The effect of Gray Heron feather on oil sorption capacity of polyurethane foam

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Abstract :

A comparative study of oil absorption using modified polyurethane foam as sorbents performed where Polyurethane type polyester was prepared locally and modified by using the feather of Grey Heron (*Ardea cinerea*) Bird.both fluff and wings feathers used to modify the foam. The objective of the study was to compare the oil spill removal capability of the pure and modified polyurethane.

Three types of Crude oil brought from west of qurna oil field with A.P.I. equal to 22.2- 27 and rumaila oil field with 35 API. Sorption test in hydrolic oil was also done.

The obtained results show that absorption capacity directly proportional to the filler type and oils according to the difference in the capillary structure of both pure and modified polyurethane and the special structure of feather with stiff central shaft, many side branches, called barb sand the barbs link together. The polyurethane foam modified with wing feather has the highest absorption ratio due to changes between contour and fluff feather. The effect of viscosity was very obvious on absorption where the viscous oils like west qurna oil 2 are unable to flow rapidly in to the sorbent due to the high cohesion more than the adhesion between oil and the sorbent materials. fiynally the modified polyurethane foam sorbents has a good buoyancy combined with high absorption ratio reach to 500% for west qurna oil with 27 A.I.P

Keywords :polyurethane , feather , crude oil , oil spill , Gray Heron , polymer

Introduction:

Due to the proximity of high density human population, when oil spills occur, human health and environmental quality are put at risk. From literature and field experiences to date, one of the most economic and efficient means of cleaning up hydrocarbon spills on the shoreline (or land) is the use of sorbents. The source of these sorbent materials can be natural or synthetic. They can be natural organic substances, synthetic organic substances, inorganic substances, or a mixture of the three. A material may also be treated with lyophilic and hydrophobic compounds to improve performance (1-6).

Some polymers have the sorption ability toward Crude oil spilt in the marine (7-13). Where they have good hydrophobic and lyophilic properties and high adsorption capacity. For example, ultra-light, open-cell polyurethane foams can absorb 100 times their weight of oil from oil-water mixtures where Polyurethane foams is a plastic material in which a proportion of the solid phase replaced by gas in the form of numerous small bubbles (cell) (14-16). Bowen published the first paper reporting sorption and recovery of some inorganic and organic compounds from aqueous solution using this sorbent in 1970. One year later, Gesser et al. proposed the use of untreated PUF for sorption of organic contaminants from water using a batch technique. Braun and Farag published the first applications of PUF for chromatographic separation in 1972(15, 17-19).

Sorbents can be either natural organic (peat moss, feathers), natural inorganic (clay, sand) or synthetic (polyethylene, nylon). There is wide variety of materials able to serve as sorbents, but nowadays the largest use is for polypropylene, which is able to absorb multiple times more oil than its own weight (21-22).

Despite the fact that synthetic polymers as polypropylene are said to represent ideal materials for marine oil-spill recovery due to their low density, low water uptake and excellent physical and chemical resistance,

These sorbents are not renewable and biodegradable (22-23).

In this paper, we focused on the union of both natural sorbents, feather to modify synthetic sorbents polyurethane foam.

Birds have four kinds of feathers, contour feather cover body and front edge of wing giving smooth surface for flight , Flight feather of wing and tail , down feather under contour feather trap air for warmth and pin feather (filoplume)like hair among down feather for increased sensitivity

Contour feathers have a stiff central shaft with many side branches, called barbs the barbs link together to form a smooth surface (22).

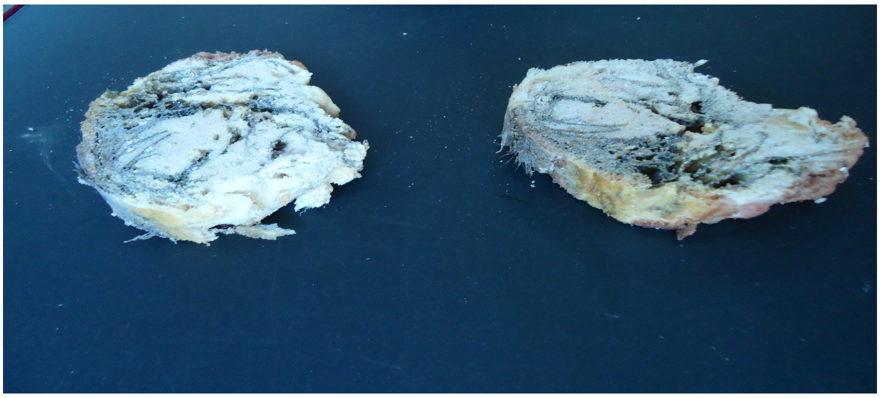
The aim of this work is to investigate the effect of adding different kinds of water bird feathers on polyurethane foam as potential sorbent materials for the oil sector.

