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Evaluations of the effect of selected wax inhibitive chemicals on wax deposition in crude oil flow in sub-sea pipe-lines

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ABSTRACT

Comparative studies were made on the effect of different wax inhibitive chemicals on the wax deposition volume during crude oils flow in pipeline. Two crude oils from Ovhor and Jisike oil fields in the southern part of Nigeria were used in the study. The four identified chemicals: Alkyl sulphonates (wax dispersant), polyethylene (wax inhibitors/crystal modifier), acrylate ester copolymer (pour point depressant, PPD) and xylene (wax solvents) inhibit wax deposition to varying degree of between 14.6–44.9% for crude oil A, and between 21.6–41.4% for crude oil B when 1500 ppm of each chemical was mixed with the crude oil sample. The optimal wax inhibition formulation of polyethylene, xylene, acrylate ester polymer and alkyl sulphonate contains 40.4, 19.2, 27.6, 12.8% and 36.3, 21.5, 25.8, 16.4% for crude oil A and B respectively. Applications of the optimal formulated mixtures of the above chemicals inhibit wax deposition by 58.9% and 62.4% for crude oil A and B respectively.

KEYWORDS

wax inhibition; flow facility; optimal formulation; dimensionless wax thickness; wax deposition

1. Introduction

Wax deposition being one of the most severe flow assurance problems in both onshore and offshore production facilities. It is due to nucleation, precipitation, coalescence and deposition of heavy paraffin (wax) present in the crude oil on the pipelines walls and in the process vessels. The depositions choke the production lines, increasing the crude oil production cost to uneconomical level. Recent efforts have been on the use of chemicals to prevent wax deposition. The chemicals are added to the well stream at the well head or at the manifold header to disrupt the nucleation and coalescence of the wax particles. Four classes of chemicals used to inhibit wax deposition are: wax dispersants, wax inhibitors or wax crystal modifiers, pour-point depressants (PPDs) or flow improvers and the wax solvents (Theyab and Diaz 2016: Norland 2012). Wax dispersant break the wax crystal into smaller particles thereby minimizing the rate at which wax particles adhere to the pipe wall reducing the wax deposition rate in the process (Kang et al. 2014; Ahn et al. 2005; Dobbs 1999). Wax inhibitors or wax crystal modifiers posses similar structures as wax, hence they get embedded into the wax network get co-crystalline with the wax crystal making the wax crystal to be weak and consequently get eroded by the shear stress exerted by the fluid flow (Pedersen and Ronningsen 2003). Pour point depressants prevent the precipitation and coalescence of wax crystal by modifying the wax structure. The effect is the reductions in the wax network, the formation of smaller wax aggregates lower the pour point and the viscosity of the crude oil making their transportations easier (Manka and Ziegler 2001). While the solvents increases the solubility of wax crystal in the crude oil dissolving the deposited wax (Jang et al. 2007: Norland 2012; Kang et al. 2014). Table 1 below shows the some of the chemicals that have been used for each of the above wax inhibition process. Each of

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