CONTINUITY OF POLLUTION BY PETROLEUM HYDROCARBONS IN WATER AND SEDIMENTS OF SHATT AL-ARAB RIVER, SOUTHERN IRAQ, NORTH WEST ARABIAN GULF

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Abstract - Shatt Al-Arab River is naturally exposed to pollution by petroleum derivatives from different sources. levels of petroleum hydrocarbons were reported since 1980. Those levels were fluctuated during the last four decades according to different activities taking place in and around the area such as leaking of petroleum fuels from sinking vessels in Shatt Al-Arab river during the first Gulf war (Iraqi - Iranian War, 1980-1988), as well as sinking of vessels used to transfer crude oil illegally and discharge of waste fuel from electric power generation stations along the banks of the river. During the eighties of the last century, levels of PHC's reported in Shatt Al-Arab river ranged between 2.6 µ g l^{-1} in Qurnah and 44 µ g l^{-1} in Basrah, while they reached 56 µ g l^{-1} in the waters of Shatt Al-Arab estuary. During the nineties those levels were reported maximum of 14 µ g l^{-1} in Shatt Al-Arab and 7 µ g l^{-1} in it's estuary, then during the early years of 2000s levels were 47 µ g l^{-1} and 80 µg l^{-1} in Shatt Al-Arab river and it's estuary respectively, while during the ongoing decade levels recorded were high in the range of 4.048-22.98 µg l^{-1} due to increase oil production and transportation in Northern part of Basrah province, the same trend was appeared in the sediments and living organisms of Shatt Al-Arab river and its estuary. Those pollutants exert great threaten to the environment of the Gulf as pollution is increase in its water, sediments and marine organisms.

Keywords - Petroleum hydrocarbons, Shatt Al-Arab River, Water, Sediments, Fluorescence.

I. INTRODUCTION

Oil spill in aquatic systems could be identified by sight as well as sophisticated tools such as rader and optical satellite (Thomas, 2017). Moreover, levels of petroleum hydrocarbons could be measured and indicates as oil spill (Al-Saad et al.,2011).
Shatt Al-Arab river is the main source for fresh water to the city of Basrah, although it is effected by many connected canals or branches namely: Al-Ashar, Al-Khandak, Al-Rubat, Al-Khorah, Al-Jubailah which were used to be an irrigation canals for the palm trees during the past, while they are using at the time being for discharge of waste water from the city of Basrah. Since the first discovered oil in the Middle East which is back to 1908 at Massjed Suleiman (Iran), and transfer of oil towards the Arabian Gulf throughout Abadan City, Basrah land and Shatt Al-Arab river were liable to pollution by oil (Kurt , 2015).

During the Iraqi - Iranian war (1980-1988) huge amounts of oil spilled in the Shatt Al-Arab waters due to military attaches which led to sinking of many ships lounge in Shatt Al-Arab and its estuary at that time (Al-Fartossi, 2013). Moreover, the Northern part of Shatt Al-Arab river is contaminated by waste water discharge through Euphrates and Tigris rivers (Al-Fartossi, 2013). During a study at 2005 an increase in water pollution by petroleum hydrocarbons in the Shatt Al-Arab river was reported, in which higher concentrations were found near oil refinaries terminals such as Muftyia at the Middle sector of Shatt Al-Arab River and Abadan at its Southern part (Al-Fartossi, 2013).

Early studies reported contamination of waters of Shatt Al-Arab river by petroleum hydrocarbons, Al-Saad (1983) reported values in the range 5.6 – 14.2 µg/l, DouAbul (1984) reported values of dissolved petroleum hydrocarbons in the water of Shatt Al-Arab in the range 12.0-86.7 µg/l, DouAbul and Al-Saad (1985) reported values in the range 5.2 – 14.2 µg/l, Al-Saad and Bedair (1989) reported values in the range 6.5 – 23.5 µg/l, Al-Saad (1995) reported values in the range 3.97 – 38.29 µg/l, Al-Saad (1998) reported values of 1.3 – 35.0 µg/l, Al-Timary et al., (2003) reported values in the range 2.5 - 47.0, Awad et al., (2004) reported values in the range 0.01 – 6.83 µg/l, Hantoush et al., (2006) reported values in the range 2.247 – 50.232 µg/l .Hantoush (2007) reported values in the range 2.3 – 50.2 µg/l, Doabul et al., (2014) reported values in the range 18.20-30.81, Farid et al. (2008) reported that the oil refinery effluents and losses during loading operations have been identified as the major sources of oil contamination in the water of Shatt Al-Arab River which empties into the North West Arabian Gulf.

