

Using geochemistry to identify and control asphaltene deposition and improve flow assurance strategies in onshore Middle-East carbonate fields

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Asphaltene deposition is a relatively common flow assurance challenge in the Middle-East, especially in maturing fields. Deposits in these fields are encountered along the entire production system, from the perforations to processing facility equipment.

Prediction of asphaltene deposition in maturing fields, as well as in new developments, remains challenging. Oil reservoirs in the Middle-East are often graded, with substantial vertical and lateral variation of fluid properties and, hence, varying behaviour towards asphaltene precipitation and deposition. Typically only a small fraction of the producing wells experience deposition in the wellbore (Fig. 1). However, secondary or tertiary recovery mechanisms may further localize asphaltene deposition. Asphaltene mitigation strategies are often based on a single representation of the reservoir fluid composition and variation of fluid properties across the field is not taken into account. In effect, this approach may lead to an underestimation of the deposition potential and, hence, to production losses, and high costs for intervention and clean-up.

Apart from difficulties in prediction of asphaltene deposition, the actual *detection* early enough to avoid loss of production still remains challenging. Detection is often based on indirect observations, such as increased pressure drop over the tubular or declined production index. It is not uncommon that these observations are mistakenly attributed to asphaltenes, and are in fact the result of other issues, such as inorganic scale, viscous emulsions, or sludges. The consequence might be that a sub-optimal mitigation strategy is applied leading to high costs without resolving the real problem.

In Shell, fluid property evaluation and geochemistry are utilized in assisting both *predicting* and *detecting* asphaltene 'problematic' fluids. Geochemical evaluation of a source rock, maturity and in-reservoir processes such as oil-to-gas cracking assist in the explanation of fluids behaviour with respect to asphaltene precipitation and deposition. Moreover, geochemical fingerprinting of crude oil samples (including basic fluid properties) is a cheap and yet accurate tool to monitor fluid properties during production.

An integrated study on asphaltene precipitation and deposition problems in an offshore carbonate field in Venezuela significantly increased the understanding

of asphaltene behaviour. Learnings from that study, combined with a review of behaviour of various fluids from around the world indicated that within a given petroleum system, only medium-mature fluids are prone to precipitation during production, while heavy oils and very light condensates do not exhibit such problems [1]. The medium maturity may be the result of mixing a crude oil with a lighter oil from the same or another source. We think that within this 'critical range' of fluids the balance between the oil solubility towards asphaltenes and the chemical composition of the asphaltenes results in the highest deposition tendency.

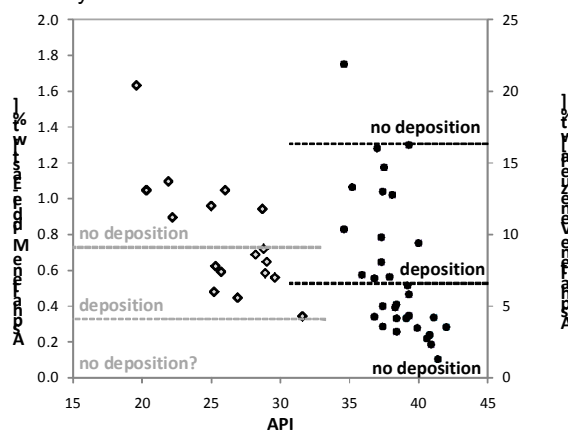


Fig. 1. API versus Asphaltene wt% for crude samples from the Middle East (●) and Venezuela (◆). Within these fields a wide range of fluids are unstable with respect to precipitation, whereas only a narrow range of fluids suffer from deposition in the field as indicated by the dashed lines.

In this paper we will expand the above concept and demonstrate its application to onshore Abu Dhabi carbonate fields. The fluids in the Abu Dhabi fields are derived from two source rocks, with varying degrees of mixing. Extensive analysis of basic fluid properties and stock tank oil stability tests, in conjunction with a review of field data, helped to identify confined areas within specific reservoirs where deposition is most likely to occur. An improved flow assurance and surveillance strategy was defined for optimum production rates, thereby potentially enhancing the overall profitability from the fields.

Reference

- [1] B. A. Stankiewicz et al, (2001) 20th International Meeting on Organic Geochemistry (IMOG) in Nancy, France.