Novel Pipeline Materials for Managing Hydrate Formation

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Under all realistic scenarios for energy utilisation to 2050, including those targeting net zero, natural gas will continue to play a major role for electricity generation and as a chemical feedstock. Continuing to produce this vital resource is therefore critical to meeting the ongoing needs of our industrial civilization. This will require production from remote offshore assets that are currently considered “stranded” due to the cost requirements associated with development. The mitigation of solids blockage hazards with flow assurance solutions is a major contributing cost – with hydrate blockage a particular concern.

Traditionally, hydrates have been dealt with by avoidance through the addition of inhibitors which shift the thermodynamic stability region of solids formation. This is an expensive proposition, and significant effort has therefore been devoted to moving towards a paradigm of hydrate management, in which limited formation may be acceptable, provided that *blockage* is avoided. Management techniques include both chemical and physical approaches. Under-inhibition with thermodynamic inhibitors can reduce the size of injection facilities or extend the life of brownfield developments, while low dosage anti-agglomerant or kinetic inhibitor strategies offer a nominally lower cost method of avoiding failures. Among the physical approaches, the use of subsea separation may reactant limit the quantity of hydrate that is able to form, while thermoplastic composite materials offer a solution to prevent deposits adhering to flowline walls.

This work deploys a low pressure Micro-Mechanical Force Apparatus to measure the adhesive force of model structure II cyclopentane hydrates to a thermoplastic composite pipe wall. We show that the adhesive force is reduced on the order of 80% versus a carbon steel surface and shows no variation as a function of contact time. Further, when an anti-agglomerant was added to the system, the contact force was reduced below the detectability threshold of the apparatus. These experimental results were coupled with flow simulations using the OLGA® transient multiphase software, to understand the macro-scale implications for production.

We present an example case which makes use of a subsea separator based on the pseudo dry gas concept to simulate the effect of hydrate formation in both a large ID gas return line – using the UWA Gas Dominant Hydrate Extension – and a small ID liquid return line – using the CSM Hydrate Kinetics model. We demonstrate the complementary nature of these different models in assessing the viability of hydrate management strategies, where the combination of experiments and modelling suggest that, for such systems: i) hydrate formation is water-limited in the gas line, and it may be easily transported; ii) hydrate severity in the liquid return line is heavily a function of the condensate to water ratio and; iii) several viable strategies exist for managing hydrates in the liquid return line. The combination of experimental and modelling capabilities that are now emerging in the research space will be critically important for meeting our future requirement for cost-effective natural gas.