

PETROLEUM HYDROCARBON LEVELS IN WATER AND SEDIMENTS OF DOHA AND UMM SAID HARBOURS, ARABIAN GULF

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ABSTRACT

Applying spectrofluorometric method, the distribution of petroleum hydrocarbons in water and sediments in Doha and Umm Said Harbours during the period between August 1986 and April, 1987 was investigated. Concentrations of petroleum hydrocarbons in surface water and in sediments ranged from 1.5 to 48.9 $\mu\text{g.l}^{-1}$ and from 1.8 to 4.4 $\mu\text{g.g}^{-1}$, respectively, with higher levels at Umm Said Harbour due to the existence of a pipeline oil terminal and extensive ship traffic.

There is a marked increase in the levels of petroleum hydrocarbons in water during April in comparison to other months in both harbours.

The sediment data of petroleum hydrocarbons at Doha Harbour are in good agreement with water values ($r=0.71$) at that site. At Umm Said, sediment data show negative correlation with water ($r=-0.66$).

Enrichment factors obtained indicate that petroleum hydrocarbons are concentrated in sediments of Doha and Umm Said at 770 and 200 respectively.

INTRODUCTION

Recent observation and measurements have shown that the Arabian Gulf is more polluted than other world oceans (Al-Harmi and Anderlini, 1979; Oostdam, 1980; Zarba et al., 1982; El-Samra et al., 1985; Emara and El-Deeb, 1988 and Emara, 1989). Petroleum hydrocarbons in the Arabian Gulf arise mainly from natural seepage and/or from human activities in the production, transportation and usage of petroleum. In literature, there is a lack of data on petroleum hydrocarbons in water and sediments of the Arabian Gulf harbours (IAEA, 1985), particularly Doha and Umm Said Harbours of state of Qatar.

The aim of this study is to show the levels and distribution of petroleum hydrocarbons in water and sediments of Doha Harbour where a desalination plant lies, as well as Umm Said Harbour which is affected by industrial wastes from Qatar Steel Company (QASCO), Qatar Fertiliser Company (QAFCO), Qatar Petrochemical Company (QAPCO) and Qatar General Petroleum Company (NGL).

MATERIALS AND METHODS

Sampling of sea-water (three cruises) and sediments (one cruise) was performed during the period August-September, December 1986, January and April 1987 in the Doha and Umm Said Harbours of the state of Qatar in the Arabian Gulf, at the stations shown in Fig. 1. Sea water samples were collected at 1 m depth with a glass bottle of capacity 2.8 l. Sediments were sampled by Van Veen grab sampler, wrapped in aluminium foil and kept deep-frozen until analysis. Spectrofluorometric determination of petroleum hydrocarbons in sea-water samples followed the procedure recommended by UNESCO, 1977, and in sediments using the method proposed by ROPME, 1983. Kuwait crude oil was selected as an arbitrary standard for comparison.

RESULTS AND DISCUSSION

Concentration of petroleum hydrocarbons in surface water of Doha and Umm Said Harbours (Figs. 2 & 3) ranged from 1.5 to 48.9 $\mu\text{g.l}^{-1}$. However, concentrations exceeding 40 $\mu\text{g.l}^{-1}$ were observed only in four samples collected during April, 1987 from stations 5 and 9 in Doha Harbour and stations 3 and 4 in Umm Said harbour. High concentrations of petroleum hydrocarbons possibly originated from refineries and port areas as well as from oil production and/or from natural seeps. The majority 79% of concentrations ranged from 1.5 to 7.9 $\mu\text{g.l}^{-1}$ in Doha water as compared with 3 - 30 $\mu\text{g.l}^{-1}$ (70.6%) recorded in the waters of Umm Said (Fig. 4). The lowest level recorded for both areas is observed at the desalination plant (1.7-3.8 $\mu\text{g.l}^{-1}$) of Doha Harbour. It is rather interesting to note that the mean level of petroleum hydrocarbons in surface water of Doha Harbour (12.4 $\mu\text{g.l}^{-1}$) is less than half the concentration of Umm Said Harbour (26.1 $\mu\text{g.l}^{-1}$) which can be attributed to the existence of a pipeline terminal within Umm Said and extensive tanker and ship traffics.

