Investigation study the ability of superhydrophobic silica to adsorb the Iraqi crude oil leaked in water

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Abstract. A superhydrophobic silica has been utilized as adsorbed the Crude oil leaked during transport in the water of the Iraqi rivers, the capacity absorbing of the aerogel powder for crude oil has been determined. This technique is very important to get rid of environmental pollution caused by the leakage of crude oil in water, which in turn cause death of living beings, this application is an important economic wealth in the country, preliminary tests on water of rivers mixed with the crude oil, by using the aerogel in powder form to clean the water from crude oil, the study depended on two parameters are surface area and contact angle. We found that the increase on surface area lead to increasing on the capacity of adsorbing the crude oil from water, also this result with contact angle.

1. Introduction

Enormous oil trips have transpired commonly because of human blunders and negligence, thoughtful doings as destruction and war as well as regular tragedies [1]. Water pollution is one of the most serious environmental problems because it causes the death of living organisms that live in water, most important fish and some aquatic plants, as well as the obstruction of sewage treatment plants [2]. water polluted in oil contains on several toxic compounds which caused hurt human or even have calumination effect on the environment system, so the expansion ways for the elimination and aggregation of amounts of organic pollutants from water is entice international care[3, 4].

Traditional ways which used to remove the oil from water such as flotation and skimming, are helpful for the separation of leaked oil from surface of water, but afford from the limits of high operation cost and low efficiency, as well as, they are not valid to the separation of leaked oil from water emulsions [5, 6]. So it is very important to find successes oil spill cleaning technology without high costing for environmental protection. This technology should also confirm the need to require the oil by separating oil from water mixtures to meet the economic demands [7, 8]. Many works prepare hydrophobic aerogel and researched with some parameters which influence on equality this product, such as effect of catalysis [9]. Doping with metal ions [10]. In recent years many researchers have been interested in this field, where determine John G. and others the capacity of oil absorbing by aerogel after mixed with water their study give a good separation and extraction and moderate oil recovery [11]. While Ding Wang and others reported the possibility of removal of emulsified vegetable oil from water by hydrophobic silica aerogel, they found that the main factors which effect on removal of oil are the size of the particles of powders which they used [12]. Whereas Zonglin Chu and others introduce experimentally description the principles of materials with selective the absorption of oil-water mixture including their fabrication, models and design[3]. In addition to we
find M. Padaki with some researchers make a review study for membrane technology improvement in the treatment of oily wastewater they found in their review that the type of materials used in the separation play important role in improving the separation performance such as ceramic and polymer films, while they found that the ceramic give a good results in the separation procedure [13]. It has been found that Ben Wang and others introduced a new strategy in water separation technology which is characterized by superhydrophobic and superhydrophilic materials [14]. Some of researchers refuse to nature precursors and materials compound and employed them to separate oil from water as Jian Li and colleagues utilized hydrophobic potato residue without any further chemical modification demonstrated for selective oil-water separation [15]. In the same context, there are many studies in which natural compounds were used to separate oil from water [16-19]. In this study, we try to separate Iraqi crude oil from its reverse by using hydrophobic aerogel as powder also determine oil absorbing capacity of the aerogel powder.

2. Experimental procedure

Silica gels were prepared via a two-step acid-base catalysed procedure. In the first step, tetraethylorthosilicate (TEOS), ethanol and acid water, molar ratios (1:7.9:1.2) respectively were kept at room temperature it's called condensed silica (CS). In the second step, 1 ml of (NH₄OH,) as catalysis was added to (CS) solution while stirring (30 min). The samples was allowed to gel and then aged for 22h at room temperature. The alcogels were washed with pure ethanol in five steps every (22 h). After washing in ethanol prepared (ethanol-Hexane) solution in order to modified the inner structure of gel, the gel wished in (ethanol-Hexane) solution in four 48h, after above steps its prepared solution (TMCS+Hexane), the procedure was in 7 steps for 3 days. Finally, the gel placed to dry out over the course of 1-2 days then placed it in oven at 120°C for 3hr. Where (TEOS) with > 99% purity from Sigma Aldrich, TMCS > 98.0% (GC), provided from TCI Japan, n-Hexane with > 98.0% purity, Sigma-Aldrich (Germany). Oils were used in this study is Crude oil extracted from Basra wells. The oil absorption capacity of the aerogels calculated using the following [20]

\[ Q_t = \frac{M_a - M_b}{M_b} \]

Where \( Q_t \) is the oil absorption capacity of the aerogel at time t, \( M_b \) (gm.) and \( M_a \) (gm.) are the aerogel weights before and after the crude oil adsorption, respectively. The degree of hydrophobicity was quantified by measuring the contact angle (θ) of a water droplet placed on the surface of the aerogel using a contact angle meter (Rame-Hart instrument, USA). The specific surface area of aerogel samples were determined by the BET method (Micromeritics ASAP 2020).

3. Results and discussion

Three different samples of silica aerogel were tested the contact angle and surface area as shown in table (1):

| aerogel | Contact angle(θ) | surface area (m²/gm.) | Density (gm./cm³) |
|---------|------------------|------------------------|--------------------|
| pH1     | 129.11           | 190                    | 0.31               |
| pH3     | 130.35           | 294                    | 0.28               |
Above table refer to that the properties of samples affected by difference of pH, therefore the same environment (acid) of preparation it has been found that the density decrease with increasing pH, this is negative property of aerogel, whereas surface area and contact angle increased with increasing of pH, this is advantage in case of this work, since the increasing of contact angle means there is enhancement in hydrophobicity property, leading to more attack of oil and replace of water [21], in addition to the increase of surface area this means that there are many gaps that in turn will hold as much oil as possible, in other hands, that increasing the surface area leads to an increase in oil absorbing capacity [22], as will be passed on to us in subsequent calculations. Figure (1) show the relationship between above parameters

For three samples it take amount of aerogel powder (known weight) and sprayed on of surface of oil mixed with river water, after (1hr) aerogel powder absorbed the oil, then calculated the oil absorbing capacity ($Q_t$). Table (2) show the amount of aerogel powder and weight after and before mixed, as well as absorbing capacity ($Q_t$).

**Table 2. Oil absorbing capacities for three different samples.**

| samples | weight before (gm) | weight after (gm) | $Q_t$ |
|---------|--------------------|-------------------|-------|
| pH1     | 0.048              | 3.5               | 71.91 |
| pH3     | 0.048              | 4.03              | 82.95 |
| pH5     | 0.048              | 4.26              | 87.75 |

**Figure 1.** pH with contact angle, surface area, and density.
Figure 2. The relation between pH and $Q_t$.

Figure (2) show the effect of varied pH on the oil absorbing capacity which associated with surface area as showed above. From these results, it can be say that the absorbing capacity of crude oil increase if only and only if provide hydrophobic (high contact angle) material with high surface area and many gaps that in turn will hold as much oil as possible. The relation between absorbing capacity with surface area and contact angle illustrated in figure (3).

Figure 3. $Q_t$ with surface area and contact angle.

4. Conclusions

The advantage of using hydrophobic aerogel with high surface area in ambient pressure with high-quality specifications, this material could be a means to solve the most important problems of the process of transporting Iraqi crude oil, it is very important in this research has been obtained high absorption capacity through the substance of hydrophobic aerogel, the absorbing capacity of crude oil increase if only and only if provide hydrophobic (high contact angle) material with high surface area and many gaps that in turn will hold as much oil as possible. This work demonstrate our super-hydrophobic aerogels, it could be used as one of the very promising sorbents for crude oil spill cleaning.
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