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Optimized spacing design for paired counter-rotating Savonius rotors

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Abstract: Two-dimensional CFD models with paired counter-rotating Savonius rotors are applied to investigated how the power coefficient to be promoted. Results show that such configuration can improve the power efficiency up to about 50% in average as the rotor spacing ratio is about 0.6.

Keywords: Paired Savonius rotors, Computation Fluid Dynamics (CFD), Output power curve, spacing of rotors

1. Introduction

Many of large size horizontal axis wind turbines (HAWTs) can obtain the power coefficient up to 0.5. But such kind of HAWTs are not able to be applied to community, factory, hospital, or remote residence. The other type wind turbines, vertical axis wind turbines (VAWTs), may be more suitable for the above regions since they have some advantages such as lower noise, lower maintenance cost.

Some studies [1~4] had adopted methods with counter-rotating arrangement to promote the power coefficient of Darrieus wind turbines, one of VAWTs. In this study, a similar arrangement was applied to Savonius turbines, also one of VAWTs. We construct two-dimensional models of paired counter-rotating Savonius rotors with different spacing lengths. Each rotor is constructed with two semi-circle blades with height 200cm, diameter 50cm and blades overlap 7.5cm.The output power curve of paired rotors with different rotating speed are simulated using computational fluid dynamics (CFD) method for wind speeds with 15m/s, 11m/s and 7m/s.

2. Results and Discussion

Fig. 1 is the power coefficient (*Cp*) variation with tip speed ratio (*TSR*) for paired counter-rotating Savonius rotors with wind speed 15m/s. The lowest line is the output of two stand-alone Sarvonius rotors for comparing. It shows that the *TSP* of maximum *Cp* increase to about 1.08 form 0.95 and maximum *Cp* reaches to 0.31 form 0.21. To check how much enhancement of *Cp* under different wind speed, we compared the ratio of maximum power of paired rotors with two stand-alone rotors with different spacing length under different wind speeds. The result, shown as Fig. 2, indicates the enhancement effect almost independents on the wind speeds. All three curves also show the enhancement approach to a saturation value about 1.5.

Cases for paired rotors with spacing ratio less than 0.5 may cause two-dimensional model results not inaccurate since the flow may turn to move along two top sides not be enforced to pass through the narrow channel. Further three-dimensional simulations or wind tunnel experiments are needed for such extreme cases study.

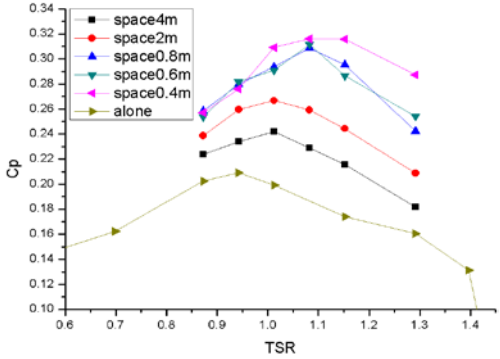

Fig. 1. The power coefficient *(Cp)* variation with tip speed ratio *(TSR)* for paired rotors with wind speed 15m/s.

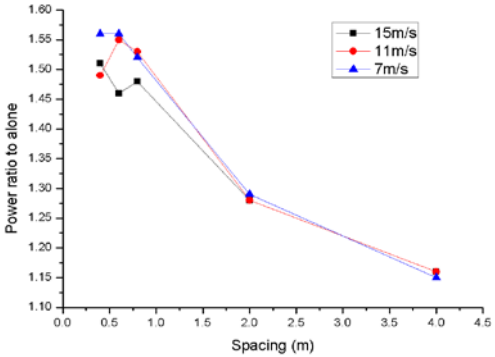

Fig. 2. The ratio of maximum power of paired rotors cpmpared with two stand-alone rotors with different spacing length under different wind speeds.

3. Concluding Remarks

Simulation results show that the smaller spacing of paired rotors and the more output power. It confirmed that the configuration of paired counter-rotating Savonius rotors can improve the power efficiency up to about 50% in average. It also shows that the optimized rotor spacing ratio (a ratio of the spacing to the rotor diameter) is about 0.6.

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