# Assessment of Oily Wastes Inputs into Marine Environment from Coastal Petroleum Refineries : Case Studies

By
***Hassan B. AWAD***
**Marine Environment Expert**
**Regional Organization for the Protection of Marine Environment (ROPME)**
hbawad@ropme.org

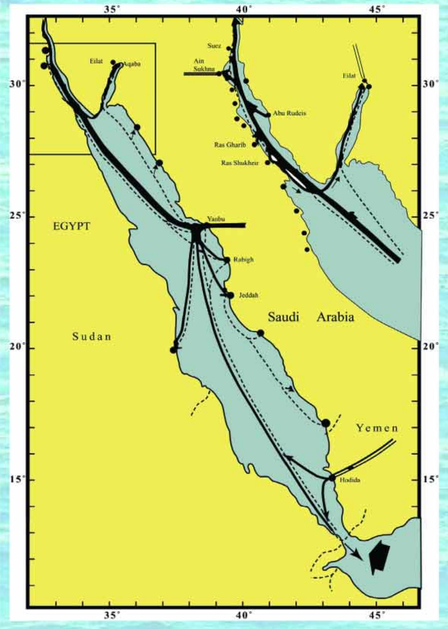


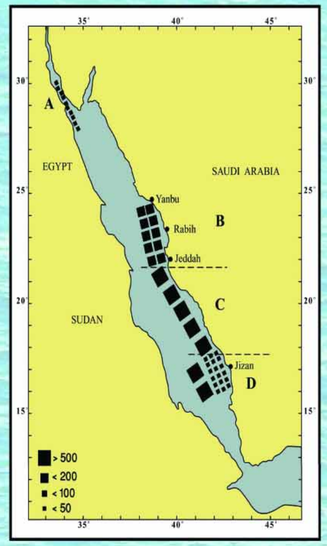

**Fig-1: Crude Oil and refined products transport across Red Sea**

The present work represents some of obtained results related to the assessment of oil pollution in the marine environments areas characterized by receiving huge amounts of crude oils and oily wastes from almost all sources; mainly Red Sea. Actually, in this area there are increasing intensive activities for oil exploration and production; especially in Gulf of Suez. This Sea is very busy by oil transport while surrounded by giant coastal petroleum refineries.
During the last two decades, efforts were devoted to link causes to the measured levels of petroleum hydrocarbons (PHs) in the marine environment, stressed by oil pollution.
Herein, three cases of assessment are presented.


**Fig-2: Main sites of crude oil production and refining activities in the Red Sea**

## Case study -1 :

### *Estimate of Oil Inputs, levels and Profile of Oil Pollution in the Red Sea Marine Environment.*



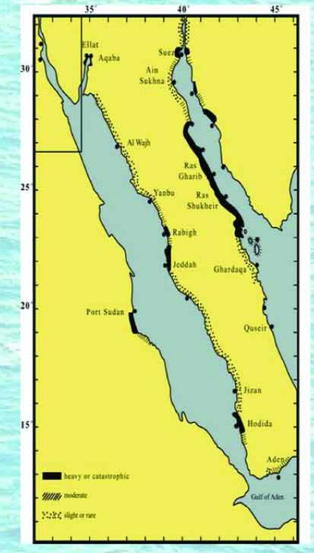

Continuous monitoring on the levels of oil pollution in Red Sea environment helped to identify the areas which are frequently subjected to oil spills. Variation of detected levels of PHs revealed the magnitude and frequency of oil spills in each zone.

The estimated annual inputs indicated that the marine environment in the Red Sea suffers from sever situation of oil pollution. Each km² in the Red Sea received 14.6 kg of oily wastes against 9.2 Kg/ km² for the World's Ocean .
Total estimated annual inputs from coastal refineries in Red Sea (6.7 Kg/ km²) correspond to 13 times more of that received by each km² of the world's ocean, from the same source at time of estimation (1981).
The Red Sea as semi-closed area helps the spilled oils and wastes to reside longer. However, impacts prolonged on its receiving marine environment.

