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Flow Assurance Modeling: Reality Check and Aspects of Transient Operations of Gas/Condensate Pipelines

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Abstract

Statoil operates a number of gas condensate pipelines in the North Sea. This paper focuses on experience gained from operation and simulation, up to and including tail end, of the 150 km long 22” Huldra to Heimdal pipeline.

During initial production at Huldra the liquid accumulation was higher than predicted by modeling. Additionally liquid surge waves not found in simulations were observed at the receiving facility. These findings were challenging due to very low liquid surge capacity in the receiving facility, and the minimum flow rate was increased. Investigations were carried out in order to explain the observations, and it was determined that condensate carry over in the Huldra scrubber significantly influenced the condensate content in pipeline. The pipeline has now entered the tail end production phase. Due to high liquid content at low production rates, water/MEG no longer reaches the receiving facility on a regular basis, causing local hydrate problems at Heimdal and a lack of MEG for re-injection. Simulations show that cyclic operation of the receiving facility will transport water/MEG out of the pipeline on a more regular basis. This change in operating philosophy may be implemented in 2006.

Introduction

The traditional gas condensate development had a process facility close to the field, and the fluids would be exported through a single phase gas line and a single phase liquid line. This involved expensive process facilities at remote locations, often off-shore, and multiple pipelines. From the 1970’s significant research efforts was put into multiphase transport. As the ability to design two phase (gas and hydrocarbon liquid) pipelines advanced it was sufficient to dehydrate the fluid close to the field, and the hydrocarbons were transported in a multiphase pipeline. This gave significant saving due to a simpler and smaller process facility and a single pipeline (MLNG [1] in Malaysia, BLNG in Brunei, Sable Island in Canada and Nam Con Son in Vietnam). The last step in the development has been the ability to design three phase pipelines (gas, hydrocarbon liquid and water), which was achieved in the early 1990’s. This completely removes the need for the process facility, which are replaced by simple wellhead platforms (Huldra [2,3] and Troll [4] in Norway, South Pars in Iran, Ras Laffan and Qatar Gas in Qatar and Goldeneye in the UK) or complete sub-sea developments (Mensa [5] and Canyon Express [6,7] in the US, Scarab/Saffron [8] in Egypt, TOGI [9], Snøhvit and Ormen Lange [10] in Norway). Table 1 and Figure 1 summarizes the development of gas condensate pipelines by some of their key parameters, such as pipeline diameter, length, two phase versus three phase and development by wellhead platform versus subsea development. The present trend is that almost all pipelines are three phase, and most are subsea developments unless the water is shallow.

The main issues considered when designing gas condensate systems are usually pressure drop, liquid handling and hydrate prevention. Pipeline pressure drop is mainly related to selection of correct pipeline size, while liquid handling relates to slug catcher size and plant liquid processing capacity. A large diameter pipeline will usually give a low pressure drop, but a high liquid content, causing liquid handling problems, while a smaller pipeline diameter will give higher pressure drop, but less liquid content. In addition liquid handling and hydrate prevention are closely tied to the operational procedures of the pipeline, for operations such as rate changes, shut-in and start-up, blow-down and pigging. Other potential issues considered are corrosion, wax deposition and erosion.

Even with proper pipeline modeling during the design phase there are still uncertainties in the simulations results. This paper summarizes some of the experiences from modeling and operation of gas condensate pipelines. The simulation results are based on analysis using the multiphase pipeline simulation tool OLGA®.