Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

R.F. Kroes

will give a presentation, entitled:

CFD for Motion of Elongated Bubbles in Viscous Liquid

Date: Friday October 4, 2013

Time: 14:00

Room: **tbd**

Summary:
The bubble drift velocity is the velocity of an elongated gas bubble that moves into a stagnant liquid in a pipe. The drift velocity is an important parameter in methods for predicting the behaviour of two-phase flows in industrial applications, such as the transport of gas and oil through pipelines. The effect of a high liquid viscosity on the flow behaviour is not yet completely understood. The goal of this study is to find the effect of the liquid viscosity on the drift velocity of an elongated gas bubble that moves into a liquid-filled horizontal pipe. This project has been carried out in Shell's multi-phase flow team at the Shell Technology Centre Amsterdam.

Computational fluid dynamics (CFD) is used to numerically simulate the motion of elongated gas bubbles into pipes or channels that are filled with liquid. In this study, computational fluid dynamics has been applied to 2D and 3D flows. In addition a simple 1D flow model has been employed. As a verification of the results of the numerical simulations, the motion of an elongated bubble into a pipe has been considered for the case of inviscid flow. The obtained steady flow solution is in good agreement with the analytically obtained solution. The inviscid-flow simulations have also been used for a mesh convergence study.

In the results of the viscous-flow simulations, different flow regimes are recognized: one for which the bubble velocity is constant and one for which the bubble velocity decreases in time. The velocity of a bubble moving into a horizontal liquid-filled pipe or channel decreases in time when viscous effects are significant.

The effect on the bubble velocity of parameters other than the liquid viscosity has also been investigated. Specifically, the decrease in bubble velocity is not observed for a bubble which is moving in an upward inclined pipe. Furthermore, when the bubble is moving in a non-stagnant liquid, with the liquid moving in the same direction as the bubble, a constant bubble velocity is found.

Finally, the usability of a simple 1D flow model to simulate the bubble velocity has been investigated. The multi-phase flow equations are solved numerically employing a semi-implicit discretization scheme. The preliminary results from these simulations are promising enough to recommend further investigation.

Assessment committee:
Prof.dr.ir. H.W.M. Hoeijmakers (chairman)
Dr.ir. B. Sanderse (Shell)
Dr.ir. C.H. Venner
Dr.ir. J.B.W. Kok
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d.d. _______________