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A Free Wake Numerical Simulation for Darrieus Vertical Axis Wind Turbine Performance Prediction RADIAN BELU, Drexel University — In the last four decades, several aerodynamic prediction models have been formulated for the Darrieus wind turbine performances and characteristics. We can identified two families: stream-tube and vortex. The paper presents a simplified numerical techniques for simulating vertical axis wind turbine flow, based on the lifting line theory and a free vortex wake model, including dynamic stall effects for predicting the performances of a 3-D vertical axis wind turbine. A vortex model is used in which the wake is composed of trailing stream-wise and shedding span-wise vortices, whose strengths are equal to the change in the bound vortex strength as required by the Helmholz and Kelvin theorems. Performance parameters are computed by application of the Biot-Savart law along with the Kutta-Jukowski theorem and a semi-empirical stall model. We tested the developed model with an adaptation of the earlier multiple stream-tube performance prediction model for the Darrieus turbines. Predictions by using our method are shown to compare favorably with existing experimental data and the outputs of other numerical models. The method can predict accurately the local and global performances of a vertical axis wind turbine, and can be used in the design and optimization of wind turbines for built environment applications.

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