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Asphaltene deposition inhibitors – a case study from laboratory chemical selection to field downhole injection trial in ESP lifted wells

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Abstract
Laboratory tests are usually performed at atmospheric pressure under excessive presence of liquid alkane to select asphaltene deposition inhibitors and dispersants. However, the relationship between laboratory and field conditions performances is unclear. This may lead to poor choices of selection criteria and to subsequent high operating costs by not selecting the most efficient chemicals. The goal of this study is to compare the field efficiency to laboratory results using multiple protocols. Under addition of n-heptane at various proportions, each laboratory protocol respectively investigates the effect of the tested chemical at multiple scales on i) the dispersion/aggregation of unstable asphaltenes, ii) the concentration of unstable separated asphaltenes, iii) the deposited mass of asphaltenes on an immersed sensor and iv) the viscosity of crude oil with commencing asphaltenes aggregation. The chemical selection results are then compared to the effect of the selected chemical(s) on the electrical submersible pump performances of a heavy crude from a South European field. This study shows how chemicals efficiency may be complicated to assess depending on the mechanism that mainly governs faced issues and to protocols of laboratory tests.

Keywords
Asphaltenes; Chemicals; Selection

Introduction
Asphaltene inhibitors, dispersants and deposition inhibitors are interchangeably used terminologies to describe chemicals used to control encountered issues related to asphaltenes in oilfield production. The injection strategy and the selection however both depend on the mechanism by which asphaltenes are constraining the flow during production operations.

Methodology
A closed stirred-batch reactor is introduced to measure asphaltenes deposition during the continuous titration of n-heptane in an initial volume of crude oil. The apparatus consists of an immersed sensor in a center-position of the reactor.
A centrifugation method is used to estimate the concentration of unstable asphaltenes as a function of time in oil-heptane mixtures, schematically illustrated in Figure 1.

Figure 1. Schematic representation of the used method

Spectrophotometry and/or turbiscan is used to evaluate the dispersing effect of asphaltenes from a crude oil droplet in heptane.
Viscosity evolution of crude oil is measured with asphaltene induced aggregation by heptane addition at moderate fraction.
Results of the 4 laboratory methods are cross-compared and compared to the following field data: ESP differential pressure performance and oil production rate as a function of time. In addition, performed soaking operation(s) of an aromatic solvent in a well provided crucial information to understand predominant mechanisms by which productivity losses happen in the field of interest.

Results and Discussion
Results obtained in the present study show that such chemical selection remains case dependent and may be multi-factorial (effect on equilibrium concentration of unstable asphaltenes, delay of destabilization, delay of aggregation etc).
Results of spectrophotometry suggest that 2 different families of additives have been suggested by chemical vendors upon candidate submission during a call for tender process involving tests in respective vendors laboratories using the crude oil of interest. As illustrated in the following Figure, 4/8 submitted chemicals tend to increase aggregation kinetics as the absorbance of the sample

decreases faster than the reference. However, 3 inhibitors showed an ability to disperse asphaltenes aggregates.

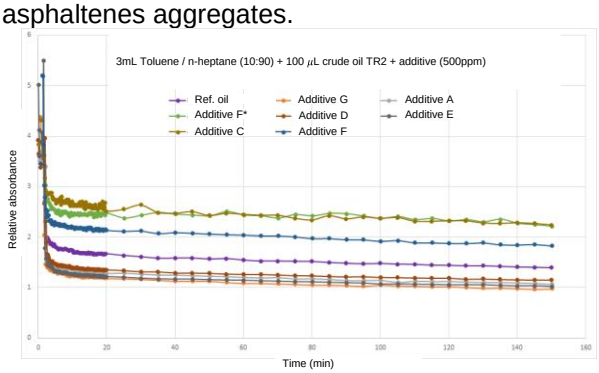

Figure 2. Absorbance of heptol + crude oil solutions as a function of time with various additives

Results of centrifugation method show coherent trends, suggesting that additives C and F do not only delay the unstable asphaltenes aggregation but rather decreases their concentration compared to blank test.

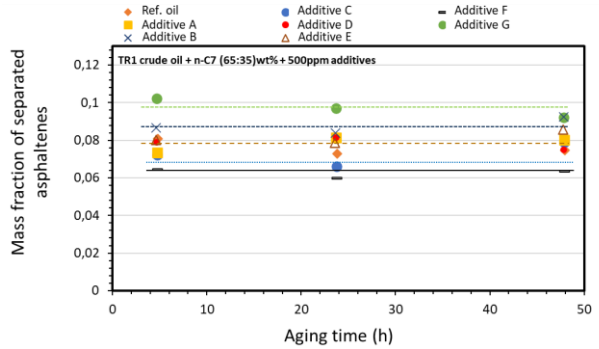

Figure 3. Centrifuged mass fraction of asphaltenes from crude oil + heptane mixtures as a function of time for multiple additives

In addition to the above results, viscometry and deposition mass recorded by an immersed piezoelectric sensor are being collected.

Meanwhile, a field trial campaign is ongoing with encouraging results, definitive conclusions cannot be shared at this stage.

Well performance simulations are used to support hypotheses and findings of the study related to transport properties of the produced oil and to the degradation of ESP performances. Final results are under comparison to field trial data in order to consolidate and present them.

Conclusions

In conclusion, good practices of asphaltene deposition inhibitors and dispersants are found thanks to results of an extensive chemical selection process (x4 different experiments) and to field trial feedbacks. Results show that asphaltene deposition may not occur as expected while transport properties of the extracted crude oil may be varying along the field life.

The study suggests that laboratory protocols must be adjusted to replicate as closely as possible mechanisms encountered in the field.

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Responsibility Notice

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