High-Lift Low Reynolds Number Aerofoils With Specified Pressure Drop for Ducted Wind Turbine

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BOOK OF ABSTRACTS

WESC2017 – Wind Energy Science Conference
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Preface

Wind Energy Science Conference 2017 (WESC-2017) is held at the Technical University of Denmark in Lyngby during June 26-29, 2017. This conference is the first of a series of bi-annual conferences launched by the European Academy of Wind Energy (EAWE). The purpose of the conference is to gather leading scientists and researchers in the field of wind energy to present their latest findings. The conference aims at covering all scientific topics in wind energy, comprising from most fundamental aspects to recent applications. It provides a world-wide forum for scientists to meet each other and exchange information of all aspects of wind energy, including aerodynamics, turbulence, wind resource assessment, wind farms and wakes, aero-serve-elasticity, loads, structural mechanics, control, operation and maintenance, generator technology, grid integration, structural design and materials, new concepts, as well as community acceptance, environmental aspects, and economics.

This volume of abstracts comprises all presentations of the conference, including two plenary lectures, and nearly 370 contributed papers, presented in either oral sessions or during 13 mini symposia. The abstracts are sorted chronologically after the day of presentation, corresponding to the way they appear in the conference programme. At the end of the book you will find a list of presenting authors, listed alphabetically, and the page number where their abstract appear.

I like to thank the scientific committee and the local organizing committee for their work with the evaluation and selection process. In particular, I thank Marianne Hjorthede Arbirk for her invaluable help in preparing the conference and this book of abstracts.

Jens N. Sørensen, chairman WESC-2017
Lyngby, June 2017

High-Lift Low Reynolds Number Aerofoils With Specified Pressure Drop for Ducted Wind Turbine

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A new high-lift aerofoil modification for the duct has been developed and will be experimentally tested in a small wind tunnel. Aerofoils for such wind tunnel ducts typically operate in the low Reynolds number range from 2×10^5 to 6×10^5. The effect of a duct and of rotor on power and pressure drop were considered separately in previous studies. This paper focuses on the optimization of aerofoil geometry for a Reynolds number of 3×10^5 taking into account of the presence of a screen, having a pressure drop similar to a real rotor. In particular, the current work concentrates on obtaining high lift, instead of high lift-to-drag ratio.

Since high lift is the only desirable feature when modifying an aerofoil for ducts, the factors most related to enhanced high-lift low Reynolds numbers aerofoil performance are investigated. Previous experimental data of a three-dimension aerofoil-shaped duct model are used. Combining these data, and applying the Liebeck type high-lift design philosophy, which is to make use of an optimal pressure recovery with aft loading, variations in thickness, camber, and the shape of leading and trailing edges are analysed through the fully inversed method. The XFOIL 6.99 code was adopted as the analyse tool in this study.

With the specified velocity distribution, it is found that an increase of both camber and thickness of the duct leads to an increase in lift coefficient with the presence of the pressure drop. In particular, the thickness increment for the aft part of the aerofoil generates higher lift coefficient.

The installation of screen divides the duct into two parts, the duct fore part starts from the leading edge until the screen plane, while the duct aft part includes the screen plane to trailing edge. It is observed from previous experimental data that, with the screen presence, the front stagnation point moves towards the inner part of the duct. Consequently, the pressure coefficient reduces in the front part of the suction side, although the pressure differences, between the upper surface and the lower surface, of the duct fore part enlarges. Decreasing the leading edge radius, in essence, accelerates the airflow around it so that a negative area was created.

Building on these results, the modified aerofoil model is fabricated and will be tested in a wind tunnel experiment. The test two-dimension model, with the assumption of symmetrical flow, is composed of an aerofoil and a uniform porous screen to simulate half part of the rotor from centreline. The aerofoil has a chord length of 20 mm and the screen has a length of 130 mm in vertical direction. To find the highest lift coefficient of this 2-dimension model, measurements will be conducted with the varying angle of attack and wind speed. Moreover, to investigate the effect of screen loading onto the configuration, there will be two different screens tested. Since the experiment will be carried out in April 2017 the comparison with the XFOIL 6.99 predictions cannot be provided at present, but will be shown during the symposium.

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