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The Effect of Fulica Atra Feather on Oil Sorption Capacity of Polyurethane Foam

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Abstract
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 Coot (*Fulica atra*) Bird. The objective of the study to compare the oil spill removal capability of the pure and modified polyurethane. Two types of Crude oil brought from Basrah oil fields used in this study, Sorption test in hydraulic oil was also done, the obtained results show that absorption capacity directly proportional to the filler type and used 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 . The polyurethane foam modified with wing feather has the highest absorption ratio due to changes between contour and fluff feather, the effect of viscosity very obvious in this study on absorption where the viscous oils unable to flow rapidly in to the sorbent due to the high cohesion more than the adhesion between oil and the sorbent materials, Finally, the modified polyurethane foam sorbents has a good buoyancy.
Keywords: Polyurethane, Feather, Crude oil, Oil spill, Fulica atra, Polymer.

1. Introduction

Oil is one of the important sources of energy in modern industrial world.It transported from the source of production to many places across the globe through oceans and inland transport during transportation the chance of oil spillage over the water body occurs due to accidents or by deliberate action during wartime and this cause environmental pollution (Karan *et a.l* 2011).Sorbentsare materials that soak up liquids. They can used to recover oil through the mechanisms of absorption, adsorption, or both. Absorbents allow oil to penetrate into pore spaces in the material they made of, while adsorbents attract oil to their surfaces but do not allow it to penetrate into the material. To be useful in combating oil spills, sorbents need to be both oleophilic and hydrophobic (water-repellant) (Lemos *et al*. 2007). Oil sorbents are able to concentrate and transform liquid oil to the semi-solid or solid phase, which can then remove from the water and handled in a convenient manner without significant oil draining out (Mark 1999; Pasila 2000; Chatterjee *et al.* 2002; Zhong *et al.* 2002; Choi *et al.* 1999). Sorbents can divided into three basic categories: natural organic, natural inorganic, and synthetic. Natural organic sorbents include peat moss, straw, hay, sawdust, ground corncobs, feathers, and other carbon-based products (Itopf 2003; Hussein *et al.* 2009; White 2010; Corneliu *et al.*2009; Tanobe *et al*. 2009; Bayat *et al*. 2005). They are relatively inexpensive and usually readily available. Organic sorbents can soak up from 3 to 15 times their weight in oil, but they do present some disadvantages. Some organic sorbents tend to soak up water as well as oil, causing them to sink. Many organic sorbents are loose particles, such as sawdust, and are difficult to collect after they spread on the water. Adding flotation devices, such as empty drums attached to sorbent bales of hay, can help to overcome the sinking problem, and wrapping loose particles in mesh will aid in collection. Natural inorganic sorbents include clay, perlite, vermiculite, glass, wool, sand, and volcanic ash. They can absorb from 4 to 20 times their weight in oil. Inorganic substances, like organic substances, are inexpensive and readily available in large quantities (Ladd *et al.*1970; McLeod *et al.* 1974; Scharzberg 1971; Usda 2008). Synthetic sorbents include fabricated materials that are similar to plastics, such as polyurethane, polyethylene, and nylon fibers. Most synthetic sorbents can absorb as much as 70 times their weight in oil, and they are the most widely used sorbents made from high molecular weight polymers such as polyurethane and polypropylene. They are available under various trade names. They have good hydrophobic and oleophilic properties and high adsorption capacity. For example, ultralight, open-cell polyurethane foams can absorb 100 times their weight of oil from oil-water mixtures some types can cleaned and reused several times. Synthetic sorbents that cannot cleaned after they are used can present difficulties because they must be stored temporarily until they can be disposed of properly (Jarre *et al*. 1979; Al-Majed *et al.*2012).

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.

2. Experimental work

The used feathers obtained from the coot (*Fulica atra*) bird. It is a wading bird of the heron Phylum Chordata, family Neomorphinae (Salam *et al*. 2006) Contour, down and flight feather of that bird used as a filler to modify the polyurethane foam to increase its ability as oil sorbents material. Each kind of feather separately distributed in to the reaction container and mixed with reaction chemicals. Pure polyurethane prepared by reacting a liquid isocyanate with a liquid blend of polyols where a mixing for a minute is required. The obtained foam cut in to small pieces to investigate their sorption capacity. Two types of Crude oil brought from rumaila oil fields. The first oil extractor directly from the wells and the second also crude oil, but passed through the insulation, Also hydraulic oil used in the sorbent evaluation procedure, used also motor oil and use the water during the experience, the materials used 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 materialsin 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 the materials surface. After a certain period of time 5, 15, 30, 60, 24, 48 and 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.

Figure 1. The modified PU foam.

