffects due to use of the conventional energy sources. In our endeavour to serve environment a prototype is developed by my team which can use wind to generate the electricity and also, a circuit which helps to regulate the output by sensing the wind speed. The Smart Generator can generate electricity even when the velocity of air is as low as 2m/s. This prototype is innovative as it can control the output of the generator when the speed changes which helps to produce electricity even where the velocity of air is very less. The best application of this prototype is to install it in the ventilation of the industries. As the ventilation structure is present on the roof top of industries and which is natural ventilator so this prototype and handle 70% of the light load present in that industry so they Don't have to pay more. Also, as world is slowly turning toward the solar energy but the main drawback of the solar is the disposing of the solar panel which is very challenging task as it produces 300 times more toxic than the conventional energy sources.

II. DESIGN OF SMART GENERATOR

Our teamhasdesigned a prototype of an Air Core Generator in which the atmosphere air will act as the medium to link the flux with the coil of the generator. Also, a circuit is designed that will change output of the generator according wind speed, and it will activate and deactivate the output of the winding according to the speed. The generator has the dual rotor topology and the coil is placed in between them.



III. CALCULATIONS

Calculations of Different parameters of smart wind generator according to theoretical values: - We have considered the average speed of 30rpm of Vertical Axis Wind Turbine (VAWT's)

Here
P = 20 = No of poles
N = 30 = Speed of VAWT's
f = frequency

$$N = \frac{120f}{p}$$

$$f = \frac{N \times p}{120} = \frac{30 \times 20}{120} = 5\text{Hz}$$

f = 5Hz.

Calculation of maximum magnetic Density

$$Bmax = Br * [\frac{Lm}{Lm + \delta}]$$

There are different type of magnetic materials (magnet) available. For our air core generator ferrite is suitable so,
L_m = 10mm = Thickness of permanent magnet
δ = 3mm = Available air gap
B_r = 0.05wb/m² Magnetic Density of Permanent magnet

$B_{max} = 0.05 \{\frac{0.01}{0.01+0.03}\} = 0.0125$ wb/m²

Calculation Of induced flux in air gap

Magnet dimensions = 40mm×25mm×10mm
A= 1000mm² = Area of magnet

$\emptyset = B_{max} \times A$

$\emptyset = 0.05 \times 1 \times 10^{-3}$

$\emptyset$ = 0.125mWeb

Number of Coils in Stator: -
A 12v battery is connected at output side of generator as a load (The battery connected is able to withstand the variable voltage ±2v). So, the expected minimum voltage should be 12v that isavailable at output side. (Voltage value may vary with respect to wind speed)

The maximum voltage condition is considered for below calculations

$$Nc = \frac{Ea}{4.44 \times f \times \delta max}$$

E_a= Output voltage
f = 5Hz = frequency
δmax = 30mm = maximum air gap
N_c = No of coils

$$Nc = \frac{Ea}{4.44 \times f \times \delta max} = Nc = \frac{14}{4.44 \times 5 \times 0.03}$$

N_c = 21 coils

Calculation of Wind Force Against Blades

$F = 0.5\rho V^2 A C_d$

F = wind force against assembly
ρ = 1.2kg/m²= air density
V = 5m/s = velocity of air
A = Expose area (area between blades) = 0.25m²
C_d = 2.2 = coefficient of drag

$F = 0.5 \times 1.2 \times 25 \times 0.25 \times 2.2 = 8.25$

F =8.25N

Calculation of torque

$T = F \times r \sin\theta f$

T = torque on Blade Nm

r = radius o blade (0.05m)