On a seasonal basis, there is a marked increase in the levels of petroleum hydrocarbons in April (33.4 $\mu\text{g.l}^{-1}$) in comparison to other months (9.9 $\mu\text{g.l}^{-1}$) in both harbours, presumably due to increasing number of ships during April, 1987.

The effect of oil pollution on the levels of dissolved oxygen in both harbours is illustrated in Fig.5. Good negative correlation exists between dissolved petroleum hydrocarbons in surface water and dissolved oxygen at Umm Said during August, 1986 ($r = -0.63$) as well as at Doha Harbour during April 1987 ($r = -0.95$). In November, 1986 and January, 1987, both harbours showed marginal positive correlation ($r=0.5$).

Transport of pollutants is directly affected by wind force and current regime in the area. In Doha Harbour, the current regime is affected by wind force and coast configuration with a predominant Northeast to Southwest direction. The current speed ranged between 1 and 70 cm/s (Hásson, 1985). At Umm Said, Beltagy (1983) recorded current speed of 4.7 - 58.1 cm/s with a predominant South to Southeast direction.

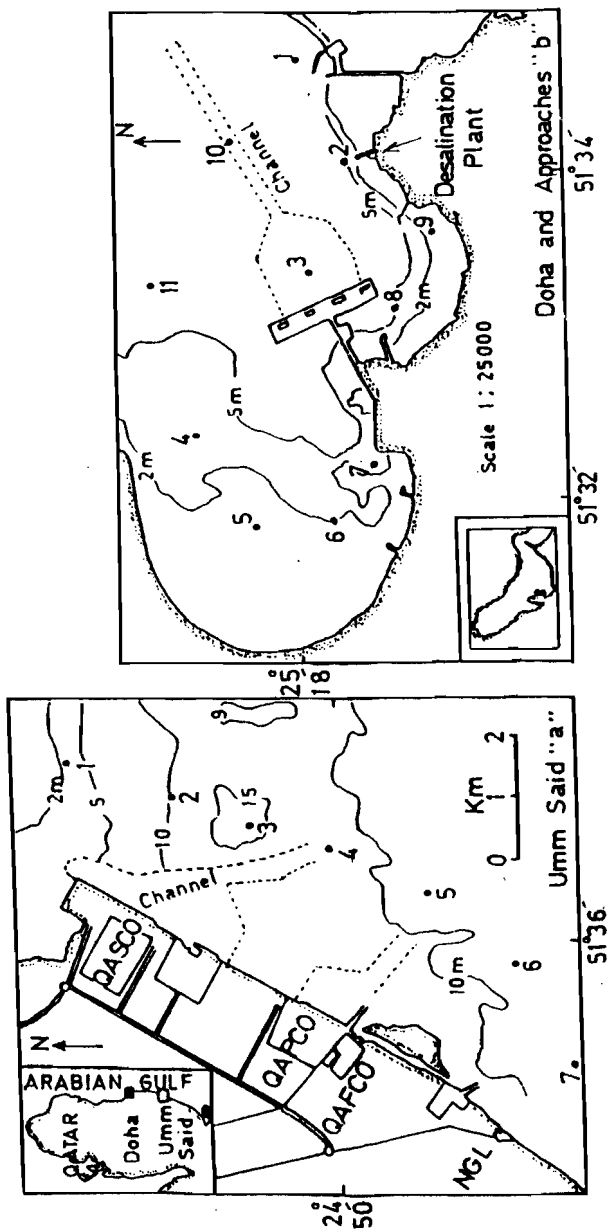


Fig. (1)
Study areas and locations of stations.

Fig. (2)
Distribution of petroleum hydrocarbons in water ($\mu\text{g. l}^{-1}$)
and in sediments ($\mu\text{g. g}^{-1}$) of Doha Harbour.

