PhD Public Defence

Title: Real-Time Monitoring and Robust Control of Offshore De-Oiling Processes

Location: AAU Esbjerg Campus, Room C1-117

Time: Wednesday 24 May at 13.00

PhD defendant: Petar Durdevic Løhndorf

Supervisor: Associate Professor Zhenyu Yang

Moderator: Associate Professor Jens Bo Holm-Nielsen

Opponents: Professor Henrik C. Pedersen, Dept. of Energy Technology, Aalborg University (Chairman)
Emeritus Prof. Morten Lind, Technical University of Denmark
Dr. Ming Yang, NEL (UK)

All are welcome. The defence will be in English.

After the public defence there will be an informal reception at C2 Ground Floor at Esbjerg Campus.
Abstract:

The offshore Oil and Gas industry has been a major contributor to the global energy pool since the early 1960’s and continues to deliver a large quantity of oil and gas products. In the North Sea region, the oil and gas production has been in steady decline since the turn of the century due to maturing oil and gas reservoirs. This depletion of the reservoirs, due to extraction of oil and gas, has led to an increasing water concentration in the reservoirs. This is because the surrounding water fills the void of the extracted crude oil and also because water is deliberately pumped in to facilitate further oil and gas extraction. Before utilization the water must be separated from the oil and gas which is a costly process. The removal of oil from the water is, in addition, crucial in order to maintain a low oil concentration in the water that is discharged into the ocean, and must adhere to governmental limits. The separation of oil and water is commonly done using a system consisting of a gravity based separator and a downstream hydrocyclone, and this de-oiling system is the main focus of this PhD work.

Initial work investigated the operation of conventional de-oiling facilities to identify issues. This was done through a theoretical and experimental analysis of the de-oiling system’s operation, where the experimental work was carried out on an in house built scaled pilot plant.

One of the significant contributions of this work was the measurement of the hydrocyclone’s de-oiling efficiency ($\varepsilon$) in real-time using a novel technique, where the dynamic changes in $\varepsilon$ were successfully measured. This type of measurement is crucial in evaluating the de-oiling system’s performance and could potentially be used as a feedback parameter for a novel control solution.

The analysis of the de-oiling system showed that the system is affected by fluctuating inflows caused by slugging in the pipelines. The conventionally used PID control solution was observed to falter under such conditions, thus affecting the performance of the de-oiling facility. A robust controller was designed to handle the aforementioned disturbances to the system and to handle the coupled dynamics. The robust controller was designed based on a linear MIMO model of the de-oiling system, and as such a MIMO model was unavailable, it was developed as part of this PhD work. The robust control solution was compared to a conventional PID based control solution and the robust control solution was shown to be a significant improvement over the PID control solution.