ISSN:2348-2079

Volume-7 Issue-2

International Journal of Intellectual Advancements and Research in Engineering Computations

Design and analysis of modified savonius rotor

V. N. Loganathan[1], D. Arulkumar[2], S. Gnanasekar[2], C. Gokul[2], M. Gokulraj[2]

[1]Associate Professor, Department of Mechanical Engineering

[2] UG Students, Department of Mechanical Engineering

Nandha Engineering College, Erode- 52, Tamil Nadu, India.

ABSTRACT

Using fossil fuels and nuclear fuels for energy generation produces co2 and are all non-renewable sources, to overcome this we are using renewable sources such as solar, wind, etc., for energy generation. Energy is generated by wind in two methods of using Horizontal and Vertical axis wind turbines. Example: Windmill and Savonius rotor. Normally, the Savonius rotor produces less energy. The changing of design in the Savonius rotor with additional things generates higher power than normal. Thus, the efficiency is increased.

Index words: Savonius Rotor, Blades, Battery, Alternator.

INTRODUCTION

Wind energy is one of the renewable sources which can be renewable again and again. Wind energy is used to produce electricity. It has two methods, one method is a vertical axis wind turbine and the other is a horizontal axis wind turbine. Horizontal axis wind turbine is used in a windmill and Vertical axis wind turbine is used in rotors. Windmills are high cost, larger construction and are used for domestic purposes. Savonius rotors are used for basic and personal purposes. Also, it requires less space and simple in construction. There are different blades of the rotor of different designs and dimensions. On due to the purpose and other properties the blade can be chosen. But, there is always less efficiency of the rotor. There are various research and experiments going on around the world to improve the efficiency of the rotor. By changing the previous and existing design the efficiency can be improved. A slight or larger modification to the rotor can improve the efficiency, it is showed by analyzing the design of previous and modified design of the rotor.

LIST OF COMPONENTS

- Ball bearing
- Steel shaft
- Coil spring
- Savonius blades

Ball Bearing

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads.

Steel Shaft

A shaft is a rotating machine element, usually circular in cross-section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as pulleys and gears are mounted on it.

Savonius Blades

Attributive Designating a rotor or turbine consisting of two opposed hollow semi-cylindrical

Author for correspondence:
Department of Mechanical Engineering, Nandha Engineering College, Erode- 52, Tamil Nadu, India

blades typically mounted on a vertical shaft, and now used in various forms to measure the speed of air and water currents and in some wind turbines.

Coil spring

A coil spring, also known as a helical spring, is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded.

Permanent Magnet Alternator

A Permanent Magnet Alternator is an Alternator that uses moving permanent magnets instead of Electromagnets to induce a current in coils of wire. Permanent Magnet Alternators work well in Wind Generators and Wind Turbines because the wind turbine blades easily attach to spin the generator and produce electricity.

LITERATURE REVIEW

In the Journal [1] they referred about the Savonius rotor with two different ways such as conducting experiments with and without shafts in an open jet wind tunnel. Those tests are conducted and measured for both the types of shafts such as the coefficient of power, coefficient of static torque and static torque. Unless both types the helical Savonius rotor without shaft get compared with conventional type Savonius rotor. On the end of the experiments, the result clearly explains the rotor without shaft has a higher coefficient of power than the rotor with a shaft. According to these results, the Savonius rotor without shaft with overlap ratio 0 has the same coefficient of power when compared with the conventional Savonius rotor.

In the Journal [2] they referred about a different type of experiment that is conducted with the combined form of Savonius and Darrieus type vertical axis wind turbine for testing its advantage over the individual of both rotor system. Design and fabrication are carried out with the simple Savonius rotor and the combined Savonius-Darrieus type rotor system. Experiments are conducted with these types such as three bucket Savonius rotor and three bladed Darrieus rotor on the different zone namely subsonic wind tunnel. The Savonius rotor has the overlap ratio variations though the other one had not considered on it. Investigations had conducted which shows that by increasing the overlap ratio of the rotor had decreased the power coefficient. Thus they resulted that the overall efficiency of the combined rotor without overlap ratio condition is higher than the efficiency of the Savonius rotor without overlap ratio condition.

In the Journal [3] they referred about various Savonius rotor configurations and made several tests on them at different wind speeds in the wind tunnel. Those are the variables that determine the rotors performance which are aspect ratio, overlap, gap and the effect of adding some extrusions. The aspect ratio also determines the efficiency as without any further addition in low aspect ratio results in low efficiency in energy generation, so increasing the aspect ratio of the rotor system with optimum blade configuration and shielding results in higher efficiency. They also conducted experiments on three and four-bladed rotors where they reflected as low efficiency on power production.

