Let's be blunt and drop the mic! An experimental study of very thick flatback airfoils

A Supergen ORE Hub Early Career Researcher Awarded Project

Project Partners: Swansea University (Lead), Vestas Technology UK Ltd

Principal Investigator: Dr Marinos Manolesos

Summary

As wind turbines grow larger to reduce the levelized cost of energy, their blades grow more slender and require significantly thicker airfoils. This project uses state-of-the-art measurements to examine a very thick trailing edge (20%) airfoil and the possibility to dynamically control its performance.

Objectives

The objectives of this project were:

1. To investigate the aerodynamic performance of an **airfoil with very thick TE (20% chord)** at high Reynolds number (Re ≈ 2M)
2. To investigate the **unsteady wake characteristics** of the same airfoil
3. To examine the **possibility of dynamic control** of airfoil performance

Objectives 1 and 2 were successfully achieved, despite the COVID-19 pandemic which severely hindered the team's access to the wind tunnel and workshop facilities. It was not possible to work on the final and most ambitious objective, as due to the pandemic it was not possible to manufacture the dynamic flap in our workshop. Instead, the focus was shifted from Experimental to Numerical work and the three-dimensional flow past flatback airfoils was investigated.

Regarding the career development of the PI, a working relationship with Vestas, the world's largest wind turbine manufacturer, was cemented. The PI and a PhD student developed new knowledge on the calibration, installation and use of state-of-the-art microphone sensors. Furthermore, the PI gained knowledge in the application of high-fidelity numerical tools.

Impact

A total of 1 journal and 4 conference publications have come out of this project. At least one more publication is currently being authored.

Journal papers:

Manolesos, M. and Papadakis, G., 2021. Investigation of the three-dimensional flow past a flatback wind turbine airfoil at high angles of attack. *Physics of Fluids*, *33*(8), p.085106.

Conference Papers:

Cene, A., Grasso, F., **Manolesos M.** 2021. An experimental investigation of the flow past a very thick flatback airfoil suitable for wind turbine blades, UK Fluids Conference, 8-10 September 2021, Southampton, UK

Manolesos, M. & Papadakis, G. 2021. Bluff Body Shedding and Stall Cells: Numerical Simulation of a Flatback Airfoil at High Angles of Attack, Wind Energy Science Conference - EAWE, May 2021, Hannover, Germany

Cene, A., Grasso, F., **Manolesos M.** 2021. Thick airfoils, Vortex Generators, Gurney Flaps and Flatback Solutions: How to get better performance out of the blade inner region? Wind Energy Science Conference - EAWE, May 2021, Hannover, Germany

Cene, A., Grasso, F., **Manolesos M.** 2022. Aerodynamic and Aeroacoustic Measurements of the Flow Past a Very Thick Flatback Airfoil with Passive Flow Control Devices 2022 AIAA SciTech Forum, *Accepted*