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Minimizing Hydrate Inhibitor injection rates

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Abstract

Inhibitor injection is probably the most popular option for avoiding gas hydrate problems. However, inhibitor injection rates are normally designed based on worst operating conditions (i.e., maximum pressure and minimum temperature) with significant safety margin (e.g., 3-5 °C). Although the system pressure normally drops with time, the injection rates are not normally changed. Furthermore, large quantities of inhibitors are used during start-ups and maintained until the system conditions at monitoring point is well outside the hydrate stability zone. This is completely understandable considering the costs and risks associated with hydrate blockage which outweigh any savings associated with reducing inhibitor injection rates.

However, high inhibitor injection rates are not sustainable later in the life of the reservoir when the water cut increases, hence there is significant interest in developing monitoring and warning systems that can adjust inhibitor injection rates and warn against any potential hydrate blockage.

This laboratory has been investigating various techniques for monitoring hydrate safety margin and detecting early signs of hydrate formation for a number of years through several JIPs. After screening many techniques we have developed two main techniques for monitoring hydrate safety margin (i.e., how far the system is outside the hydrate stability zone) and detecting early signs of hydrate formation. The techniques have now been tested and implemented in many places around the world. These techniques enable us to adjust inhibitor injection rates based on system parameters, hence a more reliable and cost effective hydrate prevention strategy. In this communication we will present the developed techniques and some of the case studies.

Introduction

Injection of hydrate inhibitors is the most common measure to prevent hydrate blockages apart from dehydration and thermal insulation (including heating). There are three types of hydrate inhibitors in terms of inhibition mechanisms, including thermodynamic hydrate inhibitors (THIs), kinetic hydrate inhibitors (KHIs), and anti-agglomerants (AAs). THIs inhibit hydrate formation by shifting the hydrate phase boundary to lower temperature and higher pressure, moving the operation conditions outside the hydrate stability zone (HSZ), while KHIs do not prevent hydrate formation but delay hydrate nucleation and hinder hydrate crystal growth within a certain degree of subcooling, which allows the hydrocarbon fluids sufficient time to pass through the length of a transport pipeline where the thermodynamic conditions are inside the HSZ [1-5]. Contrary to THIs and KHIs, AAs allow hydrate formation but prevent individual hydrate crystals from agglomerating together, therefore, maintain the hydrocarbon system transportable [5, 6].

In practice, injection rates of a hydrate inhibitor is determined based on the predicted or measured hydrate phase boundary and the operation conditions such as temperature and pressure, water-cut, and possible loss of the inhibitor to non-aqueous phases. In some cases, for example, severe thermodynamic conditions or well start-up, high concentrations up to 60 mass% of mono ethylene glycol (MEG) and methanol (MeOH) may be required to achieve sufficient inhibition [6, 7]. In comparison with THIs, typical concentrations of KHIs and AAs are less than 3% so that KHIs and AAs together are known as low dosage hydrate inhibitors (LDHIs) [8, 9]. To ensure gas hydrate risks are eliminated for the worst conditions and any uncertainties in the

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