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Design methodology of hybrid turbine towards better extraction of wind energy

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Abstract

Hybrid vertical axis turbines that combine Savonius and Darrieus turbines on a single shaft have been proposed as a way of combining the excellent starting torque of Savonius turbine with the high operational efficiency of the Darrieus turbine. Although hybrid turbines with improved starting characteristics have been demonstrated in literature, the performance of these turbines at higher tip speed ratios have been poor. In this work systematic study of stand-alone Savonius and Darrieus turbines have been carried out using experimental and numerical techniques as a precursor to study their roles in hybrid configuration. The radius ratio of the two turbines, when combined in the form of a hybrid turbine, is identified as an important parameter that dictates the performance of hybrid turbines. An expression for an optimal radius ratio is derived and a methodology for designing hybrid turbines is proposed. The efficiency in energy conversion by hybrid turbine can be expressed in terms of a parameter called effectiveness given by the ratio of power produced by the hybrid turbine to the sum of the power produced by individual Darrieus and Savonius turbines. This idea has been verified through experiments and numerical simulations.

Keywords: Hybrid turbine, Darrieus turbine, Savonius turbine, Radius ratio, Effectiveness

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