Experimental work:

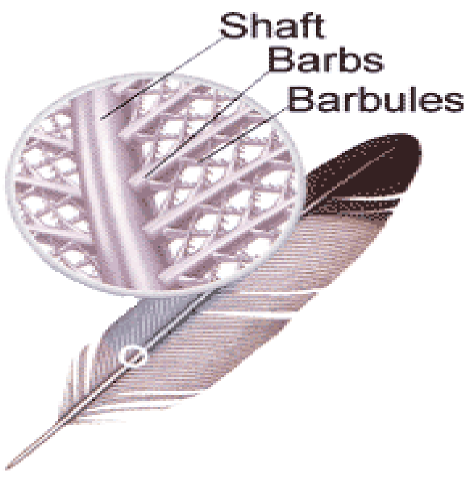
The used feather is obtained from the Grey Heron (*Ardea cinerea*) Bird where such birds and many others migrate to the marshes in south of Iraq during winter time. It is a wading bird of the heron family Ardeidae, native throughout temperate Europe and Asia and also parts of Africa. It is resident in the milder south and west, but many birds retreat in winter from the ice in colder regions. Contour, down and flight feather used as a filler to modify the polyurethane foam. Two kinds of feather fluff and wings feather used, each type of feather distributed in to the reaction container and mixed with reaction chemicals.

Pure polyurethane type polyester foams are prepared by two pure kinds and modified polyurethane. Pure polyurethane is prepared by react a liquid isocyanate with a liquid blend of polyols. Reacting same chemicals in the container, which has the feather pieces where a mixing is required, prepare the modified polyurethane. The obtained foam cut in to small pieces to investigate their sorption capacity.

Three types of Crude oil brought from Qurna west oil field with A.P.I. equal to 22.2-27 and rumaila oil fields with A.P.I 35 .Also hydraulic oil used in the sorbent evaluation procedure. For the sorption experiments, crude oil poured in to an uncovered glass jar of 3- liters capacity and a diameter of 14.8 cm. In each experiment 2 liters of water and 250 ml of an oil sample placed in the jar. The amount of oil in the beaker chosen so that there was still plenty of oil remaining in the beaker after completion of the sorption test. The dry weights of polyurethane pieces taken before immersing them into the jar. Each pieces gently placed on to the oil surface. After a certain period of time 5, 10, 20, 30, 60, 120, 180 and 2880 (48 hours) the samples periodically removed from the test jar. The wet surfaces of the material are dried between filter paper and weighed immediately to the nearest (+ 0.1 g).The samples are placed back immediately into the test jar and the experiments are carried out in progress. The experiments repeated at the same conditions using modified polyurethane. Figure (1) shows the modified polyurethane foam added with feather. Figure (2) shows the structure of feather



