Wake rotation Analysis of Dual-Rotor Applied to Axial Turbines

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ABSTRACT

Dual-rotor turbines have been studied in recent years as an alternative to improve turbine performance. The use of dual rotors enables the extraction of residual energy from the flow after passing through the first rotor, increasing efficiency. This configuration of two rotors is especially important for horizontal axis hydrokinetic turbines, as depth is a big limitation in small rivers. However, there are still challenges on theories to explain how the second rotor depends on the first one. This study conducts a mathematical analysis of dual-rotor turbines, combining axial momentum theory applied to actuator disks, including wake rotation. The study evaluates dual-rotor configuration and determines its characteristics based on variables of interest, such as axial induction factor, pressure coefficients, and operating conditions. The result indicates a potential efficiency increase exceeding 8%, on the theoretical maximum power, compared to conventional single rotor, and the pressure coefficient drives this increase. Another important resultis that, depending on the operating condition, the power coefficient can exceed 70% the theoretical value for a single-rotor. The proposed methodology provides simplified and properly validated models to support the design of turbines adapted to unidirectional flows, such as hydrokinetic turbines applied to rivers of one way streaming, contributing to the advancement of sustainable energy solutions.