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Impact of rusty pipelines on risk of hydrate formation

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The North Sea is covered by close to 8000 km of pipelines transporting hydrocarbons. Pressures are high and temperatures are generally low. Temperatures can be as low as 272 K in the north, due to seawater salinity, and rarely exceeds 279 K for the southernmost pipelines. The most common procedure for hydrate risk analysis involves calculation of water dew-point for a gas mixture containing water. Pipelines are normally covered by rust even before they are put in place. Rust is a mixture of iron oxide and one of the most stable is Hematite, Fe_2O_3. Due to the distribution of partial charges on the Hematite surface, adsorbed water will be highly structured, resulting in low chemical potentials and low adsorption energy for the water molecules. The adsorbed water on the walls is thermodynamically cold in terms of the functional derivative of the internal energy of the adsorbed layer with respect to the entropy of the adsorbed layer. This fact adds on top of the walls being the coldest region of the pipeline due to the cooling towards outside seawater. The low chemical potential of adsorbed water and incompatibility of partial charges between Hematite and hydrate surface will not permit hydrate to directly attach to the surface of the walls but the walls can serve as nucleation surfaces and hydrates formed can be bridged by structured water layers to the rusty pipeline surface. Earlier studies for various simple hydrocarbon systems indicate that the tolerance for water content based on dew point might be 20 times higher than the water content corresponding to water adsorbing from gas onto solid Hematite surface. In this study, we apply a similar comparison for a real hydrocarbon mixture for the first time, using composition data which is openly available for the troll gas from the North Sea. Since the average chemical potential of adsorbed water can be as much as 3.4 kJ/moles lower that liquid water chemical potential route to hydrate formation dominates totally in determining the risk of water dropping out from the gas and eventually forms hydrate.

Biography

Bjørn Kvamme obtained his MSc in Chemical Engineering (1981) and PhD in Chemical Engineering (1984) from the Norwegian University of Technology and Natural Sciences. After a short period with SINTEF and two years at Bergen University College, he was appointed as full Professor in 1987 and started education of MSc and PhD in Process Technology in Telemark. He is appointed as a Professor in Gas Processing at the Department of Physics, University of Bergen in March 2000. He is the author/co-author of 422 publications during last 25 years, of which 148 are in good international scientific journals. He has 2270 citations as per May 1, 2017, and has presented numerous papers at international conferences.

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