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Modeling of the adsorption breakthrough behaviors of oil from salty waters in a fixed bed of commercial organoclay/sand mixture

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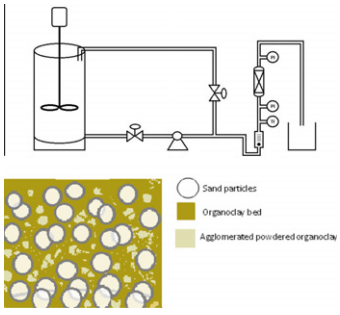
HIGHLIGHTS

- Oil removal from salty water using a commercial organoclay was studied.
- Cloisite 30B in mixture with sand particles in a fixed bed column was used.
- Dispersed plug flow model through column bed was formulated and solved numerically.
- The axial dispersion coefficient and mass transfer coefficient were estimated.
- Nelder–Mead simplex optimization method was used for parameter estimation.

GRAPHICAL ABSTRACT



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ABSTRACT

A commercial powdered organoclay in a mixture with inert sand particles was used to study its capability for removal of a crude oil from salty water in a fixed bed adsorption column. For this purpose, after obtaining adsorption isotherm, the fixed bed breakthrough experiments were accomplished. In addition a dispersed plug flow model with an overall mass transfer resistance through column was proposed and solved numerically. The axial dispersion coefficient (D_L) and the overall mass transfer coefficient (K_F) were estimated using the experimental data and Nelder–Mead simplex optimization method. The results of modeling and optimization showed that the presence of inert particles and agglomeration of powdered organoclay decrease the mass transfer coefficient extremely. This parameter is also decreased by increasing of bed height and organoclay percentage in the mixture. In addition, the obtained results showed that breakthrough curve becomes steeper with decreasing bed height, increasing flow rate and increasing feed concentration. Furthermore break point time is decreased with decreasing bed height, increasing flow rate and increasing inlet oil content.

1. Introduction

Oil pollution, particularly of sea and navigable waters, has caused significant environmental impact and excited more public concern than other waste materials. Oil pollution of the sea has steadily increased with the increase in oil consumption too [1]. Also produced water, a byproduct of oil and gas production, which includes almost 98% of all waste generated by oil and gas exploration and their production activities, has a great impact on our environment. Moreover, day by day discharge standards are getting more and more stringent in most of the operating areas of the world. Therefore, produced water treatment and disposal have become subjects of growing attention and interest in exploration and production operations everywhere [2,3].

The U.S. Environmental Protection Agency (EPA) classifies oil production by offshore and coastal regions. BAT (Best Available Technology) effluent limitations specify a maximum of 29 mg/l. oil

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