*Estimate for possible annual inputs of oil in the Red Sea from main sources*

| Source | Location | Oil capacity (Mt yr⁻¹) | Water discharge (Mt yr⁻¹) | Assumed oil conc. in water ppm | Released oil amount (t yr⁻¹) | Notes |
|---|---|---|---|---|---|---|
| ***Eastern coast*** | | | | | | |
| **Refinery effluent** | Jeddah | 0.25 | 6.5 | 10 | 13 | One lubricating oil refinery |
| | Jeddah | 5 | 131.5 | 10 | 260 | One refinery for local consumption |
| | Yanbu | 21.3 | 560[a] | 2[b] | 1120 | Two refineries: for local consumption and exportation |
| | Rabigh | 17.5 | 450[a] | 2[b] | 900 | Ready to start for processing for exportation |
| **Petroline Terminals (clean tanker ballast water)** | Yanbu | 160 | 52[c] | 10[d] | 345 | Two terminals: One for exporting Iraqian oil (capacity: 0.5 mb d⁻¹), the other for Saudian oil (cap. 2.6 Mb d⁻¹) for supplying Saudian refineries and exporting the rest (about 115 Mt yr⁻¹) |
| **Yemenian Oil Terminal (clean tanker ballast water)** | Sana'a | 10 | 3[c] | 15 | 150 | Press declaration: The N. Yemen starts to export its recently discovered oil at rate of 0.2 Mb d⁻¹ |
| ***Gulf of Aqaba*** | | | | | | |
| **Oil Terminal (clean tanker ballast water)** | Eilat | 25 | 7.5[c] | 6 | 45 | Supposing that at Eilat, there are the same deballastation facilities as for the other Red-Mediterranean Seas pipeline (SUMED) in Egypt |
| **Terminal spills** | Eilat | | | | 100 | Annual accidental spillage rate during oil deloading |
| ***Gulf of Suez*** | | | | | | |
| **Refinery effluent** | Suez bay | 3 | 70 | 2 and 100 | 826 | Two refineries, discharges at 2 ppm for cooling waters and process waters at 100 ppm |
| **Oil production waters** | Offshore waters | 24.3 | 0.243 | 100 | 972 | Assuming that production water amount represent 10% of produced oil (1 Mb yr⁻¹) |
| **Tanker-ballast waters** | Coastal waters | 24.3 | 7.3[c] | 15 | 218 | |
| **Suez Canal** | | | 1680[e] | $115 \times 10^{-6}$ | 1902 | Estimated annual amount of dissolved/dispersed hydrocarbon to the Red Sea |
| **Total input** | | | | | **6851** | |

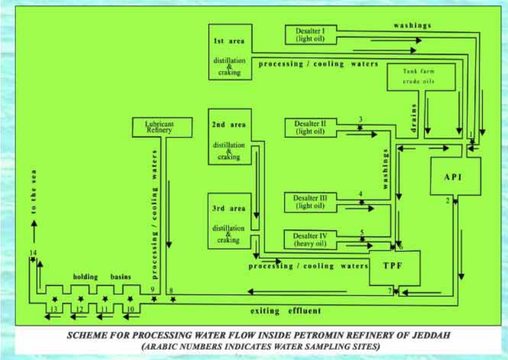
[a] Values obtained according to Blokker (1971), in coastal refineries; 3000 $m^3$ $hr^{-1}$ of processing waters are needed for refining 1 Mt $yr^{-1}$
[b] The low concentration (2 ppm) of oil in the water discharged from Saudian refineries (other than Jeddah refinery) is considered in the estimation because of central ultra-modern waste treatment system, including refineries effluent, in the industrial zone at Yanbu, recycling water coolant and air cooling systems are used
[c] Assuming that ballast water represents 30% of the total tanker capacity to be loaded at terminal
[d] Mean concentration of discharged ballast waters in the coastal water off Yanbu given by Neff *et al*. (1983)
[e] Annual quantity of Suez Canal water effluent enter the Red Sea during 3 mo of summer at rate of 5.6 x $10^6$ $m^3$ $mo^{-1}$ and 1.15 ppb concentration of hydrocarbons, during southwards current
Mb $d^{-1}$ : Million barrel per day




Based on observation, published data, national contingency plans, on-shore tar balls assessment and oil levels monitoring, a coastal oil pollution profile was constructed for the whole Red Sea coasts.

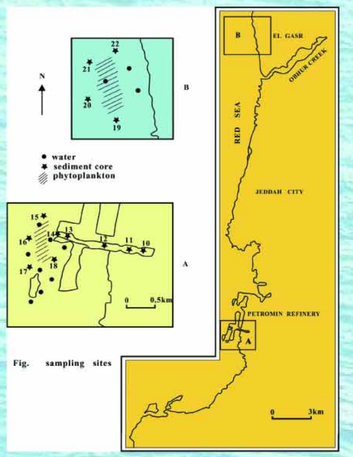
## Case study -2 :

