DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title:	A Design & Optimization Framework for Valves in Digital Displacement Units
Location:	Pontoppidanstræde 111, auditorium
Time:	Thursday 9 January at 13.00
PhD defendant:	Niels Christian Bender
Supervisor:	Professor Henrik C. Pedersen
Moderator:	Associate Professor Lasse Schmidt
Opponents:	Associate Professor Henrik Sørensen, Dept. of Energy Technology, Aalborg University (Chairman) Professor Perry Li, University of Minnesota, USA Professor Petter Krus, Linköping University, Sweden

All are welcome. The defence will be in English.

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Abstract:

This thesis deals with various aspects related to the design and optimization of fast switching valves used in Digital Displacement machines. Here, the focus is primarily on developing model-based methods to predict the fluid dynamics during valve switching, because this is essential for predicting the performance of such machines.

The need for more detailed simulation tools is related to the time consuming process of developing new technologies/products in hydraulic systems. This applies to both performance and durability. One of the latest proposals for a more efficient pump technology has therefore driven the motivation for developing design methodologies and prototypes of so-called "digital valves".

Based on a valve concept and state-of-the-art design methodologies, a set of equations has been established to describe the motion of the valve plunger. The method is based on an interaction between equations solved analytically and numerically, to describe the influence of the flow geometry on the switching time and the fluid dynamic energy loss. During the optimization process, the simpler models are used to find a dimensioning that fits the purpose. Here, there is special focus on mechanisms that lower the speed of the plunger before it is stopped by the valve seat.

The primary conclusions regarding the flow geometry are drawn on the basis of transient and dynamic CFD simulations. The formulation of this simulation model is novel in the manner the dynamic mesh is updated and how the maximum time step is limited as a function of the current plunger position.