Model Predictive Control for Slug Flow Suppression and Water Treatment in Daily Operations of Oil Field Facilities

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We develop a model predictive control (MPC) based advanced process control (APC) system for offshore oil and gas production processes that can significantly reduce oil concentration in discharged water while maintaining high oil and gas production. Using engineering domain knowledge, we model the flow line, the three-phase separator and the de-oiling hydrocyclones to simulate and control oil-in-water concentration in the produced water, while maximizing the oil and gas production. Figure 1 shows an illustration of the production system, from well to zero harmful discharge of produced water. We implement MPC technology for simultaneously stabilizing and optimizing the oil and gas production processes to maximize the oil production without violating legislative requirements of the discharged water. Novel sensors are combined with the APC system for monitoring oil-in-water concentration and providing data for modeling. The APC system will be tested using industry standard digital twins as well as in a pilot plant at Aalborg University in Esbjerg.

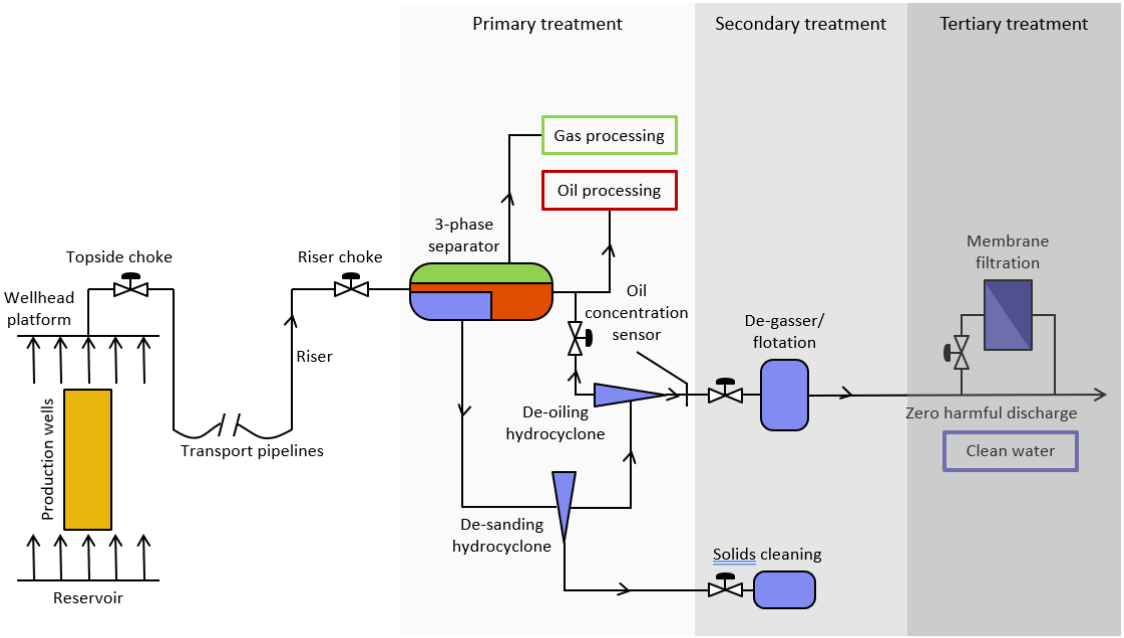

Figure 1: Units operations of offshore oil and gas production. The processes consists of a flow line and riser (where slug flow phenomenon can occur and cause large disturbances to the following separation processes), a 3-phase separator (oil, gas, water), de-oiling hydro-cyclones, de-gasser, and membrane filtration.