The influence of chemical inhibitors on the rheological properties of waxy crude oil

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Abstract

Oil companies are expanding their activities in cold environments such as offshore deep water and onshore for more reservoirs due to increased global demand for energy. These oil companies face the problem of wax deposition from the crude oil building up on the pipe wall during hydrocarbon processing in the cold climate. It contributes to a rise in operating and remedial costs, as well as a reduction in productivity, although simultaneously stifling oil production Wax inhibitors are one of the mitigation technologies whose effect on crude oil viscosity and wax appearance temperature has been studied (the temperature at which the first crystal of wax starts to deposit from crude oil). During this research, the performance of wax inhibitors such as acetone, copolymer + acrylate monomers coded W804, and copolymer + acrylate monomers coded W804 and copolymer + acrylate monomers coded W804 and copolymer + acrylate monomers coded W804 and copolymer + acrylate monomers coded W805 was evaluated to determine their effects on the crude oil rheology, using the programmable remoter rig at gradient temperatures 55 to 0°C and shear rate 120 1/s. By applying 250, 500, 1000, 1500, and 2000 ppm of inhibitor mixtures to crude oil, the synergy of using mixtures of such chemical inhibitors was investigated. Acetone with copolymer + acrylate monomers (W804) is used in the first mixture, and acetone with copolymer + acrylate monomers is used in the second mixture (W805). In comparison to their original components, these mixtures perform well. Without inhibitors, the wax appearance temperature of the crude oil used in this analysis is 30°C. At concentrations of 250, 500, 1000, 1500, and 2000 ppm, the first mixture of inhibitors lowered the wax appearance temperature of oil to 25.2, 24, 18.4, 16.8, and 15.4°C, respectively. At concentrations of 250, 500, 1000, 1500, and 2000 ppm, the second mixture of inhibitors lowered the wax appearance temperature of the crude oil to 24.3, 21.7, 16.7, 15.3, and 14.2°C, respectively. This combination of inhibitory properties and a major decrease in wax appearance temperature and oil viscosity makes it a one-of-a-kind contribution to wax removal methods.

Paraffin deposition is a significant issue, particularly during crude oil transportation through pipelines and during tubing string development, where the unwanted material causes an increase in pressure drop (requiring higher pressure to transport the crude oil). Paraffin is a class of i-alkanes and n-alkanes with a long hydrocarbon chain that is normally linked by single bonds. Solid wax deposits usually contain high molecular weight paraffin's with carbon numbers ranging from 18 to 75 and melting points ranging from 40 to 70 degrees Celsius. Figure 1 shows the conformational structure of the lowest-energy chain alkane, which consists of carbon atoms with hydrogen atoms in planes moving perpendicularly through the carbon atoms to the chain axes. Strong phase specific heat is usually between 1.80 and 2.30 kJ/kg•K.

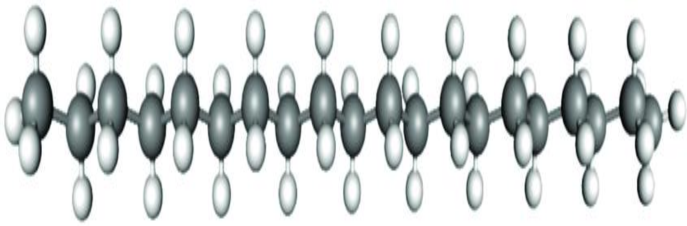

Figure 1. Structure of the lowest energy chain alkane.

Microcrystalline wax leads to tank-bottom sludge and microcrystalline wax triggers flow assurance issues in manufacturing and transportation operations. Paraffin wax crystallizes or precipitates out of crude oil before being deposited. The precipitation of paraffin wax occurs in two stages, which are recognized 2020, 10, 479; doi: 10.3390/app10020479; www.mdpi.com/journal/applsci as nucleation and crystal formation, Appl. Sci. 2020, 10, 479 2 of 18 as the temperature of the crude oil drops below the wax appearance temperature, nucleation occurs (WAT). The wax molecules cluster together, giving the surface a cloudy appearance—hence the term "cloud point," which refers to the WAT meaning. The paraffin wax molecules gradually bind and detach until they enter a critical size cluster, at which point they become stable. These clusters are called nuclei, and the process of nucleation is the creation of these nuclei. In the absence of contaminant or nucleating materials, homogeneous nucleation occurs. Meanwhile, in the presence of nucleating material(s) in the liquid, heterogeneous nucleation occurs. After the nuclei have stabilized, the crystal growth phase continues as more molecules bind in a plate-like or lamellar structure. While wax does not adhere to the pipe wall, the precipitation of wax can cause an increase in crude oil viscosity in general. A group of researchers has looked into the relationship between crude oil properties and rheology, including the deposition as well as the precipitation of wax during flow. The established correlation is used to forecast the start of wax deposition and precipitation in the pipeline. A cold finger device, flow loop, or viscometer apparatus is the traditional method for investigating wax precipitation. Nonetheless, modeling Deposition along pipeline walls

With precision is difficult. Thermodynamic factors, hydrodynamic flow, heat and mass transfer, as well as solid–solid and surface–solid interactions all contribute to this. Manually calculating wax deposition in the presence of multiphase flow is much more difficult due to the various variables that must be taken into account. In addition, over the last few years, researchers have proposed a few wax deposition models to explain wax precipitation using computer simulation software such as Schlumberger's OLGATM, Kongsberg's Leda Flow, and KB's FloWax. A reference for Model Software Description OLGATM Rygg, Rydahl, and RØnningsen Wax deposition in wells and pipelines is predicted using a multiphase flow wax deposition model. OLGATM Matzain to predict wax deposition, a semi-empirical model that takes into account shear stripping, molecular diffusion, and shear dispersion is used. Heat as a metaphor OLGATM is a trademark of OLGA, Inc. Using the heat transfer analogy, calculates the mass transfer rate of wax. Leda Flow Model from the University of Michigan The wax crystallization and wax deposition on the pipe wall was modelled. FloWax is a brand of wax made by FloWax FloWax is a full compositional wax deposition model that takes into account wax precipitation thermodynamics, wax diffusion using a heat and mass transfer analogy, and the shearing effect. As a result, the aim of this review paper is to address the current state of knowledge about the wax deposition process in pipelines.

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