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An Experimental Study of Rheological Properties of Nigerian Waxy Crude Oil

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Abstract Nigerian crude oils are known for their good quality (low sulfur, high American Petroleum Institute gravity). However, similar to any other paraffinic-based crudes, most Nigerian crudes contain moderate to high contents of paraffinic waxes. These waxy crudes exhibit non-Newtonian flow behavior at temperatures below the cloud point because of wax crystallization. In order to accurately predict flowing and static temperature profiles, design waxy crude oil pipelines, evaluate flow interruption scenarios, and start up requirements in the handling of waxy crude oils, the effect of temperature and shear rate on the rheology of crude oils must be determined. This work presented some experimental results on the rheology of two waxy crude oils produced from different Nigerian oil fields. A Brookfield DV-III ultraprogammable rheometer (Brookfield Engineering Laboratories, Middleboro, MA) was utilized. The temperature dependence of rheological properties and thixotropy of these crudes were investigated. The influence of some petroleum-based diluents to depress the wax appearance temperature (WAT), their effect on the thixotropic/yield pseudoplastic behavior of two Nigerian crudes were studied and it was observed that lower wax content crude has higher tendency to regain its cohesive lattice bonding (yield strength) when left undisturbed for some days at its gel point after agitation. The experimental results showed that the addition of petroleum-based diluents to the lower wax content crude oil leads to its lost some of its yield strength regaining capacity.

Keywords paraffinic crude, pour points, rheological properties, shear rate, thixotropic behavior

Introduction

Wax precipitation results in handling problems and increased production costs. Despite these problems waxy crudes are of economic importance because of their lightness, low sulfur content, considerable reserves worldwide, and higher prices.

Rheology is the study of the change in form and flow of matter in term of elasticity, viscosity, and plasticity. A clear understanding of the rheological properties of waxy crude is vital in the design and construction of petroleum pipelines, and subsurface and surface production equipment in the oil industry.

The rheological behavior of waxy oil is thus considered to have crucial importance in the design of pipeline, flow handling equipment, and processing purposes. Similar to global trend of occurrence, Nigeria has a substantial reserve of paraffinic crude oils (Ajienka and Ioku, 1997). Also the terminal blends contain substantial amounts of wax. Holder and Winkler (1965) reported that just 2% wax content is enough to give rise to a high pour point. Characteristically, waxy crude oils have undesirably high pour points.

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