Fig(1) the modified polyurethane foam



Fig(2) the structure of feather

Result and discussion

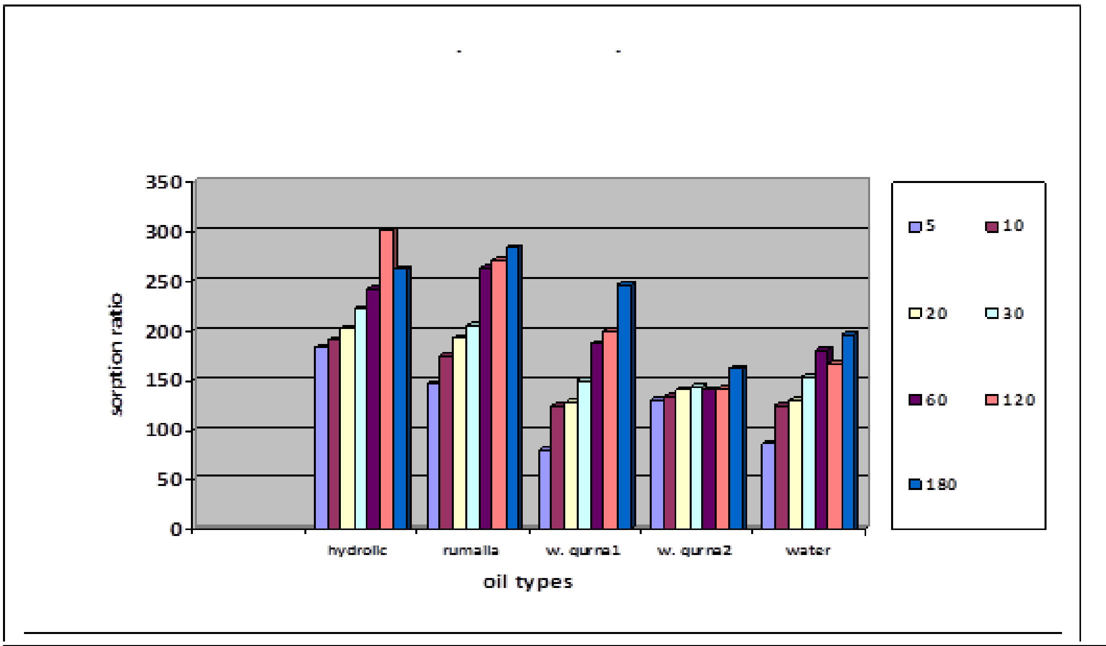


Figure (3) The Sorption Ratio as a function of Immersion Ratio in Oil

Figure (3) shows the variation of sorption ration as a function of immersion time in oils of polyurethane foam modified with wing feather. It is obvious the higher ratio for hydrolic oil but with time a decrease sorption due to release of hydrolic release as the weight of recovered liquid can cause the sorbents to sag and deform. This rate of release is directly dependent upon the viscosity of the oil, with lighter, less viscous oil dripping off more rapidly.

The sorption ratio for rumaila crude has a strong increase with time until 60 minutes where the sorbent (modified polyurethane foam) saturated by rumaila oil. At 120 and 180 minutes, the sorbent cannot recover further oil; else, the higher sorption ratio obtained at 180 minutes.

A different behavior for the sorption of both west qurna oils obtained. Less absorption is achieved for west qurna oil 2 more than that of west qurna oil 1 where this result is totally agreed with the different values of A.P.I and viscosity where viscous oils unable to flow into a sorbent and the absorption ratio will be determined effectively by the external surface area.

West qurna oil 2 according to its high viscosity reach the saturation of absorption ration from first 5 minutes in opposite behavior of west qurna oil 2.

