Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

B.J.W. Molenaar

will give a presentation, entitled:

Effect of Appreciable Stall on Pressure Recovery in Diffuser

Date: Thursday July 11, 2013

Time: 14:00

Room: **ZH 286**

Summary:
A diffuser is a diverging section in a duct used to recover potential energy (pressure) from the kinetic energy (velocity) of the flow. Its application can be found, for example, in gas pipe lines at locations where pipes of different diameters are connected. In the design of a diffuser, the efficiency is determined by the fraction of recovered kinetic energy. Paradoxically a diffuser with an optimal time-averaged efficiency will experience large transitory stall. This means that the flow separates from the wall resulting into vortex shedding. Aim of the present work has been to obtain insight into the relationship between geometrical parameters and diffuser performance, for the time averaged as well as for its dynamical behavior.
To obtain insight into the range of the efficiency that can be achieved, a one-dimensional analytical model is used. This gives the recovery for an ideal diffuser, as well as for a worst case diffuser with full flow separation.
Experiments have been carried out on a diffuser with adjustable geometry. A geometry with marginal flow separation and one with appreciable flow separation were tested. The pressure profile along the test channel, the outlet flow profile and the response to acoustically imposed velocity fluctuations have been measured.
The flow in the diffuser has been analyzed using a numerical method for solving the Reynolds Averaged Navier-Stokes (RANS) equations for 2D steady flow. The study was restricted to the use of a commercial CFD package with standard turbulence models. When comparing the results of the numerical method with the experimental results it has become clear that 3-D flow effects are present. A quasi 2-D boundary layer correction was used, which significantly improves the prediction.
It is not clear that a RANS method for 3D flow would perform much better than this simpler method for quasi 2-D flow. A great advantage of the method for quasi-2D flow is that it is numerically more efficient and therefore can be used to explore time-dependent flow effects.
In the present research the dynamical response has been studied experimentally for high non-dimensional frequencies and for velocity fluctuations up to 30% of the main flow velocity. Globally this acoustical forcing has only a minor effect on the time-averaged flow through the diffuser.

Assessment committee:
Prof.dr.ir. H.W.M. Hoeijmakers (chairman)
Prof.dr.ir. A. Hirschberg (mentor)
Dr. G.G.M. Stoffels
Dr.ir. C.H. Venner

Chairman,

d.d. _______________