Rheo-PIV Analysis of the Yielding and Flow of Model Waxy Crude Oils

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Abstract

Waxes are a commonly encountered precipitate that can result in gelation of crude oils and cessation of flow in pipelines. In this work we develop a model wax-oil system that exhibits rheological behavior similar to waxy crude oils encountered in production scenarios. To study the consequences of gelation on the rheology of the model system we perform simultaneous measurements of the bulk flow behavior using rheometry and of the local shearing deformation using Particle Image Velocimetry. The bulk rheological measurements are correlated to deviations from the linear velocity profile anticipated for a homogenous sample undergoing simple shear - this provides new insights into the structural and rheological evolution of these wax-oil systems under representative shearing conditions.

The restart of flow and breakdown of the gelled wax-oil structure is observed under two scenarios - a constant applied stress, and a constant applied strain rate. In addition, the effect of varying surface roughness on flow restart is investigated by comparing the temporal evolution

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of the velocity fields for an initially gelled fluid in contact with both a roughened and smooth surface. The material response in each case indicates that some classes of surface act as slip inhibitors and prevent the gelled wax-oil system from slipping against them. This promotes bulk deformation and the more rapid breakdown of the gel structure. These results are consistent with recent observations in other jammed/yielding systems and have an immediate bearing on pipeline restart strategies.