In the Journal [4] they referred about the semicircular blades and three bladed twisted rotor system and made tests on it at low speed and compared the results on performance with semicircular blades. There are many characteristics are taken on the performance analysis which are the major criteria on energy generation such as static torque, rotational speed etc., while comparing both rotor system three bladed twisted rotor has a advantage on self starting characteristics but it is improved by increasing the twist angle of blade because the semicircular blades has zero twist angles. So by increasing the twist angle of the three-bladed twisted rotor the performance of the Savonius rotor gets increased. Twist angles also describe a segment about increasing the twist angle will lead to low wind velocity.

In the Journal [5] they referred about the three stages Savonius rotor and conducted tests in the wind tunnel experiments. So they had increased the characteristics of the rotor by decreasing the torque variation of the Savonius rotor. They aimed

to make a smooth rotation on three stage rotor on each revolution when compared to single stage Savonius rotor on one rotation. They also used guide vanes to measure the torque characteristics in three stage Savonius rotor. On these measures, they spotted ha the guide vanes increased the torque coefficient at low tip speed ratio but it is decreased at the high tip speed ratio. At last, their three stage rotor needs to improve its aspect ratio on its every stage and also they proved that the three-stage rotor with guide vanes had better torque characteristics than the single stage Savonius rotor.

In the Journal [6] they referred about the design and performance of Savonius wind turbine. The only reason is the world's energy transition is because of the development of the wind energy system, which reduces the production of CO2 due to the reduction of fossil fuels. In this type of energy generation using the Savonius rotor, there is a simple design that favors independent wind direction but faces major issues such as low efficiency and high negative torque. So they planned to make a new design of the Savonius rotor instead of the existing one to increase the performance characteristics by their review. Power coefficient value differs from the type of the rotors they prefer in such cases they noted that conventional Savonius rotor ranges from 0.1-0.25. So they installed a new set of different components that had achieved an improvement in the coefficient range of 27.3% when compared to conventional type Savonius rotor. At last, their review had resulted that the installation of the Savonius rotor with a different set of new components would cause major drawbacks in rotor efficiency and made their system complex.

Summary of literature review

- Various tests are conducted on Savonius rotor including rotor with and without shaft.
- Combination of different rotor system and single rotor system with and without considering overlap ratio.
- Increment of aspect ratio in Savonius rotor had lead to performance raise for energy generation.
- Based on the twist angle, performance of the three bladed Savonius rotor has increased.
- With guide vanes on three sage Savonius rotor tests conducted for performance improvement.
- Environmental development and reduction of harmful gases, Savonius wind turbines design characteristics had been changed to increased the performance.

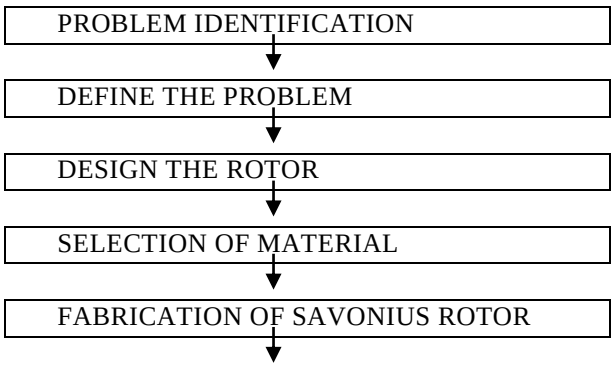
PROBLEM IDENTIFICATION

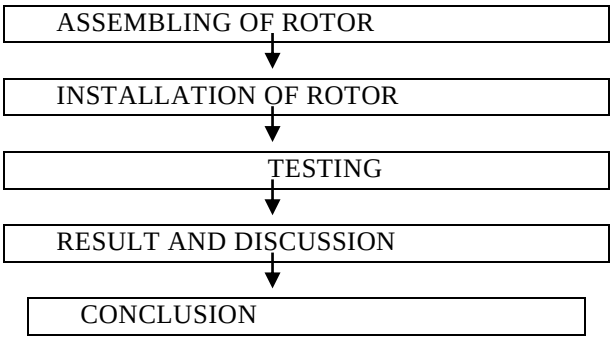
We have identified the several problems which can make normal Savonius rotor as an efficient less model. There are several problems are identified and experiments have done for the problems.

In our project, we have designed a new Savonius rotor model which is suitable to eliminate the major three problems are,

- Power loss due to vibration
- Low Performance
- Blade Damage in the High wind flow

