

Analysis and Control of an Integrated System of Oil Wells, Flowline, Riser, and Three-Phase Separator

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ABSTRACT

Oil is a resource of historical and economic importance, serving as the source of energy and raw material in the manufacturing of various industrial products. According to the International Energy Agency (2024), oil continues to play a significant role in the global economy, with no immediate substitutes for many of its key applications. It is unlikely that global oil demand will decrease significantly after reaching its peak, remaining at similar levels for an extended period. The aim of this study is to develop a comprehensive modeling approach that describes the flow from the well phase to the initial separation stage, aiming to explore the potential of Multivariable Predictive Control (MPC) in managing critical variables in the oil production system. The goal is to investigate the most effective control strategy to ensure compliance with quality standards, facilitating subsequent stages of the oil and gas production process. This includes maintaining proper specifications for the oil and water to be discarded, as well as reducing emissions of burned gases in the flare, while simultaneously seeking to optimize production. The FOWM (Fast Offshore Well Model) was used to represent the well, flowline, and riser, including frictional pressure drop calculations. The three-phase separator model followed the approach proposed by Nunes (1994), with efficiency based on Ribeiro (2012) work. With the complete model, MPC was applied to optimize production while keeping critical variables within predefined limits. The EMSO platform was used for modeling, which was later integrated with MATLAB for MPC implementation. Communication between EMSO and MATLAB was established through the EMSO OPC platform and Matrikon OPC tools. The results indicate that the model provided a comprehensive representation of the plant, reflecting the expected behavior of process variables. Moreover, it was concluded that the MPC control strategy offered advantages in the integrated model by allowing control and optimization through adjustments to specific variable setpoints and weights, rather than employing separate individual controls.

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