Design, manufacture & DOE of Aerofoils for a Darrieus Wind Turbine

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Aim of the Project

This project is about the design & manufacture of 3 different types of aerofoils to fit a Darrieus wind turbine. Once designed and manufactured a design of experiment (DOE) will be conducted in relation to finding the RPM to determine what specific aerofoil will be the most efficient for the turbine

Background

The most relevant turbine in relation to this project is the Darrieus “In the 1930s, Goerge Darrieus invented lift-based vertical axis wind turbines in France and filed a patent in the US in 1931. His turbine designs patent covers both curved blades and straight blade rotors. In the configuration of the curved blades, blades are directly connected to a rotating shaft, while for straight blades, a cross arm is used to connect blades with the shaft.

Figure 1: VAWT manufactured by Martin Donnelan

The wind turbine designed from a previous 3rd year, I will install my aerofoil designs on this Darrieus VAWT and carry out DOE

Aerofoils

The blades of wind turbines or other aerodynamic devices are known as aerofoil blades. An aerofoil is a structure that makes use of the laws of aerodynamics to generate lift and Drag, these are the main areas we will need for this project to find out the best Aerofoil for the turbine. Aerofoil blades have a specific shape that is designed to generate lift and drag when they interact with fluids such as air and water. When discussing the aerodynamics of an aerofoil blade, lift and drag are two fundamental forces that come into play.

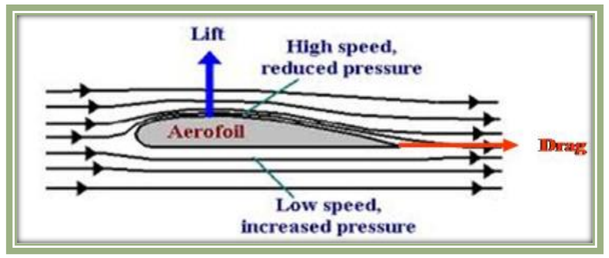

Figure 2: Aerofoil showing lift & drag

Lift is the component of the total force vector that works through the centre of pressure of an object and is perpendicular to the incoming flow. For a zero angle of attack, it acts opposite to the weight. Lift is a mechanical force that is produced by the movement of an object through the air.

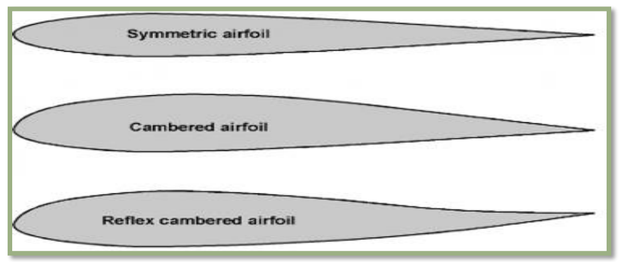

Figure 3: Aerofoil Profiles

Design & Manufacture

For the design the profiles are generated on the website www.airfoiltools.com , from there the profiles like the one below are chosen to be made

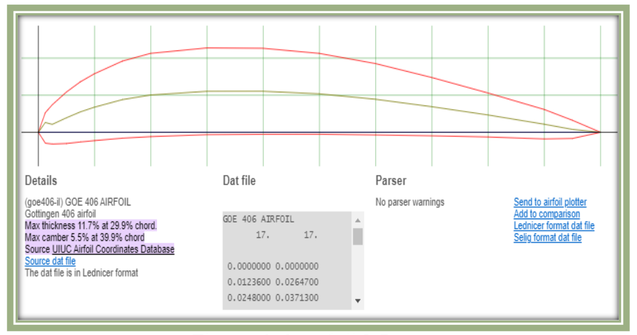

Figure 4: Aerofoil & Data

Once this was then imported onto solidworks and extruded I then 3D the Aerofoil.

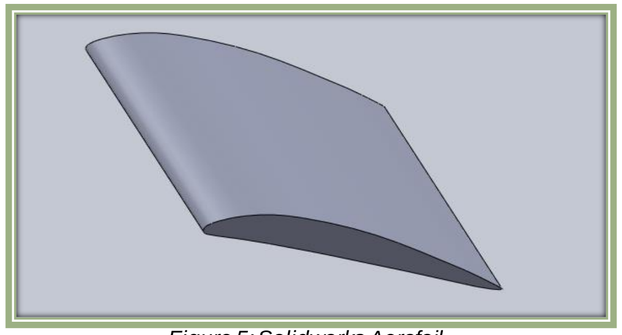

Figure 5: Solidworks Aerofoil

DOE

DOE stands for Design of Experiments. It is a systematic approach used in research and engineering to optimize processes, improve product design, and understand the factors that influence outcomes. DOE involves planning and conducting experiments in a structured manner to gather relevant data and draw meaningful conclusions. Full and fractional factorials are experimental designs used in Design of Experiments (DOE) to systematically study the effects of multiple factors

Conclusion

Below shows a snapshot of the DOE in a real time. The GOE 406 profiles on the VAWT turbine. Voltage reader showing 1.5 volts

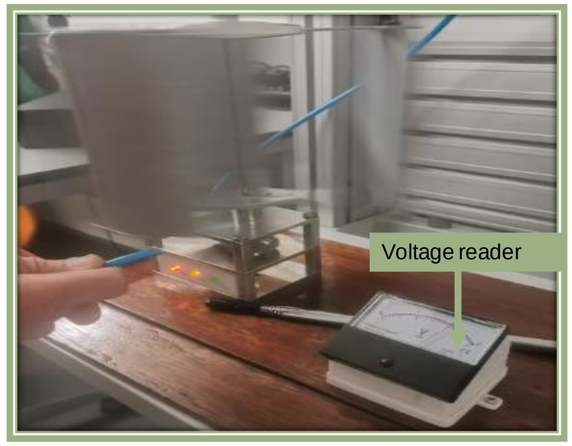

Figure 6: GOE 406 aerofoil being tested

- A digital anemometer works better than a probe anemometer.
- Further designing needed for the rig to hold air flow at the same distance each run
- More research needed on angle of attack and where exactly to put air flow pointing at the aerofoil

References

Figure 1: 2021/22 academic year, Student Martin Donnelan

Figure 2: This Photo by Unknown Author is licensed under CC BY-SA

Figure 3: Aeronautical University, eaglepubs.erau.edu

Figure 4: GOE 406 profile, www.airfoiltools.com