Bull. Nat. Inst. Oceanogr. & Fish., ARE, 15 (1), 1989: 191 - 195.

ROLE OF ANTIFOAMERS IN EXTRACTING OIL FROM DESALINATED SEA WATERS

HASSAN AWAD AND SAMIR GHAZY*

Department of Oceanography, Faculty of Science, Alexandria University, Moharam Bey, Alexandria, Egypt.
*MEPA, Jeddah, Saudi Arabia.

ABSTRACT

In the countries surrounding the Arabian Gulf, as in all similar arid areas, seawater desalination is the absolutely vital industry. Because of the concentration of enormous petroleum activities in this area, this industry is in continuous menace from all risks of marine oil pollution.

In the present work, an investigation is conducted for the possible role antifoaming agents in minimizing the load of dissolved petroleum products interfered within the distilled seawater during its desalination processes. By laboratory experiments, the results showed that the added antifoamers could extract considerable amounts of dissolved petroleum hydrocarbons. For two dominant used types of antifoamers (Antifroth and U-Con), equations for their capacities in extracting petroleum hydrocarbons from seawater were deduced.

INTRODUCTION

In the arid areas where potable and irrigation waters are rare, desalination of seawater is a convenient means of supplying the local water demand. In all countries surrounding the Arabian Gulf, seawater desalination represents a very vital industry for their survival and development. As this region is well known by its richness in various petroleum activities (production, transportation and processing), the oil pollution in the Gulf marine environment is normally existing in the same order of magnitude as the enormous petroleum activities. However, the coastal desalination plants in the area are usually in continuous menace by stopping their operational activities -when the pumped seawater become contaminated by oil. This was the case following the disaster of Nowruz in 1983 during the Iran-Iraq war (1982 -1988) when almost all desalination plants were closed for long duration. This is inspite of the fact that the regions of water intakes for most of the desalination plants in the area are usually protected by fence or curtain booms. In fact, this type of protection is useful for spreaded and to some extent for dispersed oil in the water, but it is useless for the dissolved or minute emulsified oil fractions. This later oil fraction could escape from the booms and interfere in the desalinated sea water causing unpleasant and harmful modifications in the final produced desalinated waters.

Multistage flash distillation (MSF) is the process used in almost all large sea water desalting production plants. The equipment is simple; the operation is relatively reliable and the manufacturing techniques and engineering design are sufficiently well established to allow dependable easily operated units to be produced (McIlhenny, 1975). This type of seawater desalting technique is in fact the dominant employed one in the area of Arabian Gulf. The method is composed of successive steps which could be summarized in the following lines :

- injection of the pumped saline water with concentrated H_2SO_4 for the prevention of scale formation of $CaCO_3$ and $Mg(OH)_2$. The used concentration is 120 ppm.

- injection with NaOH to nutralize the effect of the previous acidification step and for keeping the pH in the range of 7.4 - 7.7.

- treatment with the antifoam agent for preventing foaming with saline waters during distillation step. Antifoam is used with concentration corresponding to 0.16 ppm.

- distillation of treated saline water in vacuum for reducing pressure to maintain the process at low temperature (about 40°C).

Before distillation step, there are two other steps which are not included in our design (treatment with hypochlorite as a source of free chlorine for killing bacteria and with lime water for preventing erosion in pipes network). According to the aim of our investigation, these two later steps are not practically significant.

Among these above operational steps, the present work is devoted to illustrate the possible role of using antifoamers in extracting dissolved oil hydrocarbons from distilled sea water. The idea of this work is developed from the fact that the antifoaming agents are surface active in nature and composition. The physical action of these compounds in the diminish the surface tension of the air bubbles in the solution leading to burst them. Hence, the use of antifoamers is necessary to avoid both loss in equipment capacity (distillation chambers) and increase in processing time (distillation time). Indeed, in the seawater desalting plants, the use of antifoamers is necessary to avoid the contamination of condensed vapours with salt particles in the distillation chambers.

MATERIAL AND METHODS

The used materials in the present work are : two types of antifoaming agents (Antifroth and U-Con), and two types of Arabian crude oils (light and heavy). The used two types of antifoamers were chosen because of their dominant use in the Saudian desalination plants which are the largest plants in the area. Also, the two selected oils are representing the most possible contaminant in the Gulf area.

The followed procedure for evaluating the efficiencies of the antifoamers in extracting dissolved hydrocarbon from sea water could be summarized in the following steps :

- working contaminated seawater by either of the two types of oil were prepared by shaking certain amount of oil in water for 2 hr; leaving for decantation overnight and withdrawing the clear water accommodated fraction (WAF) of oil. The percentage of oil in water was adopted to produce a working WAFs with a concentration of 4 ppm (0.3% and 0.2% oil in water for heavy and light oils respectively).

- for a fixed aliquot of the prepared oil WAFs (500 ml), increaments of antifoamers were added (2, 4, 6, 8 and 10 ml), shaked for 5 min, left overnight for phases separation.

