Petroleum Research

Petroleum Research 2019(April-May), Vol. 29, No. 104, 40-43

DOI: 10.22078/pr.2018.3143.2450

Laboratory Study of the Effect of Inhibitors on Asphaltene Adsorption on the Reservoir Rock by Experimental Design Method

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DOI: 10.22078/pr.2018.3143.2450

Received: January/30/2018 Accepted: September/26/2018

INTRODUCTION

Asphaltene due to its intrinsic property, which includes many functional groups, is able to adsorb on different surfaces. Absorbents also have various active sites for the asphaltene linkage. Asphaltene adsorption is also directly related to the strength of these bonds [1]. Asphaltene adsorption on different surfaces has always caused problems. Moreover, adsorption on the metal surfaces of pipes and reservoir surfaces causes eclipse in the oil pipeline and increases costs. Adsorption on the reservoir rock also changes the wettability and clogging its cavities, which reduces the production of crude oil. Many studies have focused on the adsorption of asphaltene on a variety of solid surfaces to understand the asphaltene adsorption conditions and effective factors on the absorption rate [2-5]. In this study, the effect of two inhibitors of coconut diethanol amide and dodecyl benzyl benzene sulfonic acid on the amount of asphaltene adsorption on the reservoir stone is investigated. In addition, this study combines both the asphaltene adsorption and the effects of inhibitors on asphaltenes simultaneously.

EXPERIMENTAL PROCEDURE

In this research, oil and rock reservoirs are used from the South Oilfield. The inhibitors are Coconut diethanol amide and dodecyl benzyl benzene sulfonic acid. To prepare synthetic oil, first, asphaltene is extracted from the oil sample by the IP-143 method. According to the references, IP-143 test is a standard way to extract asphaltene from crude oil. The base solution is then prepared at a certain concentration by dissolving a certain amount of asphaltene into a certain volume of toluene. After preparing the solutions, the reservoir powder with a weight ratio of 1/10 (one stone powder to ten solutions) is added to the solution. The solution is mixed with magnetic stirrer for 24 hours. The Uv-vis device is used for indicating the concentration of solution. After determining the final concentration, the asphaltene adsorption rate on the surface is determined with Eq. 1.

$$q_e = \frac{(C_0 - C_e)}{m} \times V \qquad (1)$$

In this equation, C_0 (mg.L^{-1}) and C_e are the Primary and equilibrium concentrations of asphaltene in solution, V (L) is the solvent volume, and m (g) is the adsorbent mass.

To carry out this research, the experimental design method has been used to reduce the number of tests and carry out statistical surveys. In this study, D-Optimal surface design was used to design the experiment. In this method, the experimental design variables were: the initial concentration of asphaltene in 1000-3000 mg.L^{-1} in 5 levels, the weight ratio of asphaltene to the inhibitor at four levels of 1:1, 2:1, 3:1, and 0:1 (without inhibitor), and two types of inhibitors are coconut diethanol amide and dodecyl benzyl benzene sulfonic acid.

RESULTS AND DISCUSSION

ADSORPTION OF ASPHALTENE IN THE PRESENCE OF INHIBITORS

Fig. 1 shows the effect of the asphaltene to inhibitor weight ratio factor based on the initial concentrations of asphaltene for the data on average two Inhibitor. According to this figure, it can be concluded that the weight ratio of asphaltene to inhibitor 1:2 (inhibitor twice asphaltene) for both inhibitors has the lowest absorption of asphaltenes.

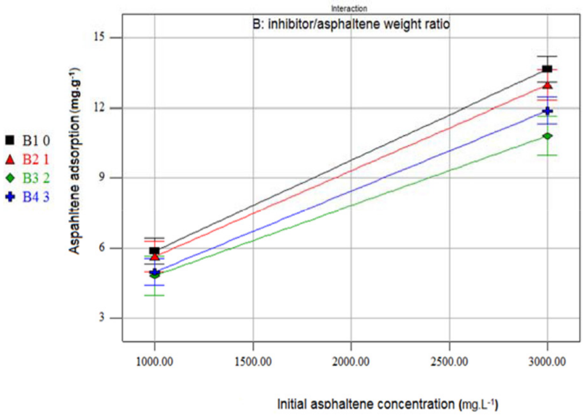

Figure 1: Effect of different weights of inhibitor to asphaltene for mean values of inhibitors.

THE POWER OF THE INHIBITORS

The graph of the effect of coconut diethanol amide nonionic inhibitor and dodecyl benzyl benzene sulfonic acid anionic inhibitor in three ratios of 1:1, 2:1, and 3:1, based on the initial concentration of asphaltene in solution, is shown in Fig. 2.

