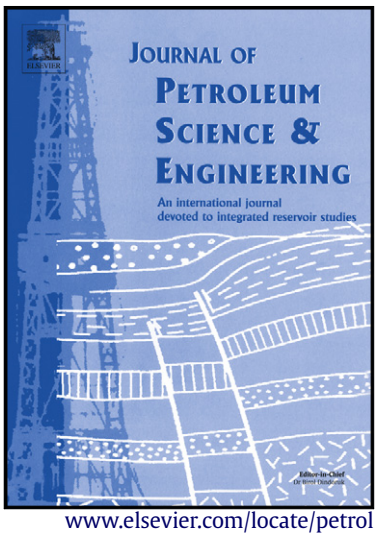

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Nanotechnology-based remediation of petroleum impurities from water.

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Abstract

Nanotechnology-based methods for removal of oil in petroleum spills and its separation from water are discussed in this review. Oil spills during petroleum extraction and processing and transport are often inavoidable and could lead to events of different impact and magnitude from small contaminations of ground and sea water up to huge disasters. In addition to classic methods of oil removal, the "nano"-techniques are being currently developed, which use nano zero-valent iron (nZVI), carbon nanotubes, sponges, aerogels and nanocomposites, metal and non-metal nanostructurized oxides, nitrides, salts, and zeolites. Some of these nanomaterials can be prepared by "greener" methods at lower costs and without damage to the environment. These methods (except nZVI) are applied presently in small scale due to insufficient knowledge of their toxicity, lack of more detailed investigations or higher costs. Some of these methods are still objects of academic laboratory studies. Simplicity of fabrication, decrease of costs, and commercial availability of applied nanomaterials and their precursors are main objectives of current investigations.

Keywords: Nanomaterials; oil spills; remediation; nZVI; titanium dioxide; peroxides.

Introduction

Hundreds of compounds can be present in the oil; every crude oil type contains 200–300 different compounds. About 50-98% of the oil composition corresponds to hydrocarbons, which are primarily alkanes (paraffins) (in the form of gases, liquids or solids, possessing relatively low toxicity and are biodegradable); 5-6 atom-per-cycle cycloalkanes (naphthenes) (stable and very poorly biodegradable); aromatic compounds (20–40% of the oil) such as volatile compounds (benzene, toluene, xylene), bicyclic compounds (naphthalene), tricyclic compounds (anthracene, phenanthrene) and polycyclic compounds (pyrene). In addition to hydrocarbons there are sulfur compounds reaching up to 10%, and fatty acids and nitrogen compounds, as well as vanadium and nickel.

During oil extraction and processing (especially in accidental situations), barely separated water/oil/solid phase mixtures can appear, representing serious problems for the environment. Oil products entering the aquatic environment very soon change their initial state. In the sea oil can be present in different migration forms, such as surface films (slicks), water-in-oil and oil-in-water emulsions, oil aggregates and lumps, in dissolved forms, sorbed by suspensions and bottom sediments, or accumulated by the aquatic organisms. In case of the cold environment, especially evaporation, dissolution and biodegradation of oil are extremely slow. In wintery conditions, cold water affects highly the oil viscosity, making it very thick and sticky. It also contributes to forming of the oil