II. STUDY AREA

Arab, tidal river, 193 km long, formed by the confluence of the Tigris and Euphrates rivers, flowing South East to the Arabian Gulf, forming part of the Iraq-Iran border; the Karun is its chief tributary. The Shatt al Arab flowed through a broad, swampy delta, and it supplies fresh water to Southern Iraq and Kuwait but the construction of dams and the demand for water upstream has led to a greatly increased salt content. Moreover, Shatt al Arab river is used to be a navigable channel for oceangoing vessels as far as

Basra, Iraq's chief port. Iraq and Iran have disputed navigation rights on the Shatt al Arab since 1935, when an international commission gave Iraq total control of the Shatt al Arab, leaving Iran with control only of the approaches to Abadan and Khorramshahr, its chief ports, and unable to develop new port facilities in the delta. To preclude Iraqi political pressure and interference with its oil and freight shipments on the Shatt al Arab, Iran built ports on the Persian Gulf to handle foreign trade. Iran and Iraq negotiated territorial agreements over the Shatt al Arab waterway in 1975, but by the end of the decade skirmishes in the area became prevalent. Full-scale war between the two countries broke out in Sept., 1980, leading to eight years of attacks on coastal areas (The Columbia Encyclopedia).

Figure 1: Location map for southern Iraq showing the Shatt Al-Arab river and its estuary

III. MATERIALS AND METHODS

Generally samples of water and bottom sediments were collected by water sampler for water and van veen Grab sampler for sediments from the middle sectors of the sampling sites along the Shatt Al-Arab River, Figure 1. Samples were kept in cool box and transferred to the laboratories of Marine Science Centre / Basrah University and kept in fridge prior to analysis for petroleum hydrocarbons. Petroleum hydrocarbons were extracted from water samples by using carbon tetrachloride solvent according to UNEP(1993). On the other hand the procedure of Goutx and Saliot (1980) was adopted for the extraction of petroleum hydrocarbons from sediments. The extracts were dried by evaporation in rotary evaporator until dryness, then to each sample, 3 ml of hexane solvent were added and the total petroleum hydrocarbons were estimated spectroflurometrically by UVF Shimadzu RF spectroflurometer fitted with direct reading DR data base unit and 1 cm path length quartz cell, excitation was at 310 nm and emission at 360 nm (Al-Saad 1995). Fluorescence as a spectroscopic technique is widely used in the analysis of petroleum hydrocarbons and polycyclic aromatic hydrocarbons (Okparanma and Manazan, 2012). Fluorescence spectra and a calibration curve was done for Basrah light crude oil, as shown in figure 2, to calculate the concentrations of TPHs in each sample of water and sediment.

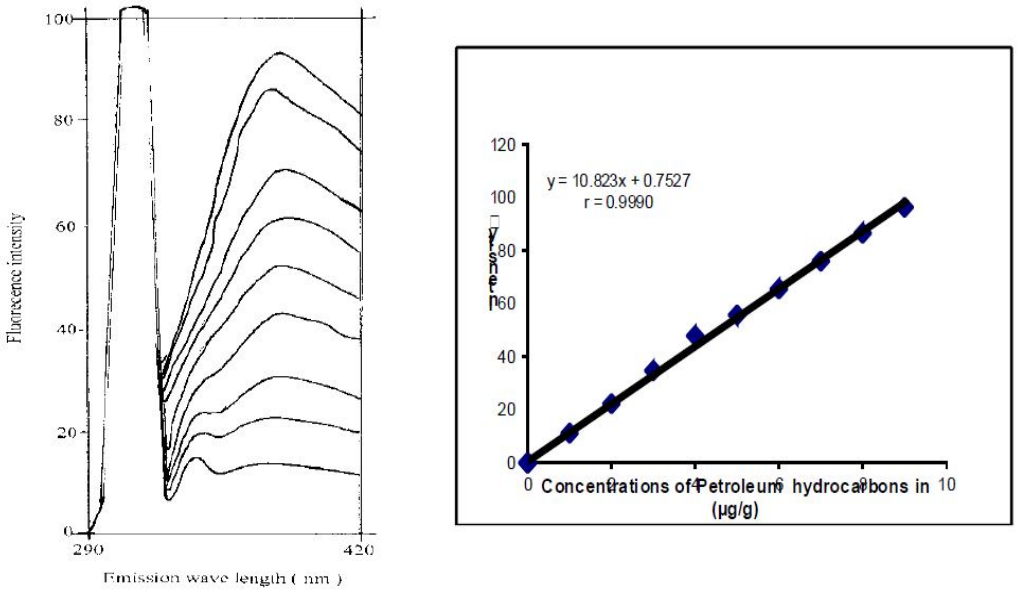

Figure2: Spectra for standard Basrah crude oil and the calibration curve

RESULTS AND DISCUSSION

Water of Shatt Al-Arab river is liable to contain petroleum contaminants because of numerous operations. Table 1 shows the Levels of total petroleum hydrocarbons in the dissolved fraction of waters from Shatt Al-Arab river since 1980 together with current studies.

