Faculty Engineering Technology
Program Mechanical Engineering

Universiteit Twente.

COLLOQUIUM

In accordance with article 4.6.8 of the SSNS-wb.

Group: **Engineering Fluid Dynamics**

As part of her MSc thesis assignment

F. A. Pathiraj

will give a presentation, entitled:

Modeling of Body Force generated by a Surface Dielectric Barrier Discharge (SDBD) Plasma Actuator from First Principles

Date: Friday July 23, 2010

Time: 14.00 hr

Room: Horstring N 109

Summary:
Active flow control with the aid of surface dielectric barrier discharge (SDBD) plasma actuators is a recent development in flow control, which involves manipulating a flow to impart a desired change. The main advantages of plasma actuators over other actuators are their robustness, simplicity, low power consumption and their ability for real-time control at high frequency.
In the imposed electric field plasma particles are accelerated and collide with the neutral gas causing momentum transfer, called the electro-hydrodynamic (EHD) force. Thus the SDBD plasma actuator can induce a flow of a neutral gas like ambient air.
To incorporate the effect of the plasma actuator in flow solution methods, a model is needed for the electro-hydrodynamic body force. Several models for SDBD's have been developed: approximate, semi-empirical, phenomenological models suitable for engineering prediction and optimization methods; as well as models based on first principles. The models based on first principles are generally more accurate and provide insight in the details of the generation of the "electric wind". However, they do require extensive computation time, which for example limits the size of the domain in which the solution can be computed.
The aim of the present research is: to study and compare existing first-principles based models; to choose a model which provides a good balance between accuracy and computation load; to implement the selected model.
The transport equations are derived from the Boltzmann equation. The plasma dynamics is modeled in a self-consistent manner using a first-principles based hydrodynamic plasma model in which the Poisson equation for the electric field is coupled to the transport equations for the three species considered; viz. one type of positive ion, one type of negative ion and electrons. The equations are discretized using a vertex-centered finite-volume method and the fluxes are treated with the Scharfetter-Gummel scheme or alternatively with a flux-vector-splitting scheme.

Assessment committee: **Chairman,**
Prof.dr.ir. H.W.M. Hoeijmakers (chairman/mentor)
Prof.dr.ir. T.H. van der Meer
Dr.ir. E.T.A. van der Weide
Dr.ir. D.R. van der Heul
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