DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Plant-wide Anti-slug Control for Offshore Oil and Gas Processes

Location: AAU Esbjerg Campus, Room A134

Time: Thursday 24 November at 12.30

PhD defendant: Simon Pedersen

Supervisor: Associate Professor Zhenyu Yang

Moderator: Associate Professor Jens Bo Holm-Nielsen

Opponents: Professor Rafal Wisniewski, Dept. of Electronic Systems, Aalborg University (Chairman)
Professor Bjarne Foss, NTNU, Norway
Dr. Yi Cao, Cranfield University, UK

All are welcome. The defence will be in English.

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

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Abstract:

In offshore Oil & Gas production processes the undesired severe slug flow regime can be present. The negative impact of severe slug is crucial to the production rate and process safety. In this work, the severe slugs which occur in the well-pipeline-riser system are experimentally and theoretically investigated though mathematical modeling, laboratory experiments, control system design and analysis, numerical simulations and laboratory implementations.

In general, this thesis studies the modeling and control of slugging flows which can occur in offshore well-pipeline-riser systems, from both theoretical and experimental perspectives. Some typical control-oriented mathematical models are reviewed and examined. Some extensions have been proposed for improving the model accuracies. The choice of control structure is analyzed based on the Input-Output (IO) controllability concept. All the respective studied measurements give better results than the frequently used riser topside pressure (P_t). A supervisory self-learning control strategy is developed and the results show that the decision making based on the supervisor drives the system close to the closed-loop bifurcation point, but a faster control scheme can reduce the settling time significantly. A number of anti-slug control strategies are proposed, where the robust control solution shows the best potential in both anti-slug control and production rate improvement. Simulation results show that control solutions with the riser bottom pressure (P_b) performs better than the ones developed for P_t. Furthermore, an alternative transmitter is experimentally investigated for online slug detection and monitoring. The transmitter is an Electrical Resistance Tomography (ERT) sensor measuring the electrical resistance over the cross-area section of the transportation channel. The results show that the transmitter can be a good alternative to conventional measurements if the oil-to-water ratio is low and the fluids are well-mixed. The severe slug's influence on the downstream separation process is examined. It is confirmed that the riser-induced slugs entering the gravity separator has significant impact on the pressure-drop-ratio (PDR) controller's tracking performance on the de-oiling hydrocyclone.