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RESEARCH ARTICLE

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Bentonite-PDMS composite foams for oil spill recovery: Sorption performance and kinetics

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Abstract

The aim of this article is the synthesis and characterization of bentonite-filled siloxane foams for oil spills recovery. Composite foams at varying filler content in the range 35–45 wt% were investigated. The sorption kinetics and capacity of composite foams in different oils (e.g., kerosene, virgin naphtha, pump oil) were assessed. As a reference, water absorption capacity was also evaluated. Among all, the composite foam filled with 40 wt% bentonite (B-40 batch) shows the lowest affinity with water and good absorption capacity with oils (mainly light oils) reaching an absorption capacity at saturation equal to 10.3 and 518.2 wt% in water and virgin naphtha, respectively. Furthermore, isothermal absorption curves were analyzed using three kinetic models: pseudo-first order, pseudo-second order, and Elovich models. The equilibrium isotherm fitting results were optimal using the pseudo-second order model, indicating that chemisorption phenomena play a key role in the speed of the absorption phase for these PDMS-based composite foams. Finally, a correlation was addressed between morphology, foam microstructure, absorption capacity, and kinetics.

KEYWORDS

bentonite, oil recovery, oil/water selectivity, siloxane foam, sorption kinetics

1 | INTRODUCTION

Oil spills represent a huge ecological problem. The sea-oil spills are generally much more harmful than land oil spills because oil can be spread on a huge surface by a thin oil slick. Possible tanker accidents, equipment failures on oil platforms, war, terrorist attacks, and illegal oil spills, during which large amounts of oil can spill into the oceans and rivers have various effects on an entire ecosystem. The biggest oil spill was in 1991, in Kuwait, involving the discharge of about 142 million liters of crude oil.[1] As a result of this ecological catastrophe, a large number of plant and animal species have irretrievably disappeared. Another huge environmental disaster, which left a big mark, was the Exxon Valdez oil tanker accident in 1989. Despite the fact that Exxon alone spent more than two billion dollars to clean up the sea and coast from pollution, serious environmental issues were noticed. According to some experts, cleaning attempts were wrong, because used detergents and various chemicals additionally polluted the sea.

Due to their potential danger to the environment and human health, various remediation techniques have been developed to mitigate hazards to the environment. Mehmood et al.[2] reported several methods for removing crude oil from