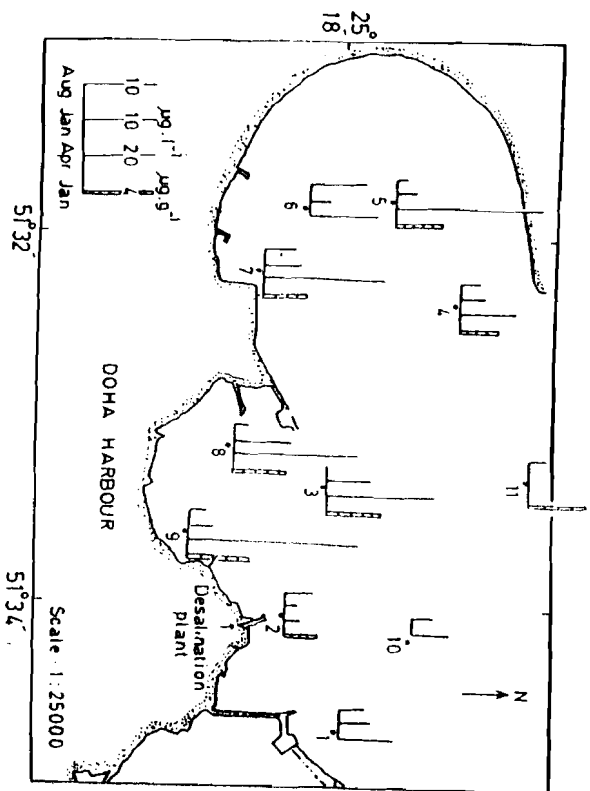
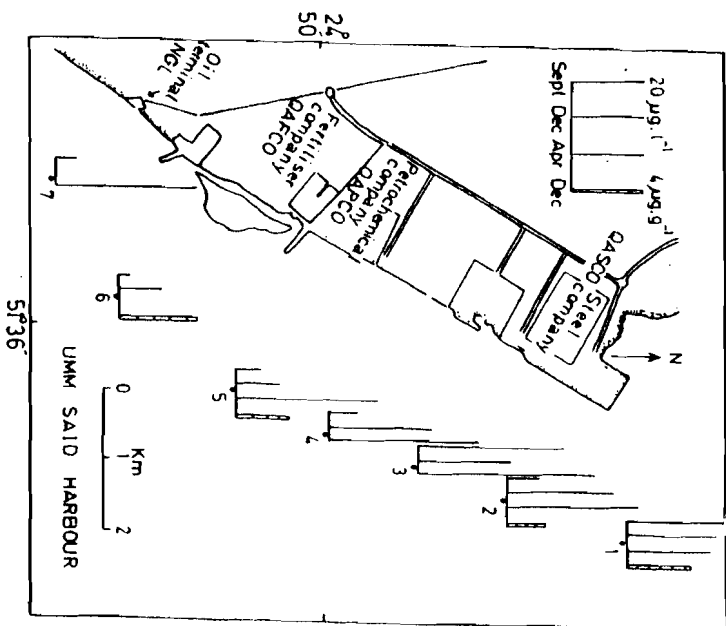


Fig. (3)
Distribution of petroleum hydrocarbons in water ($\mu\text{g. l}^{-1}$)
and in sediments ($\mu\text{g. g}^{-1}$) of Umm Said Harbour.



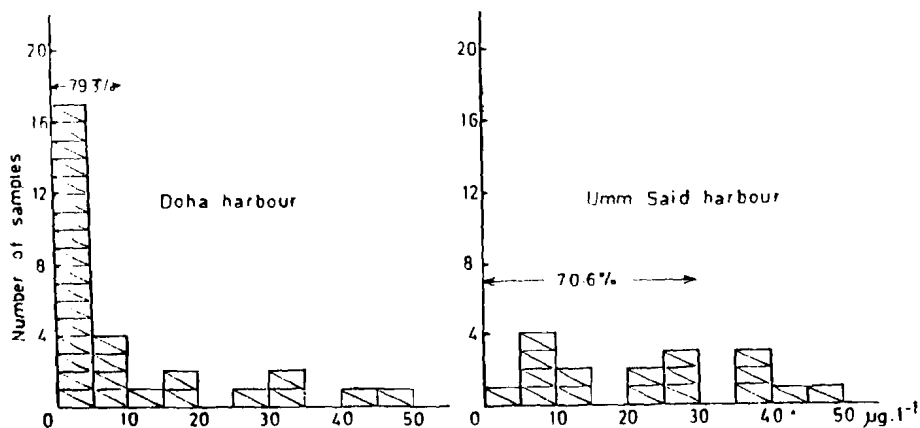


Fig. (4)
Histograms of number of samples vs. concentration of petroleum hydrocarbons in water.

