

PARAFFIN AND ASPHALTENE DEPOSITION RESULTING FROM COMMINGLING OF OILS DURING PIPELINE TRANSPORTATION AND STORAGE.

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ABSTRACT

Commingling of oils from different reservoirs and different sources is a common process during production and transportation. In certain situations, this may lead to the precipitation of solid residues and cause serious production problems. The question arises as to the nature of the solid residues produced in this manner. Are they waxes or asphaltenes or mixtures? In this paper we will describe a recent study of such a problem. Using recently developed processes in our laboratory the characterization of such a residue in a storage tank in terms of its asphaltene and paraffin content will be described. In addition high temperature gas chromatography has been used to document high concentrations of hydrocarbons up to C_{30} in the wax despite their relatively low concentration of these components in the original sample. Laboratory mixing experiments have also been undertaken in an effort to simulate the production of such residues in the storage tanks to determine whether or not such problems could have been avoided by adjusting the relative proportions of the two oils prior to mixing in the pipeline.

INTRODUCTION

In many cases crude oils produced from different wells in the same field have to be commingled during production or in pipelines to storage facilities prior to shipping. In certain situations oils, which when transported independently may not produce any problems, may have significant problems resulting from paraffin or asphaltene deposition when commingled with other oils with slightly different properties but produced from the same field. In a recent study we had the opportunity to examine such a situation from a geochemical perspective. In this study, two oils being produced from a certain field had to be commingled and transported via pipeline to a storage tank prior to shipping. Neither of these oils showed any signs of paraffin or asphaltene deposition when transported individually. However when commingled, it was observed that within a relatively short period of time, the storage tank containing the commingled oils was filled to about 30% of its capacity with a black residue. Characterization of this residue demonstrated that it consisted of predominantly paraffins with a small amount of asphaltenes. In this paper it is proposed to discuss the characteristics of the original oils, particularly in terms of their wax contents as determined by high temperature gas chromatography, as well as the characteristics of the black residue and the liquid oil in the storage tank. It is also anticipated that by the time of the meeting additional laboratory data will be available to show the nature of the residues formed as a result of mixing various proportions of these two oils in the laboratory and permitting them to stand for different periods of time.

DISCUSSION

In the initial part of this study oils from the two sources were characterized by high temperature gas chromatography. The resulting chromatograms obtained in this way suggested that the oils contained some high molecular weight hydrocarbons above C_{35} , although the concentrations of these compounds were relatively low. In order to get a better indication of the distribution of hydrocarbons in these samples a wax concentrate was isolated from each sample and using a method developed in our laboratory the asphaltenes were quantitatively separated from the wax components. HTGC analysis of the asphaltene fraction clearly showed that there were no hydrocarbons in the wax fraction. HTGC analysis of the wax concentrate gave a clearer picture of the HMWHC distribution but clearly the relative concentrations of these compounds was still relatively low in the individual oils.

As mentioned above mixing of the two oils in question did not produce any paraffin deposition problems in the pipeline transporting the mixture to the storage tanks. IN Fig. 1 the top chromatogram shows the oil mixture from the pipeline and the relatively low concentration of HMWHCs present in this mixture. However in the storage tanks a considerable quantity of a heavy black residue accumulated over a relatively short period

of time. This residue was treated in the same way as the oils, with the separation of a wax concentrate and removal of the small quantity of asphaltenes in the sample. The wax content in this sample was around 34%, asphaltenes 0.5% and the remaining part of the sample was low molecular weight hydrocarbons. Fig. 1c shows the HTGC chromatogram for the residue and it can be seen very clearly that there has been significant concentration of the hydrocarbons in the region above C_{40} , and in view of the relatively low concentrations of these compounds in the original oils this clearly represents the accumulation from several filling episodes of the tank. Quantitation of individual components in this wax concentrate and comparison with their concentrations in the original sample should permit one to determine the volumes of oils necessary to produce this amount of residue.

Fig. 1b shows the HTGC chromatograms of the oil produced from the storage tank. A comparison of the chromatogram for the pipeline mixture and the produced oil from the storage tank shows that the difference in the envelope of these two chromatograms represents the wax material that has precipitated in the storage tank. Over time significantly higher concentrations of the compounds above C_{40} have accumulated.

SUMMARY

Whilst HTGC could not prevent this type of wax accumulation it does provide us with the ability to quantitatively assess what is happening in this particular situation and determine the amount of material that is basically being lost as a result of mixing these two oil samples. Furthermore it is anticipated that careful and detailed laboratory mixing studies should permit one to determine the optimum mixture of these two oils which will minimize the amount of wax precipitation occurring in the storage tank as a result of mixing the two oils. Finally it is also suggested that no wax problems are observed in the pipeline transporting the mixture of these two oils simply because of the turbulence and shearing effects in the pipeline preventing such deposition. The wax crystals in this particular case are of a microcrystalline nature and relatively fine. Hence it is only when the oil has reached the storage tank that these crystals can finally undergo separation as a result of gravitational segregation. The use of HTGC is also vitally important in these types of studies since it permits one to clearly differentiate between the waxes and asphaltenes and also on the purity of these different fractions which can have a significant impact in any purification or remedial steps that may be used at a later stage of the process.

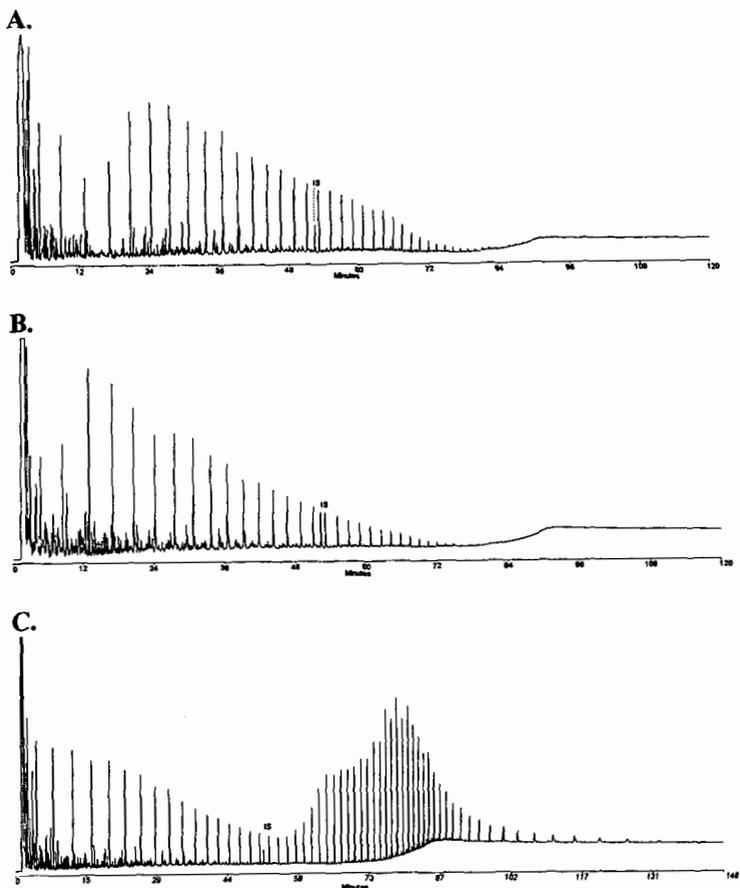


Fig. 1. Chromatograms showing (a) the pipeline mixture (note-IS is the internal standard and is $C_{24}D_{50}$); (b) the liquid crude in the tank; and (c) the solid residue in the tank (note also that the top two chromatograms have total run times of 120 mins and the bottom chromatogram has a run time of 146mins).