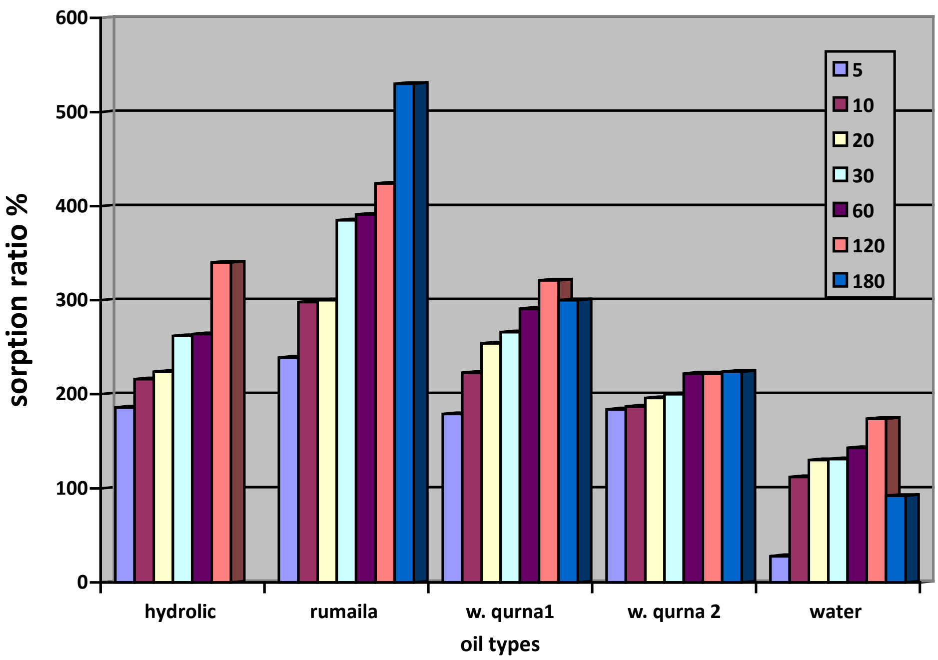


Fig (4) the variation of sorption ratio with oil types

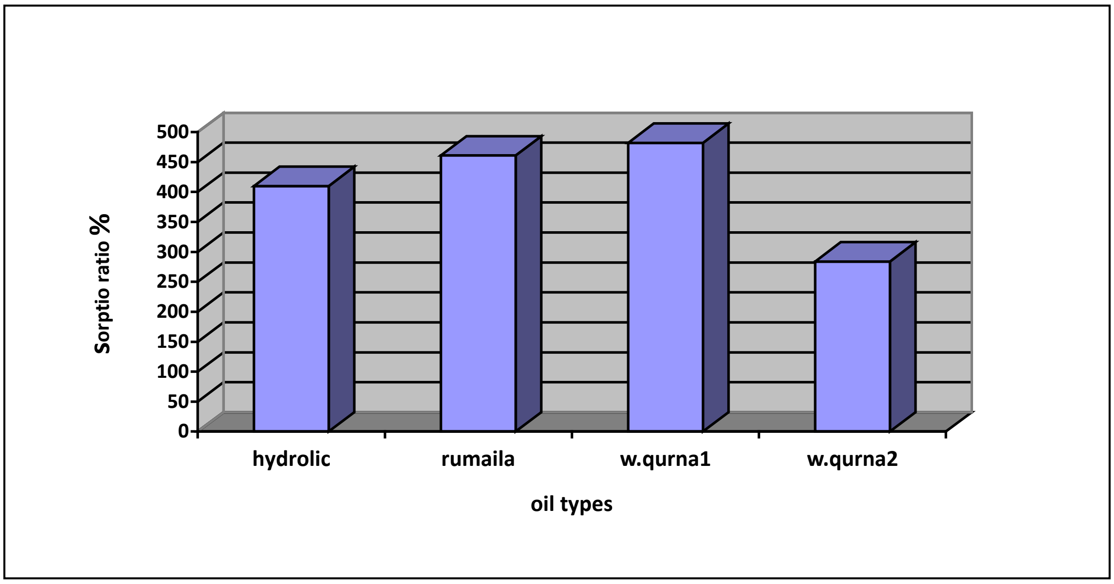
immersion time in oils for polyurethane foam modified with fluff feather. It is obvious the higher ratio for rumaila oil where the saturation value is missing through the test time. The sorption of hydraulic is also high but less than that of rumaila oil. The similarity behavior of both rumaila and hydraulic oils due to the rapid flow in to the sorbent materials causing a high rate of penetration in to the sorbent.

West qurna oil 2 reach the saturation value at first 5 minutes due to the fast oil penetration leading the sorbent to saturation where the sorbent cannot cover more oil. A versus behavior with west qurna oil 2 is obtained where the absorption ration is increased with immersion time until 120 minutes where after the modified polyurethane sorbent releases oil.

The difference in values of absorption is related to the difference in viscosity of both west qurna 1 and 2 (22.2-27 A.P.I)

Less absorption ratio obtained for water with saturation value at 10 minutes of immersion time and a release is occurring at 180 minutes due to adhesion between water and the sorbent.

The differences in absorption ratio due to using two kinds of feather may related to the fact that the amount of oil absorbed by the modified sorbent is mainly affected by the capillary structure, the spreading of the oil on the sorbent, adhesive energy of the oil on the sorbent, and cohesive energy of the oil.