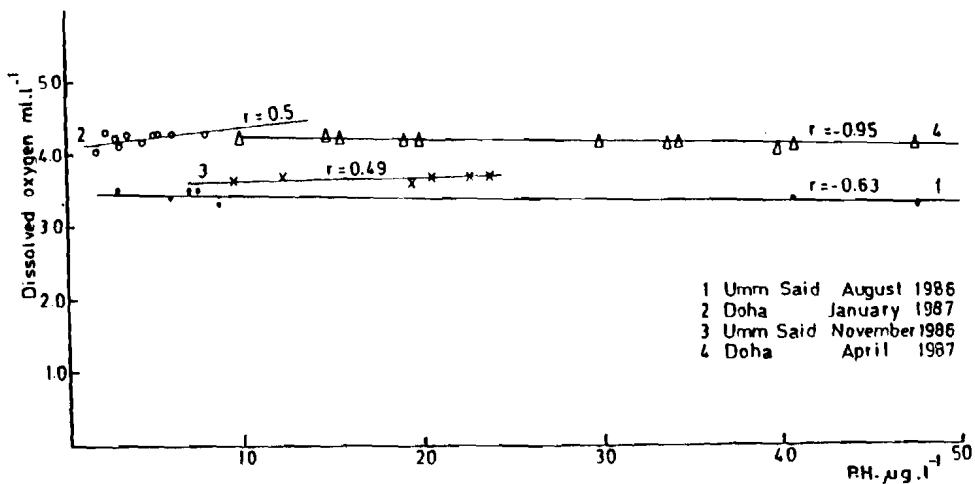


Fig. (5)
Dissolved oxygen-petroleum hydrocarbons relationship in surface water.

The concentrations of petroleum hydrocarbons in sediments of Doha and Umm Said Harbours (Figs. 2 & 3) varied in a narrow range of 1.8 - 3.5 $\mu\text{g.g}^{-1}$ and 2.2 - 4.4 $\mu\text{g.g}^{-1}$ dry weight, respectively, with 22% higher concentration at Umm Said Harbour. As expected, the highest level is recorded at the area of pipeline terminal at Umm Said, and the lowest at the desalination plant of Doha harbour.

Comparison of the values of petroleum hydrocarbons in water and sediments (Table 1) with concentrations in other areas of Kuwait, Bahraian, United Arab Emirates and Oman in the Arabian Gulf suggests that, current levels of petroleum hydrocarbons in Doha and Umm Said Harbours are not exceptionally high.

The sediment data of petroleum hydrocarbons at Doha Harbour are in good agreement with water values ($r=0.71$) at that site (Fig. 6) with the exception of station 9 which reflects relatively high level of petroleum hydrocarbons in sediments associated with low concentration in water. Sediments at this station are of muddy-sand which is relatively good accumulator of petroleum. The effect of grain size on petroleum concentrations is clearly shown by Burns et al. (1982). On the other hand, sediment data from Umm Said Harbour show negative correlation with water ($r=-0.66$).

