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Experimental Study on the Cluster of Savonius Wind Turbine Models

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Abstract—*In this experimental work six models of savonius wind turbines had been fabricated , and kept before the wind coming out from a blower for the purpose of getting mechanical or rotational power. The wind velocities are varied from 17.5m/s , 19.5m/s and to 21.5m/s. Five models are kept in an inclined manner i.e. the five models are not kept in an straight line not one after another along the direction of flow rather than Savonius wind turbine models are kept in an inclined manner before the direction of air velocity in an area of 2.0m*0.9m ,in second case the six models are kept along the circumference of a circle , (but not two wind turbines are kept just one behind other , rather than position co-ordinates are slightly changed.) in area of 1.4m*0.8m. It has been observed that when VAWT models are kept in an inclined manner before the direction of flow the rotational speed (hence power) obtained by all the models is 3160 rpm when there is no overlap, 3840 rpm when the overlap is 1.8 cm , 3440 rpm when the overlap is 2.5 cm , 3210 rpm when the overlap is 3.2 cm. Models are kept in area of 2m*0.9m.Similarly when the wind turbine models are kept along the periphery of a circle in an area of 1.4m*0.8m , it is observed that total rpm (hence power) obtained is 3880 rpm, 4320rpm when the overlap is 1.8cm rpm , 4160 rpm when the overlap is 2.5 cm, 4315 rpm when the overlap is 3.2 cm. When the Savonius wind turbine models are kept just behind one-another the rotational power obtained is very less due to wake effect and are of keeping wind turbine models are more. The above rpm is obtained for a wind velocity of 17.5m/s. Finally , it is observed that when Savonius wind turbine models are kept along the perimeter of circle before the direction of wind velocity ,it is observed that power obtained is more , and the cost of area is less. This type of research work is very useful in making wind farm for the benefit of rural people of India.*

1. INTRODUCTION

Savonius wind turbines are mostly drag type vertical axis wind turbine. Since Savonius wind rotors are used in irrigation and electricity generation , therefore much study is needed for the construction of wind farm in a particular area.

By keeping this in mind the experimental model study of a cluster of savonius wind turbines is done.

2. REVIEW ON SAVONIUS ROTOR

Savonius rotor is given by the Finnish engineer Savonius [1] in 1931is a kind of drag type vertical axis wind turbine .The rotor was made by cutting Flettner's cylinder from top to bottom , and then guiding the two semi cylindrical surfaces sideways along the cutting plane so that the cross section resembled the letter 'S'. Different types of 30 models of S-rotor tested by Savonius in front of wind tunnel and natural wind. After a rigorous study he reported that the best model gave a maximum efficiency of 31% whereas the prototype gave efficiency of 37%. After Savonius , Bach [2]made some investigation of the Savonius rotor and related machine in 1931 and observed highest efficiencywas 24%. Following them McPherson [3], Newman [4], Modi [5] had studied savonius rotor and reported maximum power coefficients of33%, 20% and 22% respectively.Ushiyamaet al. [6],Mojola [7],Sivasegaram [8] had also studied the savonius rotor and reported that power coefficient varies from 20% to 25%. This lower range of power coefficient is nothing because of low rotational speed of the savonius rotor blades comparable that of the horizontal axis wind turbine.

Blackwell [9] in 1978 has done studied on savonius rotors and he studied the performances of fifteen model configuration of two and three – bucket savonius rotor in wind tunnel conditions. The study was done both on the variation of torque and power coefficientas afunction of tip speed ratio for different overlap conditions and Reynolds number of flow. The maximum C_p obtained as 0.27 for two bucket S-rotor at an overlap of 10%for tip speed ratio of 1.0and Reynolds number of $4.33x10^5$, while the maximum C_t was 0.45 at tip-speed ratio of 0.4 for some other conditions. For three bucket s-rotor the maximum C_p was obtained 0.18 at an overlap of 10%for TSR of o.8 and having similar Reynolds number. And maximum C_t was obtained at0.35 at TSR of 0.3 for another condition so it is found that maximum obtained at lower value of overlap ratio.

Baird [10]1983 has improved the various performance parameter of savonius rotor by using a specially designed clutch between the turbine and water pump.Which is not only improved the power coefficient from 0.19 to 0.23 but also overcomes the high starting torque of the pump.

Sivasegaram[8] in1979 studied on augmentation of power in savonius type wind rotor by using a symmetrical straight

walled concentrator on the upstream of savonius rotor. He observer the effects of straight walled concentrator with different duct angles on the rotor performances and he observed a maximum C_p of about 0.21 and maximum C_t of 0.31 with a duct angle of 40 degree the power augmentation was by a factor of 1.5 he also suggested that wider duct angle gave better augmentation than that of narrow angles and comparable sizes.

savonius rotor affected its performance. Savonius rotor performance is affected by operational condition geometrical and air flow parameters. The range of operated value for maximum averaged power coefficient includes value around 0.05 to 0.30 for most settings. Performance gains if up to 50% of TSR of maximum averaged power coefficient are reported with the use of stators.

2.3 Objectives of the present study

As per the literature present above, it is clear that very few works had been done to study the effects of numbers of blade, overlap and different array on the performance of savonius VAWTs. Considering all these, the following objectives are set in the present study:

(1) To design and fabricate two-bladed Savonius wind turbine models with no overlap and different overlap.

(2) To design and fabricate three-bladed Savonius wind tubine models with no overlap and different overlap.

(3) To design and study the two different array arrangements of cluster of wind turbines and study the power output for two different orientations of wind turbines placed in an specified area.

Fabrication and Experimental Set-up :

In this experimental work five models of savonius wind turbines had been fabricated , and kept before the wind coming out from a blower for the purpose of getting mechanical or rotational power. The wind velocities are varied from 17.5m/s , 19.5m/s and to 21.5m/s.

Fig. 1: When the wind turbine models are kept in an inclined manner to the direction of wind flow coming from the blower.

Five models are kept in an inclined manner i.e. the five models are not kept in an straight line not one after another along the direction of flow rather than Savonius wind turbine models are kept in an inclined manner before the direction of air velocity in an area of 2.0m*0.9m as shown in **(Fig. 1)** , in second case the five models are kept along the circumference of a circle , (but not two wind turbines are kept just one behind other , rather than position co-ordinates are slightly changed.) in area of 1.4m*0.8m **(Fig. 2).**

Fig. 2: When the wind turbine models are kept along the periphery of a circle in front of blower.

3. CONCLUSIONS

It has been concluded that when VAWT models are kept in an inclined manner before the direction of flow the rotational speed (hence power) obtained by all the models is 3160 rpm when there is no overlap, 3840 rpm when the overlap is 1.8 cm , 3440 rpm when the overlap is 2.5 cm , 3210 rpm when the overlap is 3.2 cm. Models are kept in area of 2m*0.9m. Similarly when the wind turbine models are kept along the periphery of a circle in an area of 1.4m*0.8m , it is observed that total rpm (hence power) obtained is 3880 rpm, 4320rpm when the overlap is 1.8cm rpm , 4160 rpm when the overlap is 2.5 cm, 4315 rpm when the overlap is 3.2 cm. When the Savonius wind turbine models are kept just behind one-another the rotational power obtained is very less due to wake effect and area of keeping wind turbine models are more. The above rpm is obtained for a wind velocity of 17.5m/s. Finally , it is observed that when Savonius wind turbine models are kept along the perimeter of circle before the direction of wind velocity ,it is observed that power obtained is more , and the cost of area is less.

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