Aerodynamic Analysis for the NREL PHASE II Experimental Wind Turbine

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ABSTRACT

Present work conducts numerical calculations with CFD (computational fluid dynamics) software to determine the aerodynamic characteristics of the NREL PhaseII experimental wind turbine. In this study, the governing equations, consisting of three-dimensional time-dependent conservation of mass, momentum, and energy, are solved using the SIMPLEC numerical scheme.To treat the turbulence effect, the k- ε two-equation turbulent model is adopted as the turbulence closure. Using an untwist, constant chord length, non-symmetrical airfoil as the design baseline of the NREL PhaseII experimental wind turbine, important aerodynamic properties, including Cp (Pressure Coefficient)、Moment、 power, are determined under board ranges of wind speed and pitch angle. Predictions can be then readily served as the input loading conditions for further the aeroelastics analysis.

Keywords : NREL PhaseIIS809, wind turbine, airfoil, computational fluid dynamics, torque, aerodynamic power.

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REFERENCES

1 呂威賢,“再生能源之風的故事”,工業技術研究院能源與資源研 究所潔淨能源技術組,383 期,2004 年11 月 2 Cardonna, F. X., and Tung, C.,“Experimental and AnalyticalStudies of Model Helicopter Rotor in Hover,” NASA TM -81232,Sept. 1981. 3 Agarwal, R. K., and Deese, J. E.,“Euler Calculations for Flowfield of a Helicopter Rotor in Hover,” Journal of Aircraft, Vol. 24, No. 4., pp. 231-238, 1987. 4 D.A. Simms, M. M. Hand,L.J. Fingersh, D. W. Jager,“ Unsteady Aerodynamics Experiment Phases II – IV Test Configurations and Available Data Campaigns,” July 1999. 5 Srinivasan, G. R., and McCroskey, W. J.,“Navier-Stokes Calculations of Hovering Rotor Flowfields,” Journal of Aircraft, Vol. 25,No. 10, pp. 865-874, 1988. 6 Srinivasan, G. R., Badeder, J. D., Obayashi, S., and McCroskey, W.J.,“Flowfield of a Lifting Rotor in Hover: A Navier-Stokes Simulations,”AIAA Journal, Vol. 30, No. 10, pp. 2371-2378, 1992. 7 Walter P. Wolfe, Stuart S,“CFD Calculations of S809 Aerodynamic Characteristics” Engineering Sciences Center, AIAA-97-0973. 8 P. Gigu?嫫e and M.S. Selig,“Design of a Tapered and Twisted Blade for the NREL Combined Experiment Rotor”,NREL, March 1998 – March 1999. 9 Allen, C. B., and Jones, D. P.,“Parallel Implementation of An Upwind Euler Solver for Hovering Rotor Flows,” The Aeronautical J., pp. 129-138, 1999. 10 Earl P.N. Duque, C. P. van Dam, Shannon C. Hughes,“NAVIER-STOKES SIMULATIONS OF THENRELCOMBINED EXPERIMENT PHASE II ROTOR”, NASA Ames Research Center, AIAA-99-0037. 11 Earl P.N. Duque,Wayne Johnson,C.P. vanDam,Regina Cortes and Karen Yee,“NUMERICAL PREDICTIONS OF WIND TURBINE POWER AND AERODYNAMIC LOADS FOR THE NREL PHASE II COMBINED EXPERIMENT ROTOR”, Ames Research Center, AIAA-2000-0038. 12 Sorensen, N.Nt , Michelsen, J.A.,“AERODYNAMIC PREDICTIONS FOR THE UNSTEADY AERODYNAMICS EXPERIMENT PHASEII ROTOR AT THE NATIONAL RENEWABLE ENERGY LABORATORY”AIAA-2000-0037. 13 Zhong, B., and Qin, N.,“Non-Inertial Multiblock Navier-Stokes calculation for Hovering Rotor Flowfields using Relative Vlocity Approach,” The Aeronautical J., pp. 379-389,2001. 14 EarlP.N. Duque, Michael D. Burklund,Wayne Johnson,“NAVIER-STOKES AND COMPREHENSIVE ANALYSIS PERFORMANCE PREDICTIONS OF THE NREL PHASE VI EXPERIMENT”, NASA Ames Research Center, AIAA-2003-0355. 15 Van Doormaal, J. P., and Raithby, G. D.,“Enhancements of The SIMPLE Method for Predicting Incompressible Fluid Flows,” Numerical Heat Transfer, Vol. 7, 1984, pp. 147-163. 16 Suhas V. Patankar,

“ Numerical Heat Transfer and Fluid Flow, ” Hemisphere Publishing Corporation, New York, 1983.