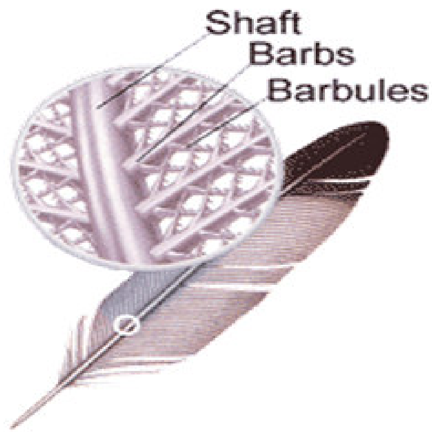

Figure 2. The structure of feather.

3. Results and discussion

Figure 3 shows the variation of oil absorption capacity of fluff feather modified polyurethane foam as a function of immersion time in different oils. The highest absorption capacity obtained with crude oil taken from the well. The absorption capacity different from one type of oil to another as shown in the above figure where this difference depended on the chemical and physical properties of oil.

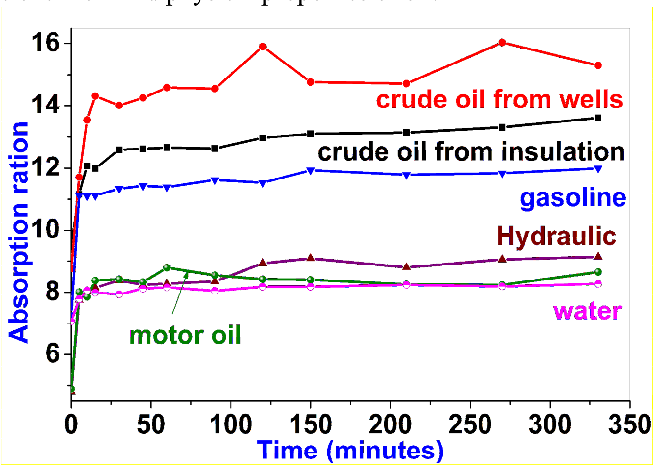

Figure 3. Variation of oil absorption capacity of polyurethane foam modified with fluff feather of fluica atra bird as a function of immersion time in different oils.

Another result obtained from Fig. 3 where that the highest absorption capacity for crude oil combined with vibration between increment and decrement where this behavior appear after reaching to saturation absorption capacity. It is obvious the higher ratio, which represents the increment followed by increment due to the release of absorbed oil 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 saturation value of absorption capacity tends to be after 30 minutes for all used oils.

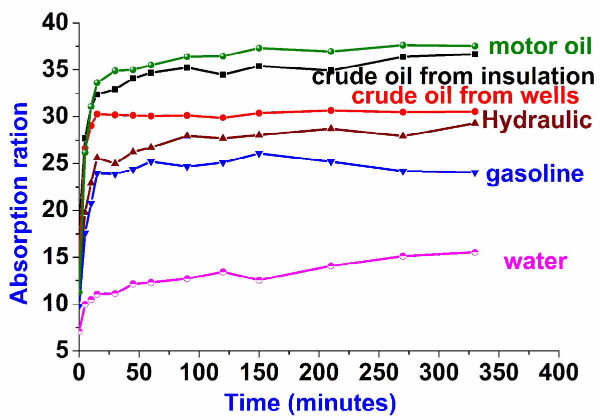

Figure 4. Variation of oil absorption capacity vis time of contour feather.

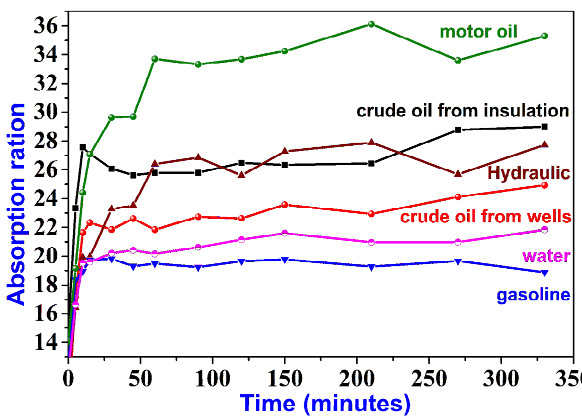

Figure 5. Variation of oil absorption capacity vis time of wings feather.

The same behavior obtained with down feather but the highest absorption capacity also with crude oil taken from distillation machine as shown in Fig. 4. Less vibration between increment and decrement obtained with such type of feather due to feather structure of such type of feather, which is different from that of fluff feather. Big changes in absorption capacity shown in Fig. 5 which shows the effect of wings feather on absorption capacity of polyurethane. The less viscous oils has the highest absorption ratio due to the rapid flow in to the sorbent materials causing a high rate of penetration in to the sorbent. The difference in values of absorption related to the difference in viscosity of oils where viscous oils unable to flow into a sorbent and the absorption ratio will be determined effectively by the external surface area.

