A Formulation for Robust Production Optimization of Gas-Lifted Oil Fields

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ABSTRACT

Managing production of complex oil fields with multiple wells and coupled constraints remains a challenge for oil and gas operators. Some technical works developed strategies for integrated production optimization to assist production engineers in reaching best operating conditions. However, these works have neglected the uncertainties in the well inflow-performance curves and production processes, which may have a significant impact on the operating practices. The uncertainties may be attributed to measurement errors, oscillating behavior, and model inaccuracy, among others. To this end, this work proposes a formulation in mathematical programming for robust production optimization of gas-lifted oil fields. The standard formulation considers the lift-gas allocation problem with separation limits and routing decisions, accounting for distinct operating pressures for each separator while only considering nominal values for all parameters. Yet, in addition, the robust formulation represents system-measured and simulated sample curves that reflect the underlying uncertainties of the production system. This representation leads to a robust MILP formulation obtained from piecewise-linear approximation of the production functions. The robust formulation is independent of the parameters chosen to carry the uncertainties. It also does not require knowledge of probability distributions, only assuming that the uncertain parameters are confined within a known set. Further, this work presents results from a computational analysis of the application of the robust and standard formulations to a representative oil field available in simulation software. A comparison between both solutions, when applied to different realizations within the uncertainty sets, shows that the standard solution may lead to an unfeasible operation, whereas the robust solution always gives a feasible operating condition. However, for some scenarios of the constraints the robust approach may provide a too conservative solution with underproduction.

KEYWORDS. Robust optimization. Gas-lift. Piecewise-linear functions.

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