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Total Petroleum Hydrocarbon Contamination in Sediment and Wastewater from the Imam Khomeini and Razi Petrochemical Companies-Iran

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Abstract**—**The present study was performed in Musa bay (northern part of the Persian Gulf) around the coastal area of Bandar-e- Imam Khomeini and Razi Petrochemical Companies. Sediment samples and effluent samples were collected from the selected stations, from June 2009 to June 2010. The samples were analyzed to determine the degree of hydrocarbon contamination. The average level of TPH concentration in the study area was more than the natural background value at all of the stations, especially at station BI1 which was the main effluent outlet of Bandar-e- Imam Khomeini petrochemical company. Also the concentration of total petroleum hydrocarbon was monitored in the effluents of aforementioned petrochemical companies and the results showed that the concentration of TPH in the effluents of Bandar-e- Imam Khomeini petrochemical company was greater than Razi petrochemical company which is may be related to the products of Bandar-e- Imam Khomeini petrochemical company (aromatics, polymers, chemicals, fuel).

Keywords**—**Musa bay, Bandar-e- Imam Khomeini and Razi Petrochemical Companies, TPH

I. Introduction

THE word "petrochemical" was referred to the row materials which are achieved from oil and this word is compound of two words; 'petrol' and 'chemistry'.

Petrochemical industries are those industries in which Hydro Carbon of the natural oil and gas is transformed into chemical products [15-17].Although petrochemical industries have too many benefits for our life, they are considered as point source pollution and today's the pollution caused by these industries have been a cause for concern and a major challenges to save the environment against their adverse impacts in all over the world [28]. These impacts not only affect the biological factors of the ecosystem but also can affect the water resource quality and threat the human health (Esmaeli Sari, 2002). In 1997, the Petrochemical Special Economic Zone (PETZONE) with an area of approximately 17 km^2 was established in the southeastern of Iran, in the vicinity of Musa Bay. Due to the diverse industries, Musa bay has become one of the main economic assets of the north-west coast of the Persian Gulf [18-22].

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PETZONE contains fifteen petrochemical companies and five effluent treatment plant. Since PETZONE was established, some parts of Musa Bay (specially Zangee and Jafari creeks) have become enclosed with its roadways and constructions and in some parts divided into two parts (PETZONE, 2001) (Fig.1). Several creeks branch out from Musa bay, including the Zangee, Jafari, Moavi, Ghanam, and Marimus creeks [3-16-26]. After treatment, the wastewaters of PETZONE petrochemical companies are directly discharged into the bay. Other petrochemical companies discharge into Zangi and Jafari creeks, which are located inside the PETZONE. These creeks are connected to the bay via surface channels, which are directly affected by the semidiurnal tide (the extreme tidal range of the bay varies up to 6 meters) [23].

Musa bay is a semi-closed ecosystem whit a limited connection to the Persian Gulf, lower capacity for self purification and high concentration of suspended solids. Thereupon great amount of discharged wastewater into the bay is the major water pollution factor and frequent tide has considerably expanded the scope of pollution [11-12-27].

After World War II, scientific researches on the impacts of oil pollution greatly increased and in 1967 the wreck of the Torrey Canyon in coast of England was used as the first comprehensive study to assess the effects of oil and heavy metal pollution and also their cleanup methods on environmental resources [4-21].

Fig. 1 Persian Gulf and Musa Bay

According to the IMO declaration, the Gulf area is the most sensitive area in the world [8]. Based on the scientific reports we learn that 49% of the world's oil production comes from the Gulf States and passes through this old waterway and it holds an estimated about 57-66% of the world oil reserves. Several studies showed that the Persian Gulf is the most oil-polluted marine area in the world, even before the Gulf war and the Gulf oil pollution is about 48 times that of any other similar area on the earth (F. Al-Awadhi, 1999; F. M. A. Al-Awadhi, 1999; Deppe, 1999; Nadim, Bagtzoglou, & Iranmahboob, 2008; Price, 1998). Department of Environment of Iran has reported that, the Musa Bay is considered as the most sensitive marine area in Iran and the Gulf area (due to its unique ecosystem). Therefore, Musa Bay is important for the whole northwestern coast of the Persian Gulf (Deppe, 2000). Due to the sensitivity of the Gulf area, several researches performed in this area, especially after the Gulf war. Oil pollution is one the major pollution in this area, especially due to its vast natural reserves of oil and gas.

Immediately after the release of crude oil into marine waters, due to lipophilic characteristics and bio resistant properties of the petroleum compounds they adsorb to the suspended particulate matter (SPM) and accumulate in bottom sediments and they can remain unchanged and toxic for long term; thereupon, they can have a long term effect on the structure of the benthic community.

Total Petroleum Hydrocarbons (TPH) is a broad family of several hundred chemical compounds that originally come from crude oil (Massoud, Al-Abdali, Al-Ghadban, & Al-Sarawi, 1996; Mirsadeghi, Zakaria, Yap, & Shahbazi, 2011; TPH, 1999).