θ = Angle against force

T = 8.25×0.05×1

T = 0.4125 Nm

Calculation of Power

$P = T\omega$

$\omega = \frac{2\pi Nmax}{60} = \frac{2\pi 100}{60} =$

$P = \frac{6.28 \times 100 \times 0.4062}{60} = 4.3175$ Watt

P = 4.2515 watt

Calculation of current

P = VI

$I = \frac{P}{V} = \frac{4.2515}{14} = 0.3541$ amp

I = 0.30amp

IV. COMPONENTS USED IN ASSEMBLY

A.GENERATOR ASSEMBLY: -

1. STATOR: -

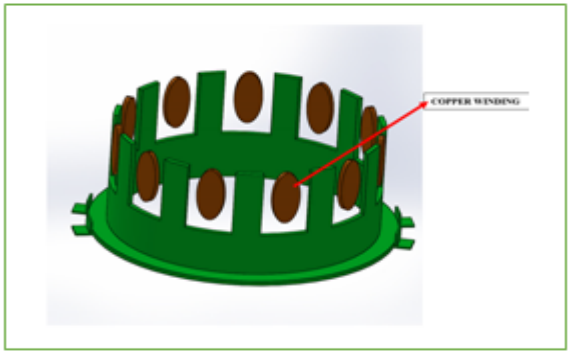


Fig2: - Stator Design

The stator is made up Mild Steel Material which is alloy of (Carbon, Manganese, Silicon). Mild Steel is easily available in all section, cheapest in all Metal, cutting ability, Machinability, grinding ability and the most important weld ability. The stator of our Smart generator has copper coil (Winding) in which the flux gets induced from the magnetic field of generated from the permanent magnet. The stator provides path for flux distribution. Also, the stator aids mechanical support to assembly. In output is obtained from stator

2. ROTOR: -

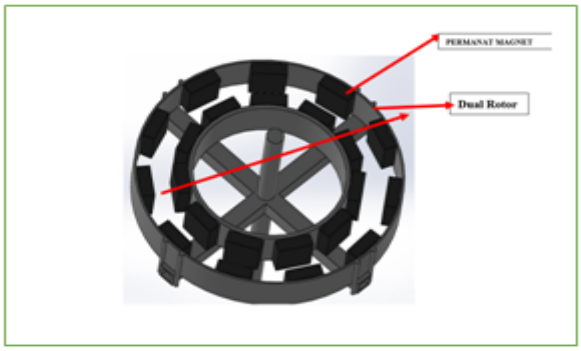


Fig3: - Rotor Design

In the generator dual rotor topology is used that means the there are two rotors and the stator is placed in between them. The assembly of rotor is made up of Mild Steel which is an alloy of (Carbon, Manganese, Silicon). Mild Steel is easily available in all section, cheapest in all Metal, cutting ability, Machinability, grinding ability and the most important weld ability. The Magnets are placed as shown in the figure which are use to link the flux to the stator and the medium that is used to link the flux is air.

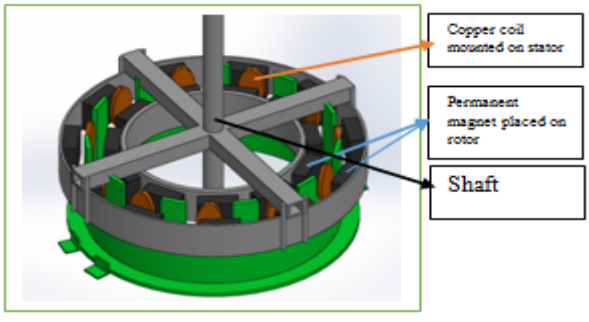


Fig2: - Stator and Rotor Assembled together

3. Permanent Magnet:

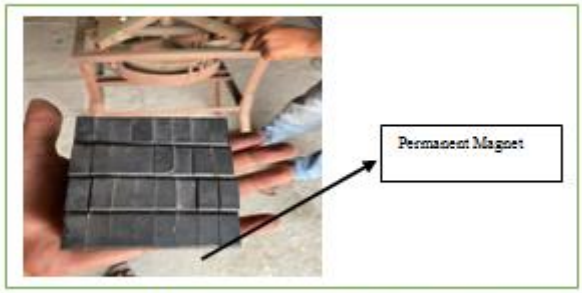


Fig4: - Magnet used in Generator

The dimensions of magnet that used are40x25x10mm. Strontium Ferrite ($SrO.6Fe_2O_3$) magnet which has stronger magnetic property which is efficient than Barium ferrite, 40 pieces of these magnet are used in the rotor.