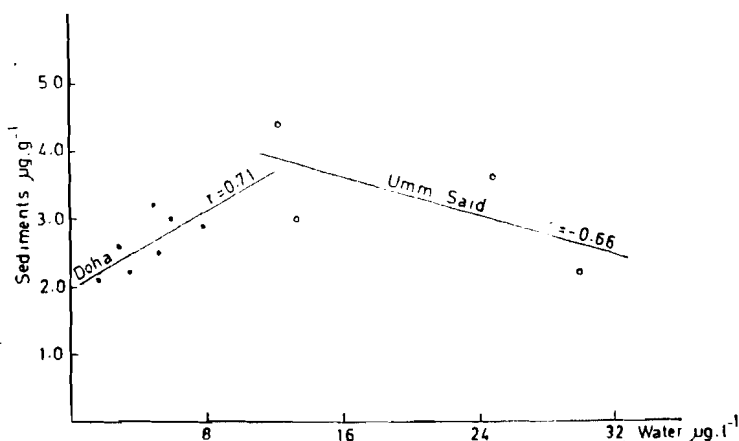


Fig. (6)
Relationship between petroleum hydrocarbons in sediments and in water.

TABLE 1
Comparison of the values of petroleum hydrocarbons in water and sediments of some areas in Arabian Gulf with concentrations of the present study.

Area	CONCENTRATION		References
	Water µg.l ⁻¹	Sediment µg.g ⁻¹	
Qatar			
Doha Harbour	1.5 - 47.7	1.8 - 3.5	Present study
Umm Said Harbour	3.0 - 48.9	2.2 - 4.4	
Kuwait	-	1 - 291	Zarba et al., 1985
Bahrain			
Askar	1.0 - 5.7	43.2 - 60.2	IAEA, 1985
Umm Nasan	0.4 - 0.63	0.8 - 8.6	
United Arab Emirates			
Umm al Nar	0.53 - 30.0	1.9 - 14.7	IAEA, 1985
Jebel Ali	0.07 - 9.3	0.1 - 0.3	
Oman			
Raysut Harbour	7.5 - 445.0	1.5 - 4.2	IAEA, 1985
Mutrah Harbour	0.6 - 3.5	30.0 - 119.0	

Sediment contamination with petroleum hydrocarbons did not show negative correlation with the oxygen levels near the bottom of Doha Harbour as expected, but a positive one ($r=0.81$) indicates that the recorded petroleum levels are not high enough to reduce the oxygen concentrations at the bottom (Table 2). At Umm Said, no data were available on dissolved oxygen near the bottom.

Enrichment factor obtained from table 2 indicates that petroleum hydrocarbons are concentrated in the sediments of Doha and Umm Said Harbours at 770 and 200 times respectively as that recorded in the water of the same harbours.

TABLE 2
Concentrations of dissolved oxygen (ml.l^{-1}) and petroleum hydrocarbons in water ($\mu\text{g.l}^{-1}$) and in sediments ($\mu\text{g.g}^{-1}$), as well as enrichment factors of Doha and Umm Said Harbours.

St.No.	Dissolved Oxygen ml.l^{-1}	Petroleum Water $\mu\text{g.l}^{-1}$	Hydrocarbons sediments $\mu\text{g.g}^{-1}$	Enrichment factor
Doha Harbour				
2	3.98	1.7	1.8	1059
3	4.19	6.0	3.0	500
4	4.11	3.4	2.15	647
5	4.11	2.9	2.6	897
7	4.21	5.2	2.5	481
8	4.25	7.9	2.9	367
9	4.22	2.2	3.5	1591
11	4.19	5.2	3.2	615
Average	4.16	4.3	2.7	769.6
Umm Said Harbour				
1	-	24.8	3.6	145
2	-	30.1	2.2	73
5	-	13.3	3.0	226
6	-	12.3	4.4	358
Average	-	20.1	3.3	200.5

CONCLUSIONS

In spite of a significant input of petroleum hydrocarbons particularly in Umm Said Harbour and to a lesser extent in Doha Harbour waters, hydrocarbon the concentrations in sediments are generally low.

The pollution topography obtained from the analysis of the sediments closely follows the pollution level of the surface water of Doha Harbour. On the other hand, sediment data from Umm Said Harbour show negative correlation with those of water. The only part that is little influenced by petroleum hydrocarbon pollution was the desalination plant in Doha Harbour as a result of water circulation pattern in the harbour.

There is a marked increase of petroleum levels in sea water during April in comparison to other months in both harbours.

Enrichment factor obtained between sediments and water reflects higher value for Doha Harbour as compared with Umm Said Harbour.

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