Double Wake implementation for

thick trailing edge wind turbine airfoils

MSc Project Proposal

July 2016

1. Introduction

With rising energy prices wind turbines are becoming more and more a viable source of energy. One of the focus points in the wind energy industry is to improve on existing aerodynamic rotor designs.

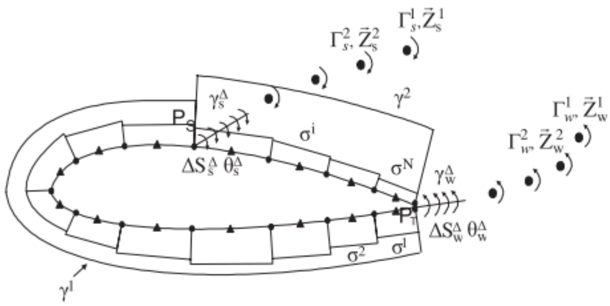
Current wind turbine rotor designs tend to employ very thick airfoil sections, possibly with very thick airfoil trailing edges. Combined with the nature of the flow in which wind turbines operate, this leads to unsteady flow features even in relatively benign flow conditions.

The simulation of thick trailing edge airfoils considering engineering tools is therefore a core relevant problem to be addressed for the most efficient blade design.

2. Problem Description

In this project you will improve and apply an advanced 2D aerodynamic design tool, RFOIL, for the case of thick trailing edge airfoils. RFOIL is an aerodynamic design tool based on XFOIL, developed by ECN together with NLR and TU Delft. Originally RFOIL solves steady state form of the equations and employs a single wake for the wake development. The proposed method adopts an unsteady approach in releasing the wake to take into consideration the wake evolution in time and the main focus will be on simulating two wakes shedding from

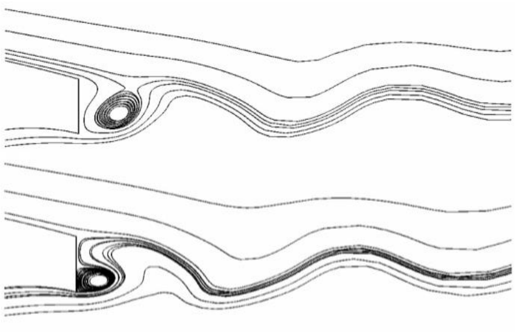
- the both ends (suction and pressure sides) of the trailing edges of the airfoils in case of a thick trailing edge airfoils
- the trailing edge and the separation point for the case of a conventional airfoil with a thinner trailing edge.



An essential subtask is to validate the numerical code results with experimental data taken from literature and CFD simulations. A particular focus will be put on post-stall aerodynamics characteristics, which are widely experienced by thick airfoil in wind turbine blades.

The major steps of the study will consist of the following:

- Literature study
- Analysis of the proposed numerical solution
- Introduction to RFOIL
- Implementation in Fortran
- Testing on thick airfoils
- Analysis and validation of the numerical results
- Report



3. Your Profile

- Basic knowledge of fluid dynamics
- Knowledge of numerical analysis and algorithm development
- Knowledge of a high level programming language (preferably Fortran)

4. Project details

- The work will be carried out at ECN
- The duration will be up to 9 months
- ECN provides a student compensation and extra compensation for housing

5. Literature

Some links to literature on the panel method, spline theory, and numerical analysis:

- J. Katz, A. Plotkin, “Low-Speed Aerodynamics”, Cambridge University Press, 2001
- A. van Garrel, “Development of a Wind Turbine Rotor Flow Panel Method”, ECN-E--11-071, 2011
- V. A. Riziotis, S. G. Voutsinas, “Dynamic stall modelling on airfoils based on strong viscous - inviscid interaction coupling”, International Journal for Numerical Methods in Fluids, 56, 185–208, 2008.
- G. Ramanujam, H. Ozdemir, H.W.M. Hoeijmakers, “Improving Airfoil Drag Prediction”, AIAA 2016-0748, AIAA SciTech, 34th Wind Energy Symposium, San Diego, 2016

6. Contact information

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