Recommendation

Enhancing blade design

The aerodynamic shape could be further optimized, where the blades could be manipulated to further improve them. One of the enhancements that was first planned to make is to slightly camber the blades along their path, which means increasing the convexity of the curve of the blade's aerofoil, and it can be calculated with this equation

$$f = \frac{|y_u + y_l|_{max}}{2c}$$

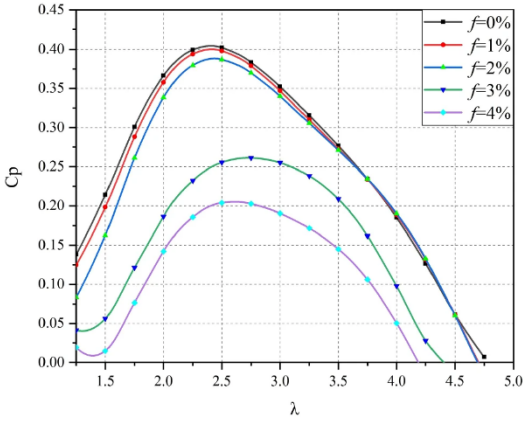

Figure 1: The camber effect on the aerodynamic performance of VAWT with wind speed v = 4 m/s

which means that the camber (*f*) of the airfoil is equal to the ratio of the maximum airfoil midline coordinates to the blade chord length (*c*). The slight camber improves the overall performance of the VAWT as shown in **Figure 1** in accordance to tip speed ratio, resulting in the generation of higher values of torque (Danao et al., 2012), that is utilized by applying a mechanical advantage to increase the rotational speed (RPM) of the generator's rotor, increasing the amount of electricity generated. Moreover, camber affects the self-starting ability of the VAWT (Pan et al., 2020), as it produces more torque over a full rotation. On the other hand, too much camber used in the blades could negatively affect them, as camber of 5% and heigher have low utilization rate of wind energy, so a camber smaller than 5% was planned to be used. However, despite all these benefits, cambered blades weren't used, as it would be harder to manufacture them, and they would cost more. The reasons for that is the blades would become asymmetrical and curved along their path, increasing the complexity of manufacturing them. But the main reasoan for not utilizing cambered blades is that there were no researches about the utilization of cambered blades in a Lenz VAWT.

References

(PDF) A numerical study of blade thickness and camber effects on vertical axis wind turbines

Parameter design and optimization for camber of vertical axis offshore wind turbine using CFD | Journal of Ocean Engineering and Marine Energy