4. BLADES OF GENERATOR (VATW's): -

PVC is used to make turbine blade because its strength is very good as compared to its weight and also the dimension which are required are readily available in the form of pipe so the pipe is bought and cut into parts so it can be used directly. Savonius rotor type VATW's is utilized. When people visualize of wind turbines, they often imagine the expansive rotors of a horizontal-axis system. A vertical axis wind turbine (VAWT) has blades mounted on the top of the main shaft, rather than in the front like an aircraft rotor

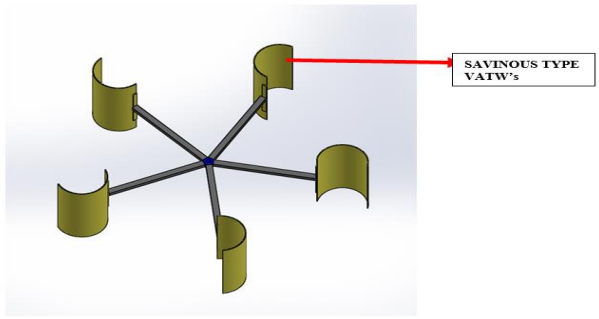


Fig5: - Savonius VAWT's

The generator is usually mounted at the tower base. Here in our Smart generator Savonius rotor is employed as shown in the figure. The material of the axis is the PVC which is very light in weight and is very suitable for our smart generator.

ASSEMBLED GENERATOR: -

The inner and the outer rotor are attached to the same shaft. A wind turbine will be the prime mover. The prime mover rotates the inner and the outer rotor. Alternating poles in double rows are present on the rotor and the stator is in between the rotor. As a result of the resulting motion between the conductors and the magnetic field an emf is generated in the winding according to the faraday's laws. The terminals from each coil in the generator can be brought out either to form a series or a parallel connection.

Hence the emf produced by the generator is the resultant of the series or the parallel connection as per required voltage. The stator in the assembly provides path for flux distribution. Also, the stator aids mechanical support to assembly and output is obtained from stator. Mild Steel is easily available in all section, cheapest in all Metal, cutting ability, Machinability, grinding ability and the most important weld ability, so that's why mild steel is our generator.

