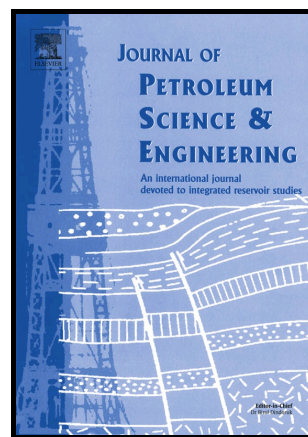


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KINETIC HYDRATE INHIBITOR REMOVAL FROM PRODUCED WATERS BY SOLVENT EXTRACTION

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Abstract

Kinetic hydrate inhibitors (KHIs) offer an attractive option for the prevention of gas hydrate problems in hydrocarbon production operations, and are seeing increasing use within the industry as an alternative to traditional inhibition methods. However, there are several challenges emerging in the handling/treatment and disposal of produced waters containing KHIs. KHIs typically contain polymers as the active component and these can precipitate as solid/semi-solid deposits at higher temperatures and/or in the presence of saline fluids, potentially causing fouling problems. This can occur during produced water handling, for example where KHI containing waters may mix with higher temperature / higher salinity waters prior to re-injection, fouling storage / pumping facilities. Furthermore, precipitation may occur in response to high temperatures experienced during re-injection into formations, where fouling can potentially result in reduced injection efficiency. In addition, there is increasing interest in reducing levels of thermodynamic inhibitor used for hydrate prevention – particularly in the case of MEG – by combining these with KHIs. In this instance, KHI drop-out could result in fouling of MEG regeneration units, interfering with production operations. Here we report the results of preliminary investigations into a technique for KHI removal from produced waters based on solvent extraction. The method uses small fractions of largely water immiscible solvents with a high affinity for KHI polymers. Contact between the solvent and aqueous KHI results in strong partitioning of the KHI polymer into the solvent. The solvent containing the polymer can then be separated by standard physical methods used to separate water and hydrocarbons (e.g. gravity settling, centrifugal separation, coalescing separation). Results show that it is possible to remove up to 100% (within detection limits) of some common KHI polymers (e.g. poly-n-vinylcaprolactam / PVCap), potentially providing a simple means to eliminate or mitigate fouling problems associated with KHI containing produced water handling/treatment.

Keywords: KHI, PVCap, hydrate inhibition, polymer removal, produced waters

Nomenclature

CGI	Crystal growth inhibition
CI	Corrosion inhibitor
EGBE	Ethylene glycol butyl ether
HSZ	Hydrate stability zone
KHI	Kinetic hydrate inhibitor
MEG	Mono-ethylene glycol
MeOH	Methanol
PLONOR	Poses little or no risk to the natural environment
PVCap	Poly-n-vinylcaprolactam
TC	Treatment chemical solvent
SI	Scale inhibitor
TI	Thermodynamic inhibitor
t_i	Hydrate induction / hold time
ΔT	Subcooling [$^{\circ}\text{C}$]

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