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Dispersion of Arabian Crude Oils in Sea Water by Finasols

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ABSTRACT. The efficiencies of 3 commonly used chemical dispersants in Saudi Arabia were tested in the laboratory. Effects of variations of both ratios of applied dispersants to oil intended to be removed from water surface and stabilization time for the produced oil dispersion were assessed. The results obtained showed that amongst the tested Finasols-type dispersants, 90% of arabian light crude oil could be removed by the application of a quantity of 10% diluted Finasol–5 corresponding to half of the spreaded crude oil. In the case of heavy arabian crude oil, the use of either of the three dispersants (Finasols–2, –5 and –7) never produce the removal of more than 60% of the spilled quantity. This is true when the same conditions are followed as in the case of arabian light. Meanwhile, by application of Finasol–7 corresponding to 80% of the heavy crude oil, 98% of it could be dispersed after 24 h.

Introduction

Chemical dispersants, as surface-active agents in nature, are working in water by reducing the oil/water surface tension leading to the break-up of oil slick into small droplets which disperse in water column and leave the surface. Because of both the ease and high efficiency of these synthesized chemicals, it was, and still is, the most common technique for combating spilled oil in the marine environment. However, the dispersed oil is more toxic than the non-dispersed one (Wardley-Smith 1976, Beynon and Cowell 1974, Nelson-Smith 1968). Consequently, the use of dispersants is not allowed in any region under any condition and many restrictions have been established, especially in U.S.A. and Europe for controlling the application of various types of dispersants in the marine environment (Boesh *et al.* 1974).

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Production of an adequate mixing between the added dispersant and oil slick and minimizing toxicity to marine life are the main two problems in the application of chemical dispersants in the marine environment (Boesh *et al.* 1974).

From local or regional point of view, more studies are still needed to evaluate the best conditions according to which a certain dispersant could be applied to exert its maximum efficiency as well as its lowest harmful effects in the marine environment. This type of study is not only ecologically important, but also largely valid when the economy of the technique is considered.

In the present work, the results of a laboratory study concerning the evaluation of the efficiency of the commonly used dispersants (Finasols–2, –5 and –7) in Saudi Arabia to disperse arabian crude oils are given.

Material and Methods

In the following, the essential properties of working materials and characteristics of the applied methods are summarized.

a. ***Crude Oils***

Samples of two types of crude oil were provided from Petromin refinery at Jeddah. The crudes are arabian light (density: 0.851 and viscosity: 5.45 cps at 37.8°C and arabian heavy (density: 0.887 and viscosity: 19.1 cps at 37.8°C).

b. ***Chemical Dispersants***

In Saudi Arabia, the old corexit-type dispersants are replaced by the relatively new Finasol generation of synthesized dispersants. Samples of the available and commonly used types of Finasols were provided by the Authority of Islamic Harbour of Jeddah. According to the producer (Finachemical Ltd., U.K.).

■ Finasol ORS–2 is an almost colourless, low-viscosity liquid containing hydrocarbon solvents and emulsifiers. It has powerful solvent action on mineral oils of all types, also on greases and tarry deposits, and emulsifies immediately on contact with fresh or salt waters and is officially approved for oil pollution at sea, on beaches and inshore installations.

■ Finasol ORS–5 is a super-concentrated emulsifier, dispersible in water and free from petroleum solvents. By dilution with water, it is particularly suitable for dealing with oil slicks at sea. On dilution with petroleum solvents, it becomes suitable for degreasing surface contaminated with residues of oils. It maintains its high efficiency over a very wide temperature range. Its dispersion efficiency depends upon water salinity, water dilution level and amount of oil to be dispersed.

