Conventional Control or AI-Based Control: What We Learned from Decade Research on the Advanced Process Control for Industrial Offshore Produced Water Treatment Processes

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Abstract: As the main side-stream from the offshore oil & gas production, the Produced Water contains different contaminants, including the hydrocarbon residuals, which are strictly forbidden to be discharged. The Produced Water Treatment (PWT) in offshore installation requires cost-effective solutions in order to protect the marine environment, and meanwhile minimize the correlated operational expenditures.

The research group at AAU Esbjerg has been committing extensive research in recent decades from the plant-wide process control point of view towards advanced control of PWT processes. Some conventional control solutions using PIDs, H_infty, MRAC and MPC etc. have been developed, tested and demonstrated based on a semi-industrial standard pilot-plant installed at AAU Esbjerg Campus as shown in the following figure 1. Though many promising results have been achieved using these conventional control solutions, some complicated multi-phase fluid dynamics still challenge the modelling of these processes, while different sensing technologies and instruments, particularly regarding to the online Oil-in-Water measurement, also lead to the concern of the quality of available process data. Thereby some AI-enhanced/-augmented control solutions are also explored, e.g., using Deep LSTM networks for modeling the separation dynamics of the de-oiling hydrocyclone systems, using off-policy reinforcement learning for model-free robust control development, as well as systematic optimization of hyperparameters of these AI models.

This presentation will give an overview of some main results and observations we achieved in these studies. Some advantages and limitations of different methods/solutions will be analyzed, along with suggested future research challenges.

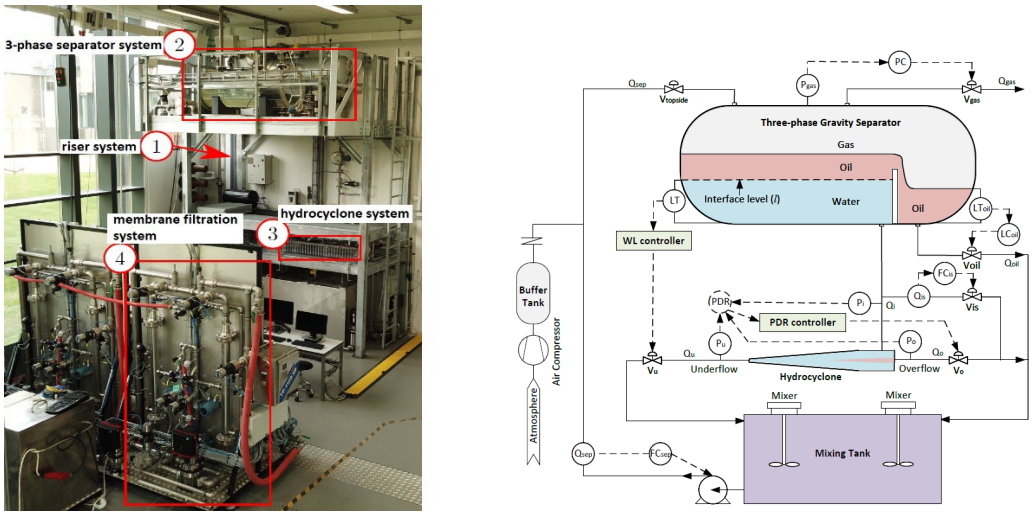

Figure 1 PWT Pilot-plant at AAU Esbjerg (left); Coupled 3-phase separator and hybdrocyclone (Right)

Keywords: PWT process, plant-wide control, robust control, MPC, MRAC, LSTM network, reinforcement learning.