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Superhydrophobic Aerogel as Sorbents for Iraqi Crude Oil Leaked In Water

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Abstract
A superhydrophobic aerogel has been utilized as adsorbed the Crude oil leaked during transport in the waters of the Tigris and Euphrates rivers, and determine the capacity absorbing of the aerogel powder for crude oil. This technique is very important to get rid of environmental pollution caused by the leakage of crude oil in water, which in turn cause the death of fish, this application is an important economic wealth in the country, preliminary tests on Tigris and Euphrates 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 increasing on surface area lead to increasing on the capacity of adsorbing the crude oil from water, also this result with contact angle.

Keywords: Aerogel, superhydrophobic silica, crude oil, environmental pollution, oil absorbing.

الخلاصة
لقد تم استخدام ايروجل القائقة في قابلية طرد الماء كممتزة للنفط الخام المتسرب في نهري دجلة والفرات وتحديد القدرة على استيعاب مسحوق الايروجل للنفط الخام. هذه التقنية مهمة جدا للتخلص من التلوث البيئي الناجم عن تسرب الزيت الخام في الماء الذي يؤدي بدوره إلى موت الأسماك كما ان هذا التطبيق يعتبر ثروة اقتصادية مهمة في البلاد. الاختبارات الاولية على نهري دجلة والفرات مخلوطة بنفط خام وباستخدام مسحوق الايروجل للتنضيف الماء من النفط الخام حيث ان الدراسة اعتمدت على عاملين هما المساحة السطحية وزاوية الالتصاق . وجدنا أن الزيادة في المساحة السطحية تؤدي إلى زيادة القدرة على امتصاص النفط الخام من الماء ، وتنطبق هذه النتيجة أيضا مع زاوية الاتصال.

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 importantly 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 calumniation 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 superhydrephobic and superhydrophilic martials [14]. Some of researchers refuge 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 e try to separate Iraqi crude oil from its revers by using hydrophobic aerogel as powder also determine oil absorbing capacity of the aerogel powder.

Materials and Methods

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 (NH_4OH,) 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 it's prepare 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^{o} 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]

$$Q_{t} = \frac{M_a - M_b}{M_b} \quad (1)$$

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).

Results and Discussion

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

Table 1: properties of aerogels

aerogel	Contact angle(θ)	surface area (m^2/gm)	Density (gm./cm^3)
pH1	129.11	190	0.31
pH3	130.35	294	0.28
pH5	135.64	357	0.23

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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 increase 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 increasing 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) shows the relation between above parameters. For three samples, it takes the amount of aerogel powder (known weight) and sprayed on of surface of oil mixed with river water, after (1hr) aerogel powder absorbed the oil, and then calculated the oil absorbing capacity (Q_t).

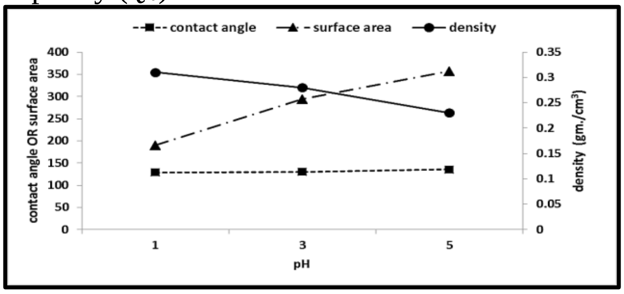

Figure (1): pH with contact angle,surface area, density

Table (2) shows the amount of aerogel powder and weight after and before as well as (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 (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)

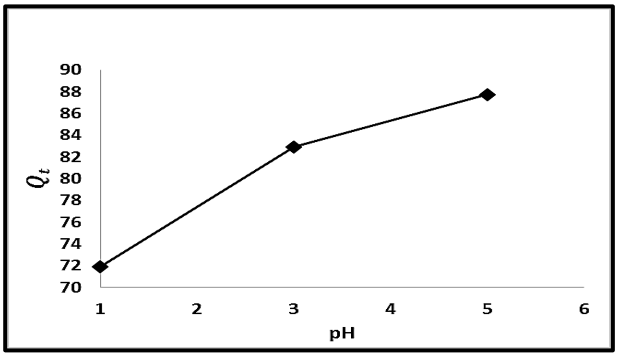

Figure (2): the relation between pH and Q_t

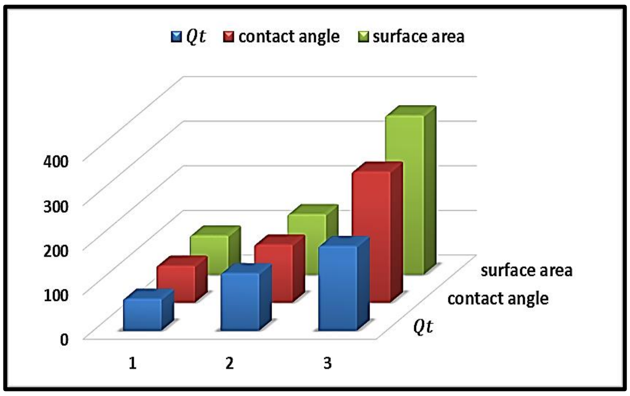

Figure (3): Q_t with surface area and contact angle

Conclusion

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 is very important in this research has been obtained high absorption capacity through the substance of hydrophobic aerogel. 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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