Abstract

Increasing the Efficiency of the Straight Bladed Vertical Axis Wind Turbine

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Most studies that involved the use of endplates were limited mainly to aircraft wings where the angle of attack varies from 0 to 10 degrees and dynamic stalling doesn't occur. In the Vertical Axis Wind Turbine (VAWT) the angle of attack varies from -20 to 20 degrees, in which the phenomenon known as dynamic stalling occurs. Also, strut streamlining studies of VAWT mainly focused on designing a strut that would act as a supporting arm.

In this study, the use of a strut modifier with the aim to enhance the efficiency of the Straight Bladed VAWT was investigated in view of increasing the efficiency to compete with the Horizontal Axis Wind Turbine.

It was observed that the lift coefficient increased as much as 6.1% at an angle of attack of -5 degrees and Reynolds number of 3.32×10^5, and increased by 1.7% at an angle of attack of -5 degrees Reynolds number of 9.64×10^5. From the data gathered it was possible to express the difference in calculated and experimental data in terms of eight (8) equations that can be used with the established theory to accurately estimate the lift coefficient of the MI-VAWT airfoil with the MI-VAWT1 endplate attached.

The flow characteristic over the strut modifier was examined experimentally using the mean surface pressure readings for a range of Reynolds numbers from 3.32×10^5 to 9.64×10^5. The results obtained for the experimental drag coefficient values were within 10.72% of the simulated XFOIL results and a mean difference of 9.43 %. The DesignFoil software also showed the same values for drag coefficient at all Reynolds numbers simulated.

From the theoretical analysis of the endplate enhancement and strut modifier, the lift coefficient increased by 4.08 % over the range of angle of attack of -10 to 10 degrees and 1.20 % over the range of angle of attack of -10 to -15 and 10 to 15 degrees. The experimental investigation supported this finding with an overall increase in lift coefficient of 8.65 % over the range of angle of attack of -10 to 10 degrees and 2.41 % over the range of angle of attack of -10 to -15 and 10 to 15 degrees.

Keywords: Rikhi Ramkissoon, Vertical Axis Wind Turbine, Endplate, airfoil and Strut modifier.