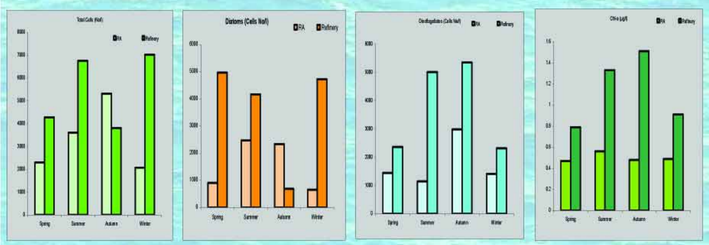
### *Role of Petromin Refinery in Adding Oily Wastes to Jeddah Coastal Waters, Saudi Arabia*




*SCHEME FOR PROCESSING WATER FLOW INSIDE PETROMIN REFINERY OF JEDDAH (ARABIC NUMBERS INDICATES WATER SAMPLING SITES)*

An amount of about 700 t of oily wastes was estimated for the annual input of Petromin Refinery (processing capacity 35 mta) into the marine environment in W-coast of Red Sea.
The assessment based on bi-weekly water sampling from 14 sites inside the refinery; representing various processing stages and from 11 sites outside. Residual PHs in water was measured. The results showed that, unless the refinery is equipped by high efficient oil treatment systems, more oil wastes might be discharged.
Crude oil-washing water was found to be the main contributor in the final discharges. Rapid dispersal of refinery effluent in receiving water led to a low PHs contents, similar to those measured in uncontaminated RA (± 2.5 µg/ l).

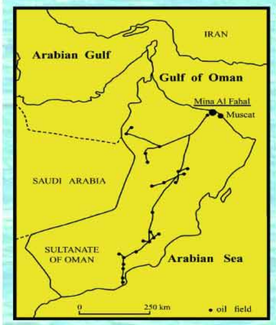


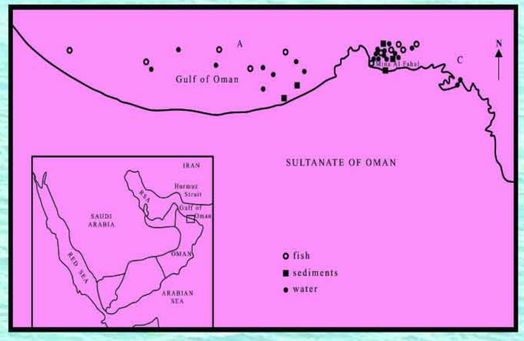

To assess the degree of impact of the refinery discharge in its receiving environment, sea water productivity in front of the refinery was monitored in comparison with that in a reference clean area (RA)
Surprisingly, the measured Chl-a and total no. of phytoplankton cells in the refinery area was superior to that found in the RA. Moreover, no. of spp. of Diatoms and Dinoflagelates were less numerous in RA than in front of the refinery.

## Case study -3 :

### *Omani Land-Based Oil Inputs in Gulf of Oman*

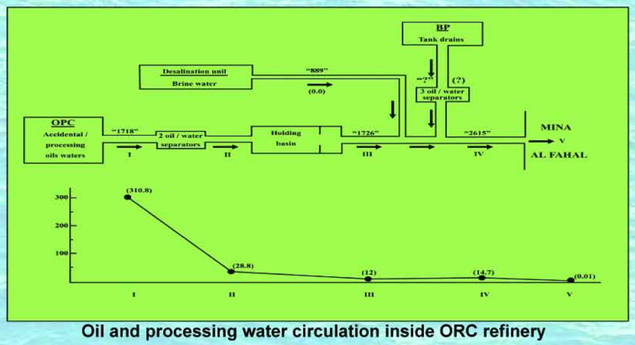



This case concerns the annual oily wastes input from the main Omani refinery (processing capacity :50000 bbl/d) in Mina Al-Fahal in Gulf of Oman. Through monitoring of the final refinery effluent, it was estimated that, the total input composed mainly from 2 sources; 160 t from processing operations and 140 t from oil tank drainage.
A high dilution factor (200 times) was calculated for the concentration of residual oil in receiving water of the refinery effluent (67 µ l/ l in receiving waters against 14.7ml/ l in the refinery outfall waters)




**Sampling sites along Omani coast**

**Omani oil fields network and Mina Al Fahal**




**Oil and processing water circulation inside ORC refinery**

Sea water, commercial fish and sediment were collected along the Omani near shore zone for assessing their levels of petroleum hydrocarbons (PHCs). The results showed that all samples collected from Mina Al-Fahal area, where the Refinery situated, contained the highest levels of PHCs and PAHs. The fine analyses indicated that other sources in the area contribute in the measured contents in different types of samples. Ballast waters discharge in area found to be the main contributor.