

Influence of Henna Extracts on Static and Dynamic Adsorption of Sodium Dodecyl Sulfate and Residual Oil Recovery from Quartz Sand

ABSTRACT

The application of surfactant flooding for enhanced oil recovery (EOR) promotes hydrocarbon recovery through reduction of oil–water interfacial tension and alteration of oil-wet rock wettability into the water-wet state. Unfortunately, surfactant depletion in porous media, due to surfactant molecule adsorption and retention, adversely affects oil recovery, thus increasing the cost of the surfactant flooding process. Chemical-based materials are normally used as inhibitors or sacrificial agents to minimize surfactant adsorption, but they are quite expensive and not environmentally friendly. Plant-based materials (henna extracts) are far more sustainable because they are obtained from natural sources. However, there is limited research on the application of henna extracts as inhibitors to reduce dynamic adsorption of the surfactant in porous media and improve oil recovery from such media. Thus, henna extracts were introduced as an eco-friendly and low-cost sacrificial agent for minimizing the static and dynamic adsorption of sodium dodecyl sulfate (SDS) onto quartz sand in this study. Results showed that the extent of surfactant adsorption was inversely proportional to the henna extract concentration, and the adsorption of the henna extract onto the quartz surface was a multilayer adsorption that followed the Freundlich isotherm model. Precisely, the henna extract adsorption on quartz sand is in the range of 3.12–4.48 mg/g (for static adsorption) and 5.49–6.73 mg/g (for dynamic adsorption), whereas the SDS adsorption on quartz sand was obtained as 2.11 and 4.79 mg/g at static and dynamic conditions, respectively. In the presence of 8000 mg/L henna extract, SDS static and dynamic adsorption was significantly reduced by 64 and 82%, respectively. At the same conditions, the residual oil recovery increased by 9.2% over normal surfactant flooding. The study suggests that the use of henna extracts as a sacrificial agent during SDS flooding could result in the reduction of static and dynamic adsorption of surfactant molecules on quartz sand, thus promoting hydrocarbon recovery from sandstone formations.