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Chemical Prevention of Asphaltene Flocculation in Oil Production System

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Abstract. The change of pressure, temperature or chemical composition of crude oil during oil production constitute the factors that may destabilize the heaviest fraction of crude oil presented in asphaltenes leading to many problems in the production system including the alteration of reservoir rock wettability, permeability reduction, plugging of tubing and production aerial facilities which generate a high production cost because of loss in the well productivity and the need of corrective measures. In this work, a crude oil sample was taken from an Algerian oil field to study the efficiency of two commercial inhibitors. The flocculation onset point of asphaltenes was measured by a solid detection system which is based on the light transmittance of flocculated particles when n-heptane is added. The effectiveness of two inhibitors was evaluated by the solid detection system at different concentration to select the best inhibitor, however, the best additive should provide a good performance at low concentration. Meanwhile, the effect of thermodynamic conditions has been also established in this work, however, the operator conditions of pressure and temperature have affected the efficiency of the added inhibitor on the flocculation of asphaltenes.

1. Introduction

Asphaltenes are friable solids having a dark brown to black color, their melting point is not defined [1]. The operational definition admits that asphaltenes constitute the fraction of petroleum insoluble in a large excess of alkane at boiling temperature but soluble in hot toluene. However, the length of this alkane varies according to the employed standard [2].

In crude oil, asphaltenes have a colloidal form stabilized by petroleum resins; the polar sites of resins interact with the polar sites of asphaltenes while the non-polar sites of resins interact with the bulk oil [3]. Several factors may affect the stabilization of asphlatenes in crude oil such as pressure [4, 5], temperature [6], chemical composition [7-9] and electrokinetic effects [8, 10]. However, destabilization of asphaltene micelles leads to asphaltene precipitation, then the precipitated particles flocculate and deposit on solid surfaces [11].

The deposition of asphaltenes can cause many problems during oil production; the tendency of flocculated asphaltenes to block the pores of the reservoir rock, which reduces its permeability, it can also alter the wettability of the reservoir rock[12]. These problems of asphaltene deposition are not limited in the reservoir; they can reach the production column too by partial or total clogging of the tubing; which is the frequent case in Hassi Messaoud field. The flocculated asphaltenes can deposit on the bottom safety valves, and plug surface facilities such as wellhead valves and separator control equipment [13].

Preventive measures are implemented to prevent flocculation and consequently the deposition of asphaltenes during oil production such as pressure, temperature and production rate manipulation in order to avoid the conditions under which asphaltenes flocculate and deposit [14]. Currently, another method is being evaluated to control asphaltenes by chemical prevention using asphaltenes inhibitor that can prevent or delay their flocculation and deposition[15].

In this work the inhibition of asphaltene flocculation is studied by the determination of flocculation onset using a solid detection system and the effect of each inhibitor on the flocculation onset at different concentrations is performed in order to select the best inhibitor who can prevent the flocculation of asphaltenes at low concentration.

2. Experimental Study

The properties of crude oil such as density and SARA analysis have been deter-mined as shown in table 1.

Asphaltene flocculation onset was determined in this work by Asphaltene Flocculation Tester. This device is a solids detection system which is based on light reflecting technique using a source of light. The setup measures the power of reflected light through crude oil as a titrant is added (Figure 1).

A volume of blank crude oil was mixed with the inhibitor A and the extracted resin at several concentrations 30, 50, 100 and 200ppm. Inhibitor mixed oil is then titrated gradually using n-heptane as the procedure described above. The amount of n-heptane is noted which is required to flocculate the asphaltene particles. The effect of inhibitor A and B evaluated using the described method at ambient condition. Higher amount of n-heptane requirement than base case shows more stability of asphaltene particles in crude oil indicating the good efficiency of inhibitor.

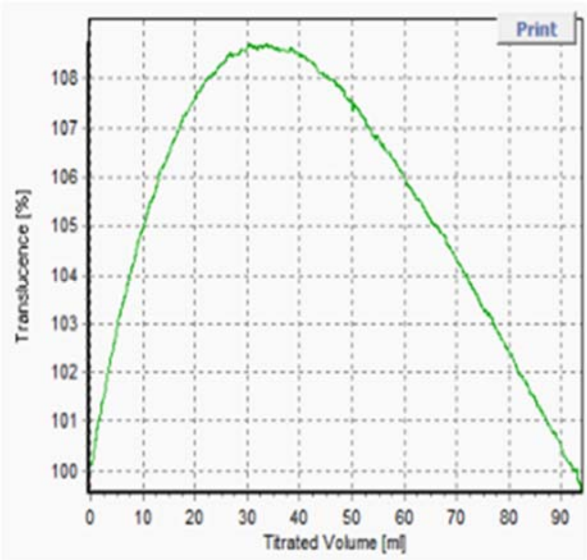
3. Results and Discussions

From the results of oil characterization it is obviously that the tested crude oil is light oil has a tiny tenor of asphaltenes 0.07% (table 1).

The onset point is reported as the minimal volume of n-heptane required for inducing the flocculation of asphaltene. For the tested crude oil without inhibitors, the onset point was measured to be 30 ml of n-heptane (for diluted oil). Figure 2 shows the effect of inhibitors A and B at ambient condition on the onset point. The addition of inhibitor A prevents asphaltene flocculation at low concentration 30 ppm, but at high concentration the efficiency inhibitor Adecreases. The onset point only starts to increase sharply when inhibitor B is added until the concentration 50 ppm where the prevention of asphaltene flocculation reaches its maximum and above this concentration the performance of this product drops. The first inhibitor (A) provides a good inhibition of asphaltene flocculation at low concentration 30 ppm at ambient conditions.

Table 1. Properties of crude oil

Density at 15°C (g/cm^3)	*Saturates (wt %)*	Aromatics (wt %)	*Resins (wt %)*	Asphaltenes (wt %)
0.8229	75.57	20.36	4.00	0.07



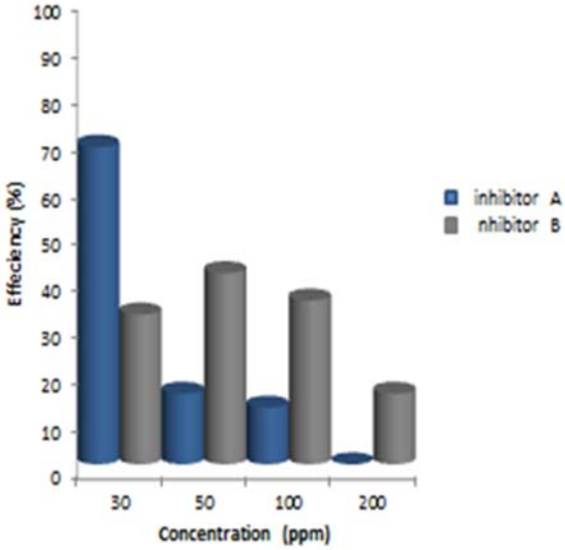


Figure 1. Asphaltene onset flocculation of algerian crude oil

Figure 2. Effect of inhibitor A and B on asphaltene onset flocculation

4. Conclusions

The chemical selection of an asphaltene inhibitor has been performed in this work and the results show that the most effective inhibitor at low concentrations of 30 ppm is product A. When the asphaltene inhibitor is injected into the well the establishment of a monitoring plan is necessary to control the chemical efficacy of the product. The effluents produced must also be controlled for unforeseen asphaltene flocculation.

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