Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

N. Braaksma

will give a presentation, entitled:

Experimental/Numerical Investigation Transient Behavior Two-phase Cooling Systems

Date: Friday November 29, 2013

Time: 14:00

Room: **Horstgebouw N.109**

Summary:
Two-phase cooling systems can be an effective solution to transfer large amounts of heat while at the same time maintaining a constant temperature. However, the transient behavior of such systems is difficult to predict when they are subject to sudden changes in heat load. Such changes cause the system pressure to increase or decrease due to evaporation and condensation of the working fluid. A so-called accumulator is used to regulate the system to reach its set-point pressure and temperature quickly upon a sudden change in the heat load. To accurately predict the transient behavior towards the set-point condition requires an accurate dynamic model.

For this study a dynamic model based on the Navier-Stokes equations for one-dimensional time-dependent compressible flow has been developed. This model assumes homogeneous flow and solves the equations for the conservation of mass and conservation of enthalpy. Since the heat transfer during evaporation and condensation shows significantly different behavior from regular single-phase heat transfer, a variety of heat transfer correlations has been investigated and implemented in the dynamic model. The model has been implemented in a numerical method employing the MacCormack discretisation scheme.

Validation experiments have been carried out by investigating a specific design of a two-phase cooling system. The response of this system to sudden application of different heat loads has been investigated by collecting data of the mass flow rate, temperature and pressure at a variety of locations in the experimental set-up. This data has been compared with numerically obtained results for the same set-up.

The dynamic model has been found to predict the behavior of the investigated system with good accuracy. It is concluded that changes in the single-phase section of the cooling system have little influence on the overall response of the system. Furthermore, uncertainties due to the used empirical relations for heat transfer have little to no effect on the system's behavior. Subsequently, the numerical method has been used to investigate the influence of a number of design parameters, e.g. the volume of the accumulator, on the performance of the system. The numerical method is easily adapted to other test set-ups with different working fluids, geometries and heat inputs.

Assessment committee:
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d.d. _______________