Aerodynamic Analysis of Horizontal Axis Wind Turbine with Numerical and Experimental Test

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ABSTRACT

This thesis contains theoretical, numerical, and experimental aerodynamic analysis of Horizontal Axis Wind Turbine (HAWT). The aim of this thesis is to utilize the simple wind turbine design in remote areas for fulfillment of electrical requirements in Myanmar. The design of this model wind turbine is to produce electrical power of 50W at rated wind velocity 6m/s. The rotor diameter is 1.5m and tip speed ratio is 6.5. Thin and unsymmetrical airfoil must be selected for low Reynolds number 100,000. Therefore, SG 6043 and NACA 4412 airfoils are selected to compare their performance. Maximum lift to drag coefficient ratio for SG 6043 is 6˚ and NACA 4412 is 7˚ at design Reynolds number. Blade Element Momentum theory is used to focus the power and coefficient of performance in theoretically. SG 6043 produce more power than NACA 4412 and higher coefficient of performance. Numerical study on lift and drag coefficients of two airfoils using Computational Fluid Dynamics (CFD) is compared with the printed results of Profili. ANSYS Fluent solver is used as CFD software to estimate the lift and drag coefficients. The numerical results are little different with Profili. Although the two airfoils produce more than 50W with numerical results, SG 6043 produce more power than NACA 4412. Therefore, SG 6043 airfoil is used to manufacture as wind turbine blade. The blade material is Ya-Ma-Nay wood and carving with hand tools. This design wind turbine assembly is constructed at Renewable Energy Department under Department of Research and Innovation. The constructed wind turbine is installed at Mandalay Technological University (MTU) main building slab. The micro-wind turbine is tested in June, July, and September. The data are collected every 15minutes during specified periods. The average wind

velocity is around 1.5m/s to 3.5m/s. Therefore, electrical power output range is from 8 to 20W because wind is fluctuated and low intensity of wind. But, instantaneous wind velocity occurred around and over 6m/s. At the average of all instantaneous wind velocity 6m/s, the designed wind turbine produces approximately 50W. All in all, this small wind turbine is suitable to use in low wind speed regions' electrification.