

Investigating the performance of clathrate hydrate inhibitors using in situ Raman spectroscopy and differential scanning calorimetry

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ABSTRACT

Raman spectroscopy and differential scanning calorimetry have been used to determine the kinetics and mode of action of a range of inhibitors on tetrahydrofuran (THF) hydrate formation. The results from these kinetic measurements were compared to those obtained from gas hydrate studies. The thermodynamic inhibitory nature of methanol was reflected in the findings as expected. However, some nucleation retardation was also observed at all concentrations studied, with higher concentrations of methanol resulting in ice formation. Addition of poly-N-vinylpyrrolidone (PVP) to THF/water mixtures caused nucleation times to increase and crystal growth to decelerate. No significant synergic effect was observed for THF hydrate inhibition using a combination of PVP and one of two glycol ethers, which were found to dramatically increase nucleation periods in natural gas hydrate formation. Only a slight synergic tendency was observed for the combination from the DSC results, while the Raman data gave no indication of a synergic effect for the combination. The results suggest that the nature of the guest species may be an important factor in the mechanism of hydrate inhibition.