Small Scale Power Generation in Remote Rural-areas

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ABSTRACT

Since due to global warming and pollution whole world is now looking for renewable source of energy because non-renewable source of energy like coal, petroleum products, natural gas etc is very limited in amount and also there excessive use cause air pollution. The interest in alternative energy source has increased in the recent past. One of the best renewable source of energy is wind energy because wind is present everywhere. The only problem in using wind energy is the wind velocity, which varies appreciably with season and place to place. The solution lies with the proper and economical design of a windmill, which can be used in a small-scale capacity at low velocity in rural areas. The main purpose of this paper is to emphasize the need of development of Savonius rotor and discuss its various design aspects.

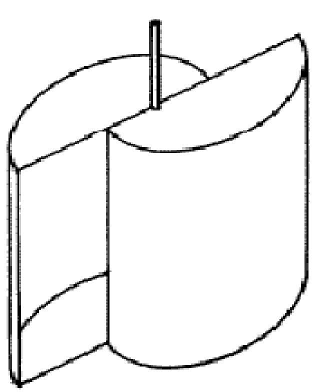
Keywords: *Wind energy, Windmill, Savonius rotor.*

Introduction

Wind energy can be utilized to wind mill, which in term drive a generator to produce electricity. During 1930-50, many wind generators were built for generating electricity in India. Few designs were developed but could not sustain because of variable wind velocity. Apart from coastal area, the wind velocity is relatively low and varies appreciably with the season. This low velocity and seasonal winds imply a high cost of exploitation of wind energy. A unit of wind energy derived from a windmill will be several times more expensive than energy derived from electrical distribution. This argument does not hold well in rural areas because electricity is not available in many remote rural areas due to high cost of generation and distribution to small-dispersed users and also there is a possibility of reducing the cost of windmills if proper design is developed. One of these economical, simple and low maintenance designs is Savonius rotor.

Description

Savonius wind turbines are a type of vertical-axis wind turbine (VAWT) whose axis of rotation is perpendicular to both, the surface of earth and wind stream, used for converting the power of the wind into torque on a rotating shaft. They were invented by the Finnish engineer Sigurd J. Savonius in 1922. Savonius rotor cannot generally compete with other types of wind turbines so far efficiency is concerned, but it has several compensating factors. Its main advantages are that it has better starting torque, independent of wind direction, simple structure and easy fabrication when compared to similar types of windmills. This makes it a suitable system for small-scale applications in wind energy conservation in remote rural regions. The Savonius rotor consists of a hollow cylinder sliced in half vertically. The two halves are fixed to a vertical axis with appropriate gap in between. The two halves are mounted in S manner as shown in figure. This S-rotor can have various shapes depending on the average power needs and wind resources. For commercial designing usually oil drum is taken and cut in two halves. The S-rotor is connected to vertical shaft, which is mounted on bearings. The power output can be directly taken from the vertical shaft.



Method and Calculation

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two or three scoops. Looking down on the rotor from above, a two-scoop machine would look like an "S" shape in cross section. Because of the curvature, the scoops experience less drag when moving against the wind than when moving with the wind. The differential drag causes the Savonius turbine to spin. Because they are drag-type devices, Savonius turbines extract much less of the wind's power than other similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor is near the ground, making the overall energy extraction less effective due to lower wind speed at lower heights as shown in figure.

Principles of wind energy conversion (WECS)

Power available in the wind is proportional to the wind speed cubed and the general formula for power in the wind is:-

$$\mathbf{P_a = \rho A V^3 / 2}$$

Where P_a is the power available in watts, ρ is the density of the air which is approximately 1.25Kg/m^3 at sea level, A is the cross section of air flow and V is the instantaneous free stream wind velocity. But we cannot extract all the available wind energy (P_a). The general expression for extractable power is given by

$$\mathbf{P_e = C_p \rho A V^3 / 2}$$

Where C_p is power coefficient and generally taken as 0.593. We can also write power coefficient

$$\mathbf{C_p = 2P_e / \rho A V^3}$$

Which is also called windmill efficiency. The torque coefficient is defined as

$$\mathbf{C_t = 2T / \rho A V^3}$$

Where T is the actual torque at wind speed V for a rotor with configuration radius R. The speed is also conventionally expressed non-dimensionally as "Tip Speed Ratio λ". This is defined as the ratio of the windmill rotor tip at radius R when rotating at ω rad/sec to the speed of the wind V m/sec and mathematically expressed as

$$\mathbf{\lambda = \omega R / V}$$

Result and Discussion

When the wind rotor is stationary, its tip speed ration is zero, and the rotor is stalled. This occurs when the torque produced by the wind below the level needed to overcome resistance of the load. $\lambda = 1$, means the blade tips are moving with the same speed as the wind and $\lambda = 2$, implies that the tips are moving at twice the speed of the wind and so on. It has been found through experiment that by overlapping of blades, rotor produces three times more power output than that of simple S-rotor. M. D. Huda observed that with the use of the deflecting plate placed in the retreating side of the blade, the C_p increases by about 20% in comparison with rotor without deflectors.

Conclusion

In the rural and remote areas, where the supply of electricity is not possible, S-rotor may be used for domestic power generation. The beauty of Savonius windmill is that they can also be coupled into a hybrid system to alternate between electricity generation and water pumping. This is very important, because it further enhance the energy resource of the rural areas. Moreover, the ease of construction and design modification means that the system is well suited for technological transfer for rural based community groups and organization working in this region.

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