- total hydrocarbon contents in the above solutions (pure WAFs and WAFs containing antifoamers) were measured following the standard procedure of IGOSS (Anon., 1976) : extraction by carbon tetrachloride and detection spectrofluorometrically using an excitation wave length at 360 nm and fluorescence wave lengthes at 371 and 380 nm for light and heavy Arabian crude oils respectively. The used instrument was Baird spectrofluorometer, model Ratiometric RC 200.

RESULTS AND DISCUSSION

Dispersion capacities for the considered antifoamers in seawater as well as their efficiencies in extracting hydrocarbons were investigated and results are included in Table 1 and represented in Fig. 1. From the results, it could be noted that by increasing the concentration of either antifroth or U-Con antifoamers while their dispersion decrease paralelly, their efficiencies for eliminating dissolved/dispersed hydrocarbons increase. This phenomenon could be elucidated by the fact that, when the concentration of an antifoaming agent increases in aqueous medium, its major amount tends to leave the medium and concentrate as a layer in the air/water interface as all surface active substances. However, it eliminates more hydrocarbons from the medium (by its surface activity property) and concentrates them on the water surface.

As shown in Figure 1, the relationship between the used concentration of antifoaming agent and the eliminated amount of dissolved/dispersed hydrocarbons from the medium is following a straight line relationship regardless of its type and source of existed hydrocarbons in the medium. The relationship could be expressed with the following deduced equations in which Y is the eliminated amount of hydrocarbons in mg/l and X is the used concentration of antifoaming agent expressed in ml/l :

a) Antifroth-like antifoamers

$$Y = 6.2 \times 10^{2} + 3.49 \times 10^{-3} X$$

(in the case of light Arabian-like crude oil spill)

TABLE 1

Efficiencies of used antifoaming agents in extracting hydrocarbons from seawaters.

conc. of antifoam ml l^{-1}	Antifroth % of dispersion	* LA	HA	U-Con % of dispersion	* LA	HA
4	9.8	640	250	6.8	170	340
8	7.0	690	305	4.3	270	460
12	6.1	733	355	3.5	320	610
16	4.7	770	413	3.0	370	686
20	3.8	850	470	2.8	420	760

* Amount of extracted petroleum hydrocarbons in mg l^{-1}

LA Light Arabian crude oil

HA Heavy Arabian crude oil

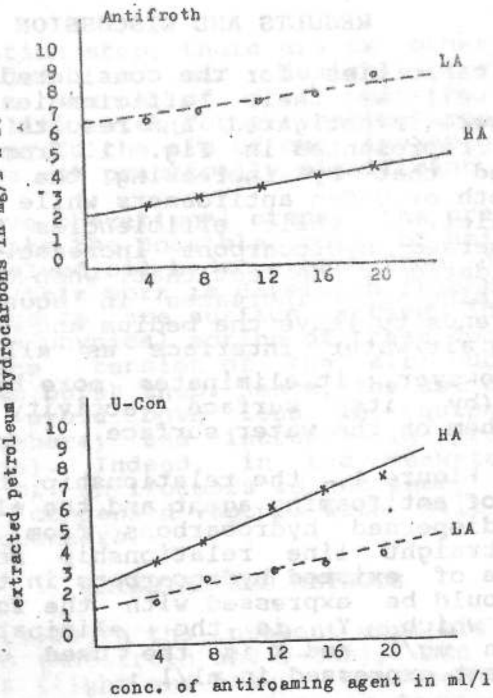

FIG. 1

Relationship between the amount of used antifoaming agents and extracted hydrocarbons from seawater.

LA : light Arabian crude oil

HA : heavy Arabian crude oil

$$Y = 2 \times 10^2 + 4.88 \times 10^{-3}X$$
(in the case of heavy Arabian-like crude oil spill)

b) U-Con-like antifoamers

$$Y = 1.3 \times 10^2 + 5.50 \times 10^{-3}X$$
(in the case of light Arabian-like crude oil spill)

$$Y = 2.85 \times 10^2 + 10.18 \times 10^{-3}X$$
(in the case of heavy Arabian-like crude oil spill)

From the above deduced equations, it could be concluded that the use of antifroth-like antifoaming agents is more suitable for eliminating interfered hydrocarbons coming from light crude oil-likes, while the U-Con-like antifoamers are more suitable for heavy crude oil-like sources.

ACKNOWLEDGMENTS

The authors are deeply grateful for the staff members of Jeddah desalination plants for providing samples of antifoaming agents and valuable processing informations as well as for Mrs. Awad for typing the manuscript.

REFERENCES

Anon., 1976. Guide to operational procedure for the IGOSS pilot project on marine pollution (petroleum) monitoring. UNESCO, Manuals and Guides, N° 7.

McIlhenny, W.F., 1975. Extraction of Economic Inorganic Materials from Seawater. In: Chemical Oceanography, J.P. RILEY, and G. SKIRROW (EDS.). Academic Press, London, Vol. 4: 155-2[illegible].