Fig(5) absorption ratio after 48 hours of immersion in oils

For sorbents to be used effectively must have high buoyancy. Figure (5) shows the variation of absorption ratio for the sorbents modified with wings feather indicating good buoyancy, which means remaining a float even when saturated with oil and water. The higher absorption ratio and the good buoyancy indicating the good ratio of open cells to closed cells of modified polyurethane foam.

The higher values of absorption ratio after 48 and good buoyancy is directly to the feather structure since wings feather is a Contour feathers and have a stiff central shaft with many side branches, called barbs The barbs link together to form a smooth surface (22) where the whole structure of the host polymer (polyurethane) and the filler (feather) forming a three dimensional matrix of absorbing and retention oils.

Conclusion:

The absorption capacities of modified polyurethane are more enhanced than those of pure polyurethane due to the capillary structure changes made to the polyurethane after adding water bird feather due to its ability of absorping oil . All obtained results suggest that that modified polyurethane has a Considerable potential as an oil sorbent specially during the first hour of oil leakage or spillage especially when the pollutants are light oils. The 5 minutes period is sufficient for both viscous oils such as heavy crude oil and light oil. A comparison between PUF and other sorbents reveals that this solid phase has obvious advantages due to the light weight, ease of fabrication and handle,high ability to be shaped in any form and its reusability as sorbent substance .

The viscocity of the oil has an important effect on the rate of pentration in to the polyurethane modified foam.

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الخلاصة :

تم في هذا البحث استخدام ريش طائر الزرقي وهو من الطيور المائية في تطوير خاصية امتصاص الملوث النفطي لرغوة اسفنجية (بولي يوريثان) هذه الرغوة الاسفنجية من نوع البوليستر وتم استخدام نوعين من الريش الاول ريش الجناح الذي يمتاز بطوله وقوته والثاني ريش الزغب لتطوير قابلية الامتصاص للنفط المتسرب ومقارنة هذه القابلية مع الرغوة المرجعية (الرغوة النقية بدون مضاف ريش الزرقي) حيث تم استخدام لأجل هذا الغرض ثلاثة انواع من النفط الخام الاول تم جلبه من حقول غرب القرنة في محافظة البصرة الثاني (A.P.I 27-22.2) والثاني من حقول الرميلة في غرب البصرة (A.P.I 35) , وايضا تم استخدام زيت الهيدروليك لحساب قابلية الامتصاص للملوث النفطي

وقد بينت النتائج المستحصلة ان قابلية الامتصاص تتناسب طرديا مع نوع المضاف (ريش طائر الزرقي) وبدوره يرتبط ارتباطا مباشرة مع التركيب الدقيق للريش والذي يتميز بامتلاكه الخاصية الشعرية إضافة الى التركيب الدقيق للريشية والتي تمتاز بامتلاكها محور مركزي متصلة به الكثير من الفروع الجانبية والتي تعرف بالشوكية حيث تتداخل هذه الشوكيات مع بعضها البعض لتكون تركيبا هندسيا متداخلة للريشة الواحدة مما يزيد من قابلية الامتصاص للملوث النفطي ودللت النتائج أيضا الى ان الرغوة الاسفنجية المطعمة بريش الجناح تمتلك اعلى نسبة امتصاص للملوث النفطي وفسرت النتائج اعتمادا على الاختلاف التركيبي بين ريش الجناح وريش الزغب

وامتدت الدراسة لتشمل تأثير اللزوجة على قابلية الامتصاص والذي كان تأثيرها واضحا حيث كان نفط غرب القرنة 2 والذي يمتاز بلزوجة عالية والذي امتاز بقابلية جريان ضعيفة في الرغوة الاسفنجية كون قابلية التماسك فيه اعلى من قابلية التلاصق بينه وبين الرغوة الاسفنجية

وأخيرا فان الرغوة الاسفنجية المطورة بريش طائر الزرقي لها القابلية الكبيرة على الطفو مصحوبة بنسبة امتصاص عالية تصل الى 500% بالنسبة لنفط حقول غرب القرنة (A.I.P 27)

الكلمات الدلالية: الرغوة الاسفنجية , الريش , النفط الخام , النفط المتسرب , طائر الزرقي, بوليمر