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Hydrate Monitoring and Warning System: A New Approach for Reducing Gas Hydrate Risks
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ABSTRACT

The current industry practice for hydrate prevention is injecting hydrate inhibitors at the upstream end of pipelines based on the calculated/measured hydrate phase boundary, water cut, worst pressure and temperature conditions, and the amount of inhibitor lost to non-aqueous phases. In general, systematic ways of controlling and monitoring along the pipeline and/or downstream to examine the degree of inhibition are very limited.

It is also known that hydrate formation would result in some changes in the aqueous phase. Therefore, it should be possible to detect initial hydrate formation by detecting these changes. The focus of our work is to develop a warning system against initial hydrate formation either by detecting minute hydrate particles and/or any changes in the water structure. The aim is to give the operator adequate time to initiate remedial steps prior to massive hydrate formation/build up which could result in pipeline blockage.

In this paper, we present a new approach for hydrate monitoring and warning system using physical property measurements such as dielectric properties and ultrasonic wave signal. The results demonstrate that dielectric properties at microwave frequencies has potential to be used as a downstream analysis and online analysis for detecting the initial hydrate formation and/or presence of hydrate particles and/or change in water structure due to hydrate formation. The ultrasonic signals (e.g., FFT and amplitude) could detect the presence of minute hydrate crystals and even nuclei, while there is no sign of hydrate formation from monitoring system pressure. The results are very encouraging and could potentially change the industrial approach to gas hydrate control strategy.

This work is part of a comprehensive project which covers monitoring the degree of inhibition against hydrate formation to further improve the safety of offshore/deepwater operations, as well as optimizing inhibitor injection rate to minimize their environmental impact and improve the economical aspects of the development. Some of the methods developed in this work are equally applicable to reducing the risks associated with wax and/or salt depositions, further improving the flow assurance aspects of deepwater developments.