METHODOLOGY





DESIGN AND ANALYSIS

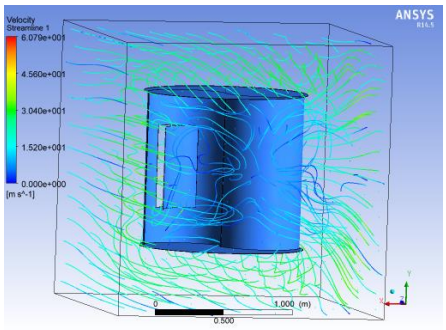


Fig. 1 Design of modified Savonius Rotor

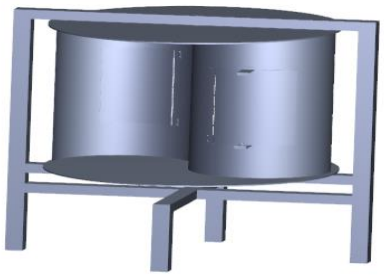


Fig. 2 Inlet velocity flow of air

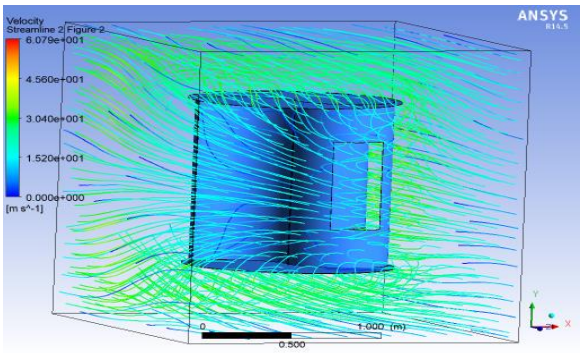


Fig. 3 Velocity flow while passing

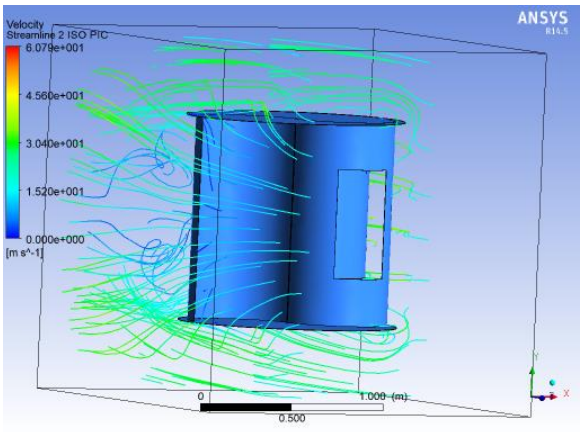


Fig. 4 Outlet velocity flow of air

Table.1 Mesh information for Air flow

Domain	Nodes	Elements	Tetrahedra	Wedges	Pyramids	Polyhedra	Hexahedra
Cavity 1	433949	2052266	2052266	0	0	0	0

WORKING PRINCIPLE

Savonius rotors which are aerodynamically drag-type devices, consisting of two blades. The Savonius wind turbine works due to the difference in forces exert on each blade. The lower blade (the concave half to the wind direction) caught the air wind and forces the blade to rotate around its central vertical shaft. Whereas, the upper blade (the convex half to wind direction) hits the blade and causes the air wind to be deflected sideway around it.

In an aerodynamic platform of the Savonius rotor there is a door step created to eliminate the vibrations in the blades in order to increase the performance of the rotor to obtain more power on rotation. A spring is connected to the doors which get connected on the blades to controls the door to open and close according to the direction of wind. These cycle of opening and closing repeats again and again which might decreases the vibration on blades while rotation in order to increase the performance of the Savonius rotor.

EXPERIMENTAL SETUP

The various parts are assembled to make the Savonius rotor. The Frame of the rotor is first to fix on the base. The curvature design of the blade is next fixed on the frame. The hinges are used to join the door on the blade. The one side hinges are fixed on the door by using bolt and nut. The other is fixed to the blade by the welding process.

CONCLUSION

The Savonius rotor has increased the performance of power generation by the modified turbine blades with cut slot of compartment. Although it may used to generate energy by wind it can be replaced with Horizontal axis wind turbines. This test attempt is conducted to resolve the power loss by rotor vibrations and similar ones. Thus the modified Savonius rotor which provides the more efficiency as compared to normal Savonius rotor by eliminating the vibration of blades.

REFERENCES

[1]. Jorge Manual Mercado - Colmenero, Miguel Angel Rubio-Paramio, “A numerical and experimental study of a new Savonius wind rotor adaption based on product design requirements", Energy conversion and management, 158, 2018, 210-234.

[2]. M. Zemamou, M. Aggour, “Review of Savonius wind turbine design and performance", Energy, 141, 2017, 383-388.
[3]. R. D. Maldonado, E. Huerta, “Design, simulation, and construction of a Savonius wind rotor for subsidized houses in Mexico”, Energy, 57, 2014, 691-697.
[4]. Rajen Pudur, Sarsing Gao, “Savonius rotor based grid connected hydrokinetic power generation scheme”, Sustainable Energy, 5, 20165, 148-155.
[5]. Renato Ricci, Roberto Romagnoli, “Experimental study on a Savonius wind rotor for street lighting systems", Applied Energy, 161, 2016, 143-152.
[6]. Sobhi Frikha, Zied Driss, “Numerical and Experimental characterization of multi-stage Savonius rotors", Energy, 114, 2016, 382-404.