Faculty Engineering Technology
Program Sustainable Energy Technology

University of Twente.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

Evangelos Fotopoulos

will give a presentation, entitled:

Experimental Study of Plasma Actuators for Active Flow Control on Wind Turbine Blades

Date: Monday August 29, 2011

Time: 14.00

Room: Horstring C101

Summary:
Current wind turbine designs are capable of pitching the blades in order to improve energy extraction. Further improvements in the aerodynamic performance could be achieved if the velocity encountered by individual blade sections could be varied spatially and temporally along the span of the blade, or in other words if the local pitch angle of sections of the blade could be adjusted. By using plasma actuators for flow control on a wind turbine blade, a higher efficiency of the system as well as load reduction could be achieved, since the turbine can operate closer to its optimum aerodynamic performance in a broader wind speed range.
The present study focuses on the induced flow field of a Single Dielectric Barrier Discharge (SDBD) plasma actuator and its applicability for flow control on an airfoil in an airstream. Experimental work has been conducted measuring, using a Pitot tube, the velocity field in the vicinity of the actuator operating in still air. This gives details of the wall jet induced by the actuator. The results of the velocity field measurements inside the induced wall jet have been correlated to the similarity solution for this type of flow. This analysis has led to the identification of a parameter that characterizes the strength of the wall jet in terms of applied power and frequency of the plasma actuator. For the present set-up the velocity within the wall jet can reach values up to 8 m/s.
Subsequently the plasma actuator, with a span wise extent of 48% span, has been mounted on the suction side of a blade with a NACA0018 airfoil. With the goal of control of flow separation the plasma actuator is positioned at 71% chord, i.e. close to the trailing edge. The blade has been placed in the test section of a wind tunnel, cross-section $0.45\times0.45m^2$, which can achieve speeds up to 35 m/s. The measured aerodynamic forces on the airfoil provide insight into the control effectiveness of plasma actuation on the lift coefficient. The wind tunnel experiments at $Re = 0.78\times10^5$ reveal that actuation in a steady manner produces a shift of the lift coefficient towards a higher c_l value, mainly in the lower speed regime. However, the SDBD plasma actuator used in the present study is not powerful enough for the higher wind speeds that a wind turbine blade encounters.

Assessment committee: **Chairman:**
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Ir. H. de Vries
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