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Predicting Hydrate Plug Formation in a Subsea Tieback

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Abstract

Field data from StatoilHydro on hydrate plug formation in the Tommeliten gas condensate field are compared to predictions of the hydrate growth model (CSMHyK-OLGA) for four typical operating scenarios: 1. steady state operation with failure of inhibitor injection, 2. restart of an uninhibited line, 3. restart of an under-inhibited line and 4. restart of a depressurized line.

Although the CSMHyK model was designed for oil flowlines, the model is able to predict the correct timescale for hydrate plug formation in this gas condensate tieback. The predicted locations of the plugs are often further upstream than observed in the field trials. This is mainly due to the assumption of a “hydrate-oil slip factor” of zero, which forces the hydrate to accumulate where it initially formed. In reality hydrate agglomerates would be carried further downstream before eventually jamming in dips.

Predicting where and when hydrate plugs will form in subsea tiebacks is of increasing importance as the industry strives to manage the risk of plugging in oil and gas flowlines while minimizing the use of costly and environmentally harmful chemicals for hydrate inhibition. The Colorado School of Mines has been developing the CSMHyK model for the past five years in collaboration with the SPT Group and several leading energy companies.

Introduction

Hydrates continue to be the most prevalent flow assurance problem in offshore oil and gas operations: an order of magnitude worse than waxes and two orders of magnitude worse than asphaltenes (Sloan and Koh 2008). The risk of hydrate plugging increases as the industry moves into deeper water with corresponding higher pressures from the additional liquid head, and to longer tiebacks in which the production fluids cool deep into the hydrate stability zone.

The cost of thermodynamically inhibiting such tiebacks under steady state and transient operations can be prohibitive and it is often not possible for the flow assurance engineer to avoid the hydrate stability zone in all foreseeable operating scenarios. Instead, a risk management approach is often adopted to prevent hydrate plug formation. Due to the potentially severe economic impact of forming a hydrate plug, it is critical to develop models that the flow assurance engineer can confidently apply when making a risk assessment of a new field design or restart procedure.

The Colorado School of Mines has been developing such a model in conjunction with SPTGroup since 2003. The model – CSMHyK – was initially developed for oil flowlines, but has also proven to be a valuable tool for Chevron when making design decisions for new field developments. Key to the development of CSMHyK has been the extensive testing against industrial flowloop data from ExxonMobil and Tulsa University (Boxall et al 2008) and against industrial field data as described in this paper.