INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Md. Nur Alom
Roll Number	:	166103030
Programme of Study	:	Ph.D

Thesis Title:
Aerodynamic Drag and Lift Characteristics of a Newly Developed Elliptical-Bladed Savonius Wind Turbine Rotor

Name of Thesis Supervisor(s)	:	Professor Ujjwal K. Saha
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SHORT ABSTRACT

The elliptical-bladed rotor that has shown its potential to harness wind energy more efficiently is considered for the present numerical and experimental studies. In the present investigations, initially 2D unsteady simulations have been conducted for the elliptical, modified Bach, Benesh and semicircular profiles of the Savonius rotor. This is to check and corroborate the past research findings. The geometric parameters such as overlap ratio, number of rotor blades and effect of shaft are then considerd. The unsteady simulations are also carried out to analyze the influence of Reynolds number on the rotor performance. Thereafter, unsteady simulations are carried out by implementing the vent-augmenters. The C_D and C_L of the elliptical-bladed rotor is evaluated and compared with that of a semicircular-bladed rotor. The average C_D for a complete rotation of elliptical and semicircular profiles are found to be 1.43 and 1.35, respectively. Hence, there is higher average C_D by 6% in the elliptical profile than the semicircular profile. Further, the C_L and C_D are also estimated for the modified Bach and Benesh profile to have a comparison in a common platform. The 3D unsteady simulations are then conducted to estimate the performance coefficents (C_T and C_P) and aerodynamic coefficients (C_D and C_L) of vented elliptical-bladed rotor.

Subsequently, the wind tunnel experiments are conducted to validate the numerical results. The wind tunnel tests show the peak C_P to be 0.19 and 0.15 for the elliptical-bladed and semicircular-bladed rotors, respectively at TSR = 0.7 and AR = 1.09. Hence, there is an improvement of C_P by 27% in elliptical-bladed rotor than the conventional semicircular-bladed rotor.

Finally, the multi-objective genetic algorithm (MOGA) has been applied to the optimized elliptical profile to minimize the incoming velocity and to obtain the maximum torque and lift coefficients. From the MOGA, the elliptical profile shows the C_P to be 0.35 at V = 5.91 m/s (at TSR = 0.80). At the same TSR, the semicircular profile shows the C_P to be 0.28 at V = 6.06 m/s. On the other hand, the unsteady numerical simulation at V = 6.2 m/s shows C_P = 0.34 and 0.27 for the elliptical- and semicircular profiles, respectively.