■ Finasol ORS–7 is a concentrated liquid dispersant, dilutable in water, biodegradable, does not contain petroleum solvents. It is suitable for all kinds of low-viscosity oil slicks spreaded on water. Its dispersion efficiency is a function of water salinity, nature of oily pollutants and its applied concentration value.

c. *Laboratory Tests*

According to the available facilities in our laboratory, the simple method of Bergueiro *et al.* (1981) was chosen to be followed in this work, in order to evaluate the relative efficiencies of Finasol types in dispersing arabian crude oils in sea water. The principle of this technique included mechanical stirring of certain amount of dispersant/oil mixture in a beaker containing fixed volume of water, stabilization of the produced emulsion, and measurement of the ratio of dispersed oil to the original added amount.

The real efficiency of any dispersant is a function of many factors amongst which are: ratios between dispersant, oil and water in their mixture, stirring power and duration, stabilization time of the produced emulsion, water salinity, applied dispersant dilution level, ... etc. Among these factors, both dispersant/oil ratio and stabilization time of the produced dispersion have the major determining role for the efficiency of any dispersant. However, laboratory investigation on these two properties for the three types of Finasols were conducted. Details of the applied efficiency tests could be summarized as follows :

- Container : 2 liters glass beaker of 12.5 cm diameter.
- Stirring mean : mechanically with 3 blades metallic propeller. The blade width is of 1.5 cm.
- Stirring power : fixed at 250 rpm.
- Stirring time : fixed at 30 mn.
- Stabilization time : 30 mn, 12 h and 24 h.
- Dispersant dilution : 10% in water for all tests.
- Dispersant/oil ratios : 1:10, 4:10 and 8:10 (diluted dispersant to oil, respectively).

Measurements of the dispersed oil amount in each experiment were carried out by withdrawing homogeneous samples from the produced dispersion from the middle of the mixture, extracted by carbon tetrachloride dried in rotary evaporator, dissolved in certain volume of *n*-hexane and concentrations of oil detected spectrofluorometrically. The excitation wavelength was fixed at 310 nm for the two types of working crude oils, fluorescence wave lengths were 371 and 382 nm for arabian light and heavy respectively. The instrument used is Baird fluoripoint spectrofluorometer, Ratiometer RC 200.

The results discussed in this work are the mean values for triplicate tests for all working materials under different conditions.

Results and Discussion

From Table 1, grouping all the results obtained for different working materials and conditions, it can be observed that the relative efficiency of each of the tested Finasol dispersants is a function of the ratio of its quantity to that of the oil as well as the type of oil.

TABLE 1. Efficiency of Finasol dispersants used.

Oil	a / b / c / dispersant	Mean concentration of dispersed oil in ml/l								
	b	10%			40%			80%		
	c	1/2	12	24	1/2	12	24	1/2	12	24
Arabian light	Finasol-2	3.55 (71%)*	1.15 (23%)	1.35 (27%)	3.15 (63%)	1.76 (34%)	2.80 (56%)	1.90 (38%)	1.52 (30.4%)	3.60 (72%)
	Finasol-5	4.60 (92%)	2.45 (49%)	3.075 (61.5%)	3.80 (76%)	2.40 (48%)	2.27 (45.4%)	3.95 (79%)	3.15 (63%)	2.075 (41.5%)
	Finasol-7	2.01 (40.2%)	2.45 (49%)	2.025 (40.5%)	2.06 (41.2%)	2.425 (48.5%)	2.50 (50%)	3.95 (79%)	2.80 (56%)	1.47 (29.4%)
Arabian heavy	Finasol-2	2.625 (52.5%)	0.935 (18.7%)	1.70 (34%)	1.80 (36%)	2.825 (56.5%)	2.85 (57%)	2.05 (41%)	3.40 (68%)	4.125 (82.5%)
	Finasol-5	1.95 (39%)	2.45 (49%)	0.925 (18.5%)	1.85 (37%)	1.40 (28%)	0.475 (9.5%)	2.00 (40%)	0.785 (15.7%)	2.55 (51%)
	Finasol-7	1.90 (38%)	1.50 (30%)	1.80 (36%)	1.60 (32%)	2.625 (52.5%)	2.475 (49.5%)	2.35 (47%)	3.25 (65%)	4.85 (97%)

a : dispersed oil in ml/l from the original 5 ml added per liter in all tests.
b : percentage of added diluted dispersant in oil.
c ; stabilization time in hours.
* : percentage of dispersed oil relatively to the original added amount.