Most studies on the fate of hydrocarbons within the effluent (especially studies of refinery wastes) have shown that the volatile compounds are lost from the water column through weathering and their fate depends on the conditions and hydrodynamics of the receiving water [34]

II. Experimental Section

Petrochemical special economic zone is located in the southwestern of Iran and it is composed of 5 sites (the area is recently been developed and Bandar-e- Imam Khomeini, Razi and Farabi Petrochemical companies has been added to this area). The Wastewater of Bandar-e- Imam Khomeini and Razi Petrochemical companies and the sediments of the coastal area of the selected petrochemical companies (in Musa Bay) were monitored from Feb 2010 to June 2010 (Fig.2 and 3).

Fig. 2 Study area in Musa Bay

Fig. 3 Sampling stations inside the selected Petrochemical companies

Sediment samples were collected by using an Ekman-Birge grab sampler (225 cm^2). Sediment samples were stored in aluminum foil and placed on ice after sampling, immediately transported to the laboratory and kept in the refrigerator at -20 °C before analysis. The extraction of freeze-dried sediment samples was conducted by using a microwave oven (temperature 115°C, 20 min). In order to avoid potential interferences of sulfur, it was removed from the samples each sample was analysed for total petroleum hydrocarbons by using UV fluorescence (UVF- 2500- fixed excitation wavelength: 310 nm; the emission wavelength: 360 nm) (De Mora et al., 2010; ROPME, 1999).

Wastewater samples were collected in 1000-ml amber glasses and transported to the laboratory for ultra-violet fluorescence (UVF) analysis. Each sample was extracted with the separatory funnel method and analyzed for total petroleum hydrocarbons by UV fluorescence (UVF-2500) (ROPME, 1999).

The concentrations of the TPH in sampling sediments and wastewaters were compared with guidelines.

III. Result

TABLE I
THE AVERAGE CONCENTRATIONS OF TPH OBTAINED IN THE SAMPLING SEDIMENTS OF MUSA BAY

Musa Bay	**TPH µg/g**	
Station code	**Mean**	**Guideline**
BI 1	57.32	Moderately polluted
BI 2	32.73	Slightly polluted
BI 3	45.93	Slightly polluted
R	17.51	Slightly polluted
Total	38.27	Slightly polluted

In 1996, experiments showed that the coastal area of Imam Khomeini port was classified as slightly polluted (but very close to lower limit of moderately polluted areas); nevertheless, the observed amount of contamination was lower than that of most Arab coasts and the TPH concentration in the Persian Gulf sediments was categorised into four levels (guideline):

Unpolluted area /natural background level (10-15 µg/g), slightly polluted area /upper permissible limits (15-50 µg/g), moderately polluted area (50-200 µg/g), heavily polluted area (> 200 µg/g). So, the concentrations <15 µg/g, as chrysene equivalents are considered to represent natural background levels in this region [10].

Results showed that, the concentration of TPH in the study area,were varied between 57.32- 17.21 µg/g with the total average 38.27µg/g. At all of the stations, the concentration of TPH was greater than the natural background value (natural background level: 10-15 µg/g (Massoud, et al., 1996)) and reach a peak on the station BI 1,which is located in the vicinity of the main effluent outlet of Bandar-e- Imam Khomeini petrochemical complex. While, the TPH concentration was lower at stations R which is may related to the high water depth at the site.

Due to the relation between the product and effluent and also the importance of Petrochemical industries as emission sources of a wide range of chemical substances (Nadal, Schuhmacher, & Domingo, 2011); the concentration of TPH in the wastewaters of these petrochemical companies was monitored and it shown in Table 2.

TABLE II
TPH CONCENTRATION (MG/L) IN THE WASTEWATER DISCHARGES OF PETZONE PETROCHEMICAL COMPANIES

No.	**Station**	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**End of Pipe Standard(mg/l)[1]**
1	**BI1**	20.13	3.57	17.60	22.66	Max. daily discharge: 5
2	**BI2**	13.10	4.02	10.19	20.00	Max. daily discharge: 5
3	**R-PC**	17.64	10.13	10.56	35.33	Max. daily discharge: 5

1(US EPA New England, 2010)

As it shown in Table 2, the high concentration of TPH was observed in the main effluent outlet of Bandar-e- Imam Khomeini petrochemical complex. At all of the stations, the concentration of TPH was greater than the guideline (5 mg/l-10 mg/l). The results showed that the concentration of TPH in the effluents of Bandar-e- Imam Khomeini petrochemical complex was greater than Razi petrochemical company that it may be related to the products of the Bandar-e- Imam Khomeini petrochemical complex. The products of Razi Petrochemical Company are: Natural Condensate, Phosphoric Acid, Granulled Sulfur, D.A.P ((NH4) 2HPO4) , Granulled Urea , Urea Peril & Amonia (RPC, 2010), the products of Imam Khomeini petrochemical company are: aromatics, polymers, chemicals, fuel [5].

IV. Discussion

In conclusion, the levels of TPH concentration in the study area was categorized in the slightly pollution level (relatively moderate pollution level) compared to chronically oil-contaminated area in the RSA and than that other highly oil-impacted sediments in other parts of the world (Tolosa et al., 2005). Compared to natural sources, hydrocarbon pollutants such as shipping activities, PETZONE and other industries significantly contributed to TPH contamination in the selected area.

Also the deposition of finer sediments along the Iranian eastern side and northwest area, which is associated with the counter-clockwise circulation from the Indian Ocean, deposition of eolian sediments and probably the effects of tidal currents, may be helped this valuable ecosystem to survive from different stresses (several point sources with different types of pollutantsof pollution) (Massoud, et al., 1996).

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