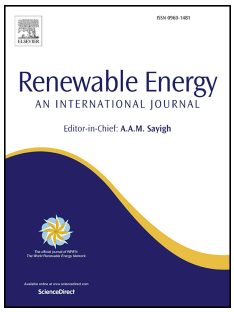
Accepted Manuscript



Numerical investigation of the aerodynamics and wake structures of horizontal axis wind turbines by using nonlinear vortex lattice method

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PII: S0960-1481(18)31037-1

DOI: 10.1016/j.renene.2018.08.087

Reference: RENE 10514

To appear in: *Renewable Energy*

Received Date: 28 March 2018

Revised Date: 6 August 2018

Accepted Date: 26 August 2018

Please cite this article as: Lee H, Lee D-J, Numerical investigation of the aerodynamics and wake structures of horizontal axis wind turbines by using nonlinear vortex lattice method, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.08.087.

Numerical investigation of the aerodynamics and wake structures of horizontal axis wind turbines by using nonlinear vortex lattice method

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Abstract

Wind turbines are emerging as one of the most promising and cost-effective renewable energy sources, due to their economical merits and technical maturity. It is important to accurately predict the aerodynamic performance of rotor blades for efficient design of wind turbine. Among the various numerical approaches, the vortex lattice method (VLM) is one of the most suitable models for wind turbine aerodynamics because the wind turbine mostly operates in the subsonic flow. However, it inherently cannot predict the nonlinear aerodynamic characteristics at a high angle of attack. In the current paper, a nonlinear vortex lattice method (NVLM) has been suggested to extend the existing VLM for handling the nonlinear stall and post-stall behaviors. This can be possible by finding a control point in the airfoil where the effective angle of attack is applied. This paper mainly discusses the development and validation of the NVLM for predicting the aerodynamic performances and the wake geometry against the measurements on the MEXICO rotor model. The comparison results show that the aerodynamic loads and tip vortex trajectories computed by NVLM are in significantly good agreement with the measured data. In addition, the complicated and unsteady wake structures are also analyzed using vortex particle method.

Keywords: Horizontal axis wind turbines; Wind turbine aerodynamics; Wind turbine wake; Vortex particle method; Vortex lattice method; Nonlinear vortex lattice method

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