In the case of arabian light crude oil, it appears that whatever the ratio of Finasol–5 to oil and for various stabilization times, it is more effective in dispersing oil than the other two types of Finasols. On the other hand, the application of this dispersant at the minimal ratio to oil (1:10) produces the maximum efficiency, as 92% of the soil is dispersed. By increasing this ratio or by lengthening the stabilization time, its efficiency is reduced. This result could be explained by the fact that continuous addition of dispersant to oil dispersion leads to the production of minute particles with lesser density which tend to leave the medium to the surface. Longer stabilization time enhances this operation. However, the measured efficiency dispersant decreases.

The results indicate that, in the case of arabian heavy crude oil, regardless of the applied type of Finasol, increasing the ratio of any of the dispersants leads to increasing the rate of dispersion of the oil. Using the maximum considered ratio of Finasol–7 to oil (8:10), almost all of the oil is dispersed after 24 h stabilization time. The same result is found when Finasol–2 is used but with lower efficiency (82% of oil is dispersed).

Details of the results for the use of different Finasols against each oil at any experimental conditions could be directly extrapolated from Table 1.

Conclusion

In the present work, the results show that while the application of Finasol–5 is suitable for removing arabian light oil from sea surface with a ratio of 1:10 (10% dispersant in water to oil), Finasol–7 is the most efficient dispersant for arabian heavy oil when it is used with a ratio 8:10 (10% dispersant in water). Taking into consideration that in the case of arabian light, short time (30 mn) is needed to obtain stable dispersion with Finasol–5, arabian heavy with Finasol–7 needs longer time (24 h) to reach a stable dispersion of the highest efficiency.

The results indicate that it is worthless to use more quantity of dispersant than what the oil spill situation needs. In fact, excess of dispersant leads to less efficiency. Moreover, it increases the cost of oil combating technique without the desirable efficient result. However, quantitative legislation for the used type of dispersants should be established in the environment in which they are intended to be used. As such legislation is economically important, it is also necessary to protect the marine environment from receiving excess quantities of toxic materials.

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تشتيت الزيوت العربية في المياه البحرية بالفيناسولات

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مستخلص

باختبار كفاية ثلاثة أنواع من المشتتات الكيميائية (الفيناسول ٢ ، ٥ ، ٧) في إزاحة نوعى البترول العربي الخفيف والثقيل بتجارب معملية اتضح أن فيناسول – ٥ هو أنسب الأنواع في إزاحة البترول العربي الخفيف من مياه البحر وذلك عند استخدامه بنسبة ١٠٪ من كمية البترول الموجودة في المياه ، في حين أن فيناسول – ٧ هو أنسب الأنواع في حالة البترول العربي الثقيل ، باستخدامه بتركيزات أعلى (٨٠٪ من كمية البترول المسكوبة) . وفى كلتا الحالتين تُستخدم المشتتات بتخفيف مبدئي ١٠٪ بالمياه البحرية .

لهذا البحث أهميتان : الأولى اقتصادية إذ بتقنين استخدام هذه الأنواع من المشتتات كميا يمكن توفير الكثير من تكاليف هذه المواد الغالية الثمن ، خاصة وأنه قد ثبت عمليا أن المبالغة في الاستخدام كميا يؤدي إلى الإنقاص من كفايتها .

والثانية بيئية إذ من المعروف أن هذه المركبات جميعها ذات نشاطات سطحية تؤدي إلى أضرار بيئية ، وبتقنين استخدام هذه المركبات يمكن منع وصول المزيد منها ، ومن ثمَّ تقليل آثارها الضارة فى البيئة المائية .