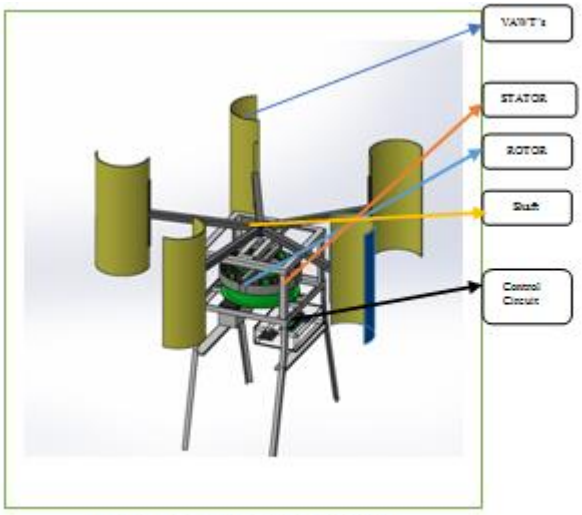


Fig6: - Generator Assembled

B. CIRCUIT DIAGRAM: -

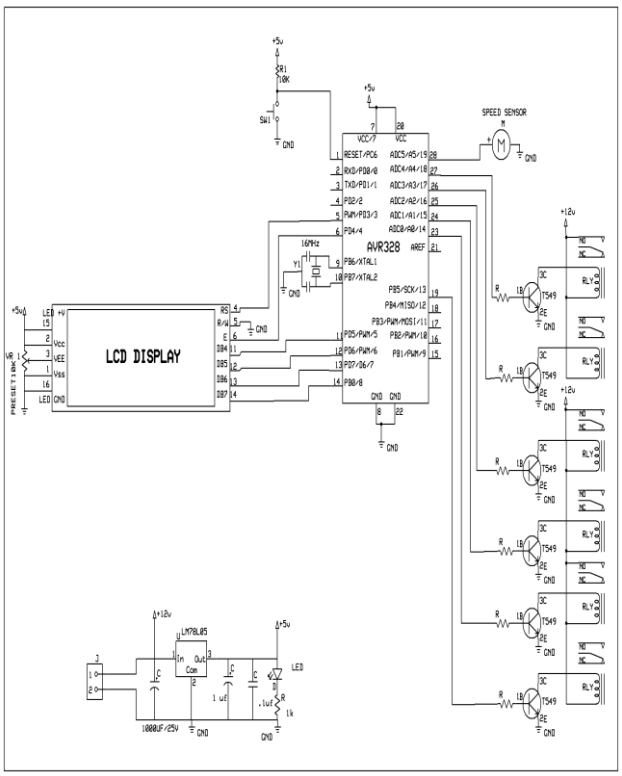


Fig7: - Circuit Diagram of Control Circuit

The circuit that has been designed has an LCD display 10x2, Arduino Uno (AVR238), 6 relays, Power supply 12v to 4 v, Battery 12v, Connectors, Anemometer (wind speed sensor), Diode (as required), Cables (as required).

The circuit diagram shown also has a motor which detects the wind speed and according to the wind speed the windings of the generator are activated and deactivated so that the output of the generator varies according to the wind speed. The output is only taken from the windings that are activated. The activation and deactivation of the windings is done by the 6 relays that are present in the circuit. This is some innovation done in the generator so that it can be installed in any region in India when the speed of the wind is less than 5m/s.

The circuit that is shown at the bottom in the fig is connected with the relay circuit to work properly. LM78L05 voltage regulator with 5v fixed and 3-terminal is utilized and it delivers the output current of 100mA with internal limiting and thermal shutdown features.

V. CONCLUSION

It is a renewable source of energy and wind is available free of cost. The smart generator id design for long term of power resource. It can create long-term jobs due to new innovations and technologies. Reduction in air pollution, focus on harnessing clean energy. The design generator reduces dependency on foreign energy sources. Reductions in peak power prices for electricity. Another application of the smart generator is that it canbe install it in the ventilation fan that are present on the roof top of the industries.

REFERENCES

[1] Abrahamsen AB, MijatovicN, SeilerE, Trholt C,Norgard P, Pedersen N, Andersen N and Ostergard J 2010Supercond Sci. Technol. 23 034019

[2] Wind in power 2015 European statistics EWEA

[3] Abrahamsen AB, Jensen B, Seiler E, Mijatovic N, Rodriguez-Zermeno V M, Andersen N H and OstergardJ 2011 Physic C: Superconductivity 471 1464

[4] Song X, Liu D, Polinder H, Mijatovic N, Holboll J, and Jensen BB 2017 IEEE Trans. Appl. Supercon. 275201505

[5] Song X, Mijatovic N, Kellers J, Buhrer C, Rebsdorf A V, Hansen J, Christensen M, Krause J, Putz H, Wiezoreck J, and Holboll J 2017 IEEE Trans. Appl. Supercon. 27 5201205

[6] Liu D, Polinder H, Abrahamsen A B, Ferreira J A 2017 IEEE Trans. Appl. Supercon. 27 5202007

[7] Haran K S, Loder D C, Deppen T O and Zheng L 2016 IEEE Trans. Appl. Supercond 26 5202508

[8] Loder D C, Haran K S 2015 IEEE Electric Machines and Drives Conference 1709

[9] Fair R et al 2012 Superconductivity for large-scale wind turbines (Online Electronic Materials)