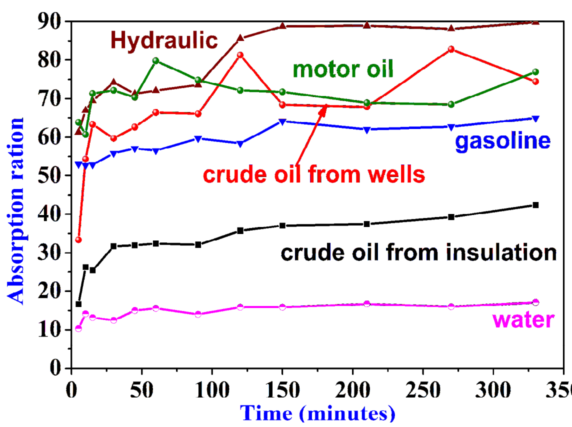

Figure 6. Variation of oil absorption percentage vis time of fluff feather.

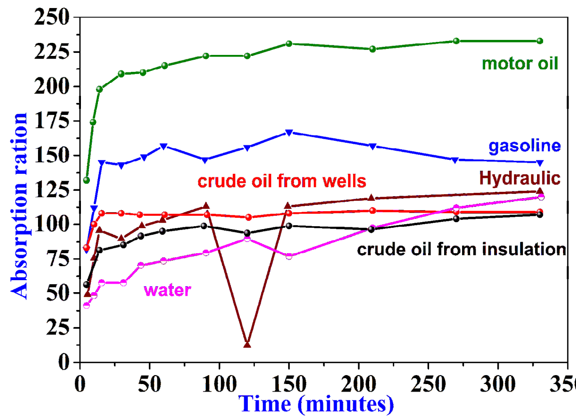

Figure 7. Variation of oil absorption percentage vis time of contour feather.

The differences in absorption capacity due to using three 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. The Fig. 6, 7 and 8 show the variation in absorption ratio that represents the difference between the final weigh of absorber minus the first value divided by the first value. The last figure shows a noticeable difference in absorption ratio for all used oil where the higher absorption ratio indicating the good ratio of open cells to closed cells of modified polyurethane foam. 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. These barbs is less cross linked with fluff feather leading to that changes in not the absorption ration only but the absorbed oil type .

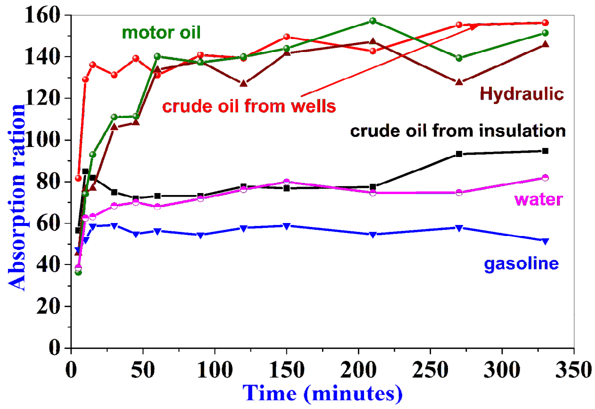

Figure 8. Variation of oil absorption percentage vis time of wings feather.

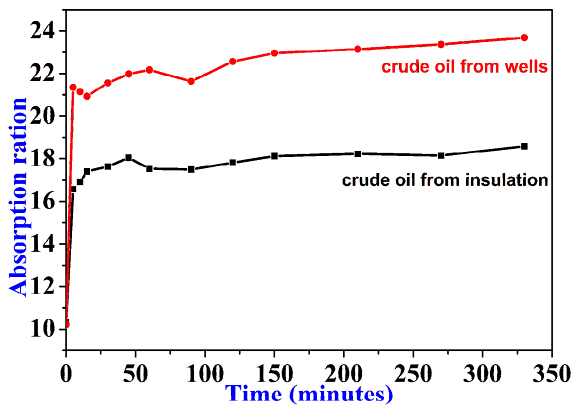

Figure 9. Effect of isocyanate to polyols ratio on crude oil absorotion percentage vis time.

For further specification, we synthesized polyurethane foam with 1:2 mixing ratio to study the absorption ratio of crude oil. We find that the absorption ratio is higher than that of 1:1 foam as shown in figure 9. The last result due to the softness of polyurethane foam of 1:2 mixing ratio where the softness leads to more flow of oil in to the absorber more than the stiffness one as shown in figure 10.

Figure 10. Polyurethane foam after the submerged oil.

Conclusion

The absorption capacities of modified polyurethane more enhanced due to the capillary structure changes made to the polyurethane after adding water bird feather. All obtained results suggest that that modified polyurethane has a considerable potential as an oil sorbent especially 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 lightweight, ease of fabrication and handle, high ability to shape in any form and its reusability as sorbent substance. The viscosity of the oil has an important effect on the rate of penetration in to the polyurethane modified foam.

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