

COLLOQUIUM

Group: Engineering Fluid Dynamics

As part of his MSc thesis assignment

F.G. Heerink

will give a presentation, entitled:

Exploratory Study on a NS-DBD Plasma Actuator for Flow Separation Control

Date: Monday August 17, 2015

Time: 14:00

Room: Horstgebouw ZH.286

Summary:

In order to be less harmful for the environment and to reduce the total fuel costs of apparatuses it is necessary to develop new sustainable energy resources, and more environmentally friendly systems. Nowadays, engineers are therefore challenged with the development of new techniques that have less impact on the environment as well as making existing ones more efficient. The efficiency of systems that make use of a blade or wing, e.g. wind turbines, gas turbines, compressors as well as aircraft, can be improved by reducing the drag by preserving a coherent and fully attached flow around the blade. To prevent or delay the flow from separating (active) flow control systems need to be developed.

In the past 15 years the use of dielectric barrier discharge (DBD) plasma actuators for active flow separation control has attracted much attention, because compared to other flow control systems they offer a significant reduction in weight, mechanical complexity and parasitic drag. In particular two types of DBD actuators show good results for flow separation control, i.e. leading edge flow separation control, namely the alternating current dielectric barrier discharge (AC-DBD) actuator and a nanosecond pulsed dielectric barrier discharge (NS-DBD) actuator. The working principle of the AC-DBD actuator is well understood: momentum transfer through ions colliding with neutral particles, which induces a gas flow. This induced flow is then used to re-energize the boundary layer such that flow separation can be delayed or even prevented. In contrast, the precise working principle of the NS-DBD actuator is unclear. The NS-DBD actuator shows good results for leading edge flow separation control at higher flow speeds up to flows with a free stream Mach number of 0.85 for chord Reynolds numbers up to 3.2 million, while the AC-DBD actuator is suitable for flow separation control up to a Mach number of 0.4 for chord Reynolds numbers below 1 million.

In the present study an attempt has been made to obtain a better insight in the working principle of a NS-DBD actuator. The study included an extensive literature study to summarize the already obtained knowledge about the NS-DBD actuator through experiments performed by other researchers. Subsequently, a safe experimental set-up has been designed and realized to perform experiments on NS-DBD actuators. Flow visualization using smoke has been utilized to shed light on the effect that a NS-DBD actuator has on quiescent air in order to verify results from literature, and to discover new phenomena that can explain the working principle of NS-DBD actuators.

Assessment committee:

Prof.dr.ir. C.H. Venner (chairman)
Prof.dr.ir. H.W.M. Hoeijmakers (mentor)
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