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[1-08-1-04] Improvement of Over-Speed Control System with Movable Arms for Butterfly Wind Turbine by Using Dampers

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Improvement of Over-Speed Control System with Movable Arms for Butterfly Wind Turbine by Using Dampers

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Abstract

Aiming at cost reduction, a butterfly wind turbine, which is a special type of small vertical axis wind turbine, has been developed by using aluminum extrusion (Fig. 1, left). To expand the operating wind speed range, a movable arm type over-speed control system (Fig. 1, right) was developed that operates by centrifugal force and aerodynamic force ⁽¹⁾. The rotor diameter of the prototype is 7 m, the movable arm length is 1.7 m, and the aileron length is 0.6 m.

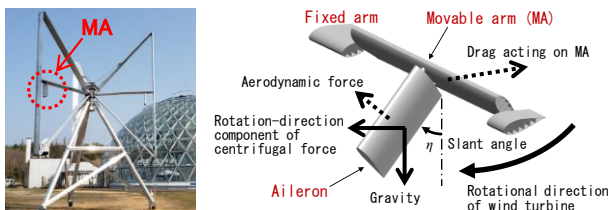
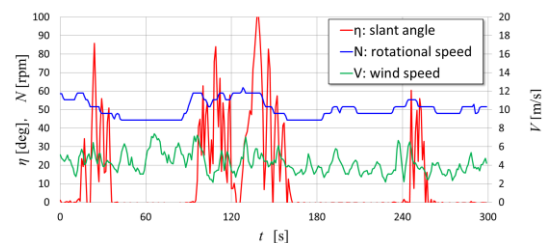


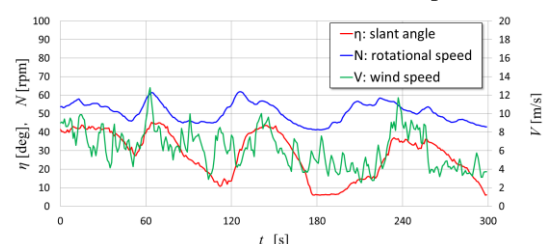
Fig. 1 Butterfly Wind Turbine (prototype, 7m diameter) and Movable Arm (MA)

However, in the first device, as the rotating shaft of the movable arm was supported only by bearings without dampers, problems occurred, i.e., the intense movement of movable arms and the impact on stoppers regulating the slant angle η . Fig. 2(a) shows the variation in the angle of a movable arm without dampers for 300 s. When the rotor rotation speed increased, the angle varied with large amplitude and, consequently, the rotation slowed down. However, noise was generated from the stoppers.

Fig. 2(b) is the result of installing dampers in the



(a) Variation of MA without dampers



(b) Variation of MA with dampers

Fig. 2 Measurement of slant angle of movable arm (MA)

movable arms. Owing to the dampers, the movable arm motion became slow and the angle amplitude decreased. As a result, the noise disappeared.

Moreover, the increase in rotation speed at wind speeds of 10 m/s or more was suppressed, and the maximum rotation speed suppression effect was also improved.

Acknowledgment

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References

(1) Hara, Y., et al., (2022) Proc. 26th National Symposium on Power and Energy Systems, C213.