

Numerical simulation for characteristic analysis of vertical axis wind turbine

Dan Yao¹⁾, Anna Kuwana¹⁾ and Haruo Kobayashi¹⁾

¹⁾ Division of Electronics and Informatics, Faculty of Engineering and Science, Gunma University
 1-5-1 Tenjin-cho, Kiryu 376-8515, Japan
t171d087@gunma-u.ac.jp

Offshore wind power generation is attracting attention as a new energy source in Japan. In the current situation of offshore wind power generation, the propeller type of the horizontal axis which has been proven in the wind power generation of the land is mainly used.

The vertical axis type is stable because it can put the generator etc at the bottom of the wind turbine, and it is considered to be suitable for installation in an unstable place like offshore. VAWT (Vertical axis wind turbine) as shown in Fig. 1 is called "Savonius wind turbine" and has the following characteristics¹⁾: (a) simple construction with low cost; (b) wind acceptance from any direction for the operation; (c) low noise and angular velocity in operation; (d) reduced wear on moving parts; (e) various rotor configuration options; (f) high static and dynamic moment. In this study, "phase" is defined as shown in Fig.2 and the optimum shape of a 2-stage Savonius wind turbine is examined using a simulation technique for fluid phenomena.

The graphs in Figs. 4 and 5 are some of the results of the startup characteristics of the wind turbine. The horizontal axis of graphs is the "attack angle" defined in Fig. 3, and the vertical axis is the torque coefficient (force to rotate the wind turbine). When the torque coefficient is negative, the wind turbine can not be start to rotate. The wind turbine shown in Fig. 4 has the highest torque coefficient compared to other wind turbines when attack angle is 40 degrees, In Fig. 5, the torque coefficients of Stage 1 and Stage 2 are canceled, and the total torque does not become negative. In other words, the wind turbine can start even if wind blows from any direction.

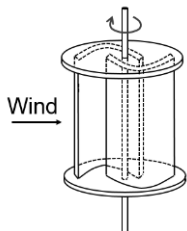


Fig.1 VAWT

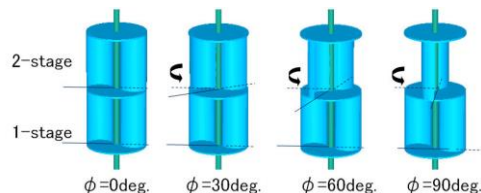


Fig. 2 Define of phase (2-stages degree)

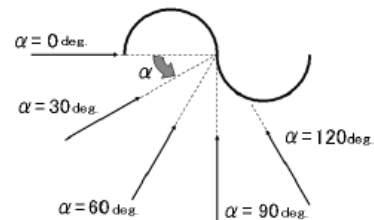


Fig.3 Define of attack angle

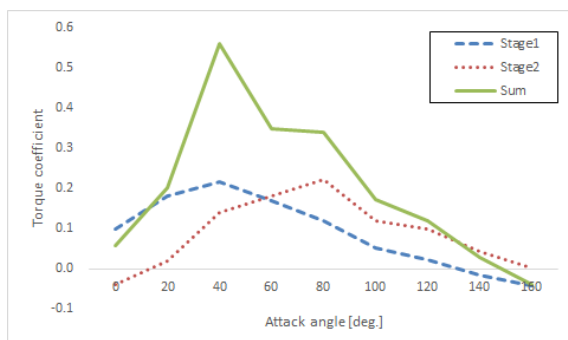


Fig.4 the startup characteristics of the wind turbine (Phase: 30 degrees)

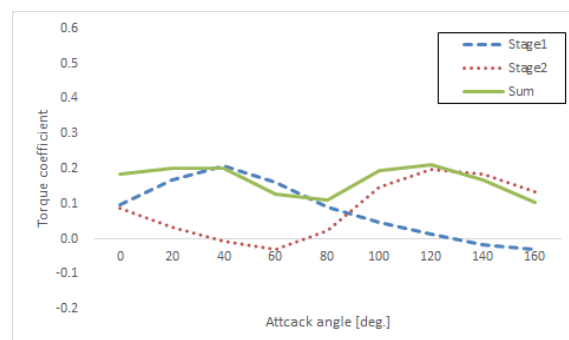


Fig.5 the startup characteristics of the wind turbine (Phase: 90 degrees)

¹⁾ J.V. Akwa, H.A. Vielmo, A. Prisco "A review on the performance of Savonius wind turbines" Renewable and Sustainable Energy Reviews, 16 (5) (2012), pp. 3054-3064