CONCLUSIONS

The proposed model has a high correlation coefficient, which suggests an adequate prediction of asphaltene adsorption data on the reservoir rock. Absorption of asphaltene in the absence of inhibitors was investigated. The adsorption rate of asphaltene varies between 0.65-13.68 mg/g in the range. Moreover, the results showed that in the presence of an inhibitor in synthetic oil solution, the use of inhibitor in a weight ratio of 1:2 has the greatest effect on reducing asphaltene adsorption on the surface of the reservoir. Among the two inhibitors of coconut diethanol amide have had the greatest effect on the stability of asphaltene in synthetic oil, and as a result, reduced the absorption of asphaltene on the surface of the reservoir surface.

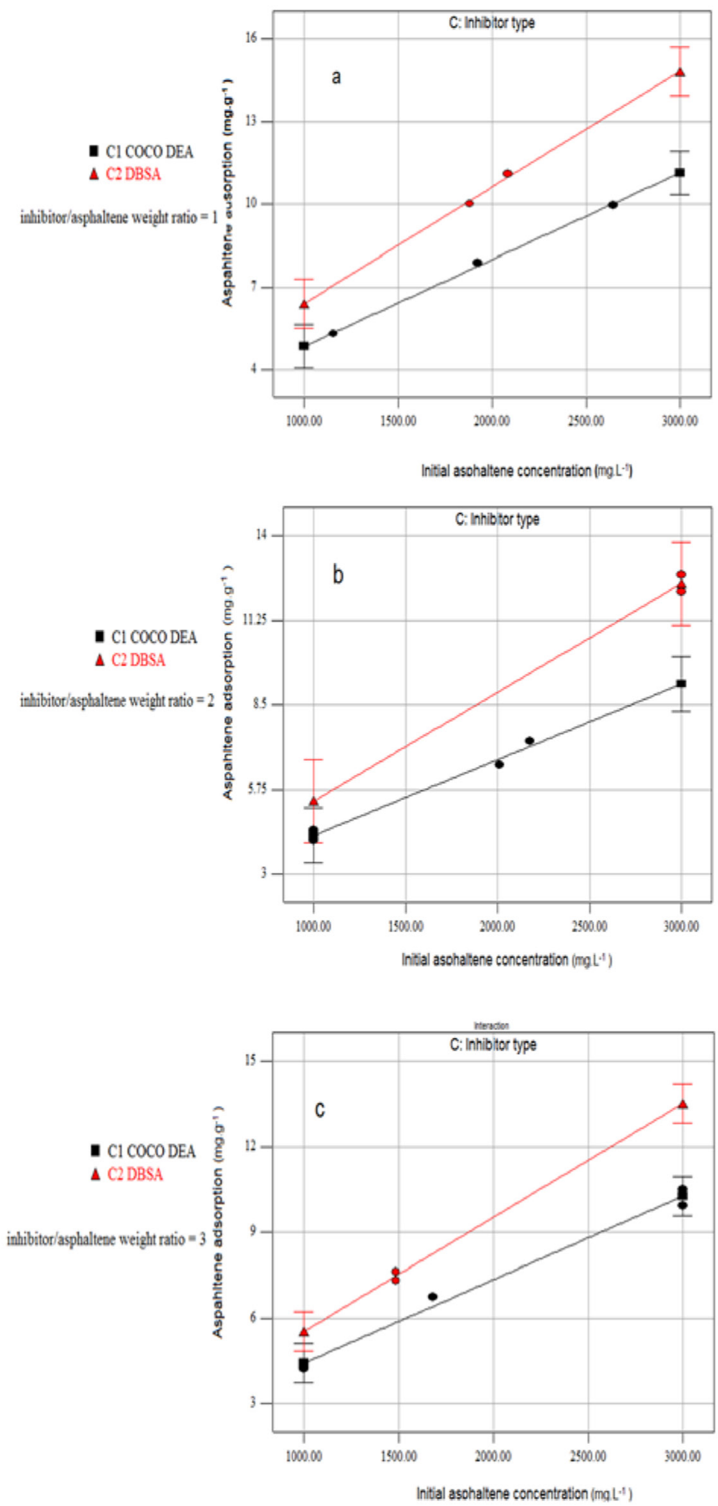

Figure 2: Graph of comparison of asphaltene adsorption in the presence of coconut diethanol amide and dodecyl benzyl benzene sulfonic acid in three weight ratio inhibitor to asphaltenes 1:1, 2:1, and 3:1.

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