Year	Level of PHCs µg/l	References
1980	5.6 – 14.2	Al-Saad ,1983
1984	12 – 86.7	DouAbul,1984
1985	5.2 – 14.2	DouAbul and Al-Saad,1985
1989	6.5 -23.5	Al-Saad and Bedair,1989
1995	3.97 – 38.29	Al-Saad, 1995
1998	1.3 – 35.0	Al-Saad, 1998
2003	2.5 -47.0	Al-Timary et al., 2003
2004	0.01 – 6.83	Awad et al., 2004
2005	2.247 – 50.232	Hantoush et al., 2006
2006	2.3 – 50.2	Hantoush, et al., 2008
2012	18.20-30.81	Doabul et al., (2014)
2014	5.18-37.58	Al-Hejuje, et al,. 2015
2015	8.124-22.98	This study
2016	4.048 - 18.987	This study
2017	5.294 - 21.738	This study

Table I. Ranges of total petroleum hydrocarbons in waters from Shatt Al-Arab river.

In another studies, recorded PHCs in the waters of Shatt Al-Arab river in the northern part which was in the range 3.97 – 11.72 µg/l(Ali, 2006) was comparable to that in the southern part 5.67 – 9.48 µg/l (Ibraheem, 2004).

On the other hand , the levels of total petroleum hydrocarbons in the sediments of Shatt Al-Arab river were recorded thoroughly by different researchers and these levels are listed in table II.

Year	Range of TPHs (µg/g)	References
1980	2.6 – 44.0	DouAbul 1984
1984	0.4 – 44.0	DouAbul and Al-Saad, 1985
1989	3.77 – 26.7	Al-Hamdi,1989
1993	2.46 – 38.33	Al-Saad et al., 1995
1998	0.108 - 37.02	Al-Khatib, 1998
2004	7.37- 24.41	Ibraheem,2004
2005	34.26- 146.64	Ali, 2006
2006	28.8 -275.4	Hantoush 2006
2007	59.4 - 148.4	Al-Imarah et al., 2007
2010	7.37 - 24.81	Al-Imarah et al., 2010
2012	28.876 - 63.159	Al-Fartossi, 2013
2015	48.48-134.619	This study
2016	19.65 - 89.88	This study
2017	4.08 - 43.82	This study

Table II. Ranges of total petroleum hydrocarbons in the sediments of Shatt Al-Arab river .

For sediments , PHCs recorded during 2005 was in the range 34.26 –146.64 µg/g in the northern part (Ali, 2006) while they were in the range 7.37 – 24.41µg/g in the southern part (Ibraheem,2004) due to open sea effects.Most studies conducted in the area of Shatt Al-Arab River over the past years using high quality monitoring techniques have observed a continuous pollution by petroleum hydrocarbons with an alternative changes in their levels from north to south (Al-Imarah et al., 2007). Moreover, most of studies revealed that levels of petroleum hydrocarbons were comparable to those observed elsewhere (de Mora et al., 2010)

Petroleum hydrocarbons in the marine environment come from natural (biogenic or diagenetic) and anthropogenic (petrogenic or pyrogenic) sources (Wu et al., 2011)]. Biogenic source hydrocarbons refer to those hydrocarbons produced by living organisms (e.g., planktons, algae, and bacteria) or through biological processes involving terrestrial plants (Sakari et al., 2012). The anthropogenic hydrocarbons are usually more in the environment than the natural ones. They are commonly generated from various human activities like industrialization, urbanization, transportation, oil utilization, operations and storage, shipping, and fishing (Sakari et al., 2008). In an early study, it was concluded that approximately 10% of the crude oil in the aquatic environment comes from natural oil seeps, and another 27% comes from oil production, refining, and transportation, while the balance of 63% originates from urban and river runoff, atmospheric emission, and municipal and industrial discharges, among others (Kvenvolden, et al., 2003).

Sources of pollution by petroleum hydrocarbons in the northern part of Shatt Al-Arab river are represented by discharge of Euphrates and Tigris Rivers, during recent study reported level of poly aromatic hydrocarbons in the sediments of Euphrates river was around 50 ng/g (Al-Saad, et al., 2016), in addition to environmental pollution due to oil industries in Iraq (Saeed, et al., 2016).

Pollution of Shatt Al-Arab waters by petroleum hydrocarbons is indicated by recorded levels of PAHs in the muscles of fishes caught from the river in which levels recorded reach 155.44 ng/g dry weight(Al-Imarah, et al., 2017a). Moreover, air pollution at Basrah due to oil production was main source of PAHs in the waters of Shatt Al-Arab river (Al-Imarah,et al., 2017b).

Pollution of Shatt Al-Arab by petroleum hydrocarbons exert a great effect upon the environment of the Arabian Gulf (Freijie, 2015). Increasing development of oil industries without considering environmental concerns has caused serious and irreparable damages to the environment and human health (Dehghan Chenari & Lak, 2014).

CONCLUSION

Most studies conducted in the area of Shatt Al-Arab River over the past years using high quality monitoring techniques have observed a continuous pollution by petroleum hydrocarbons with an alternative changes in their levels from north to south depending upon different factors, the increase of activities in the river, establishment of new wells for crude oil production on the land, discharge of pollutants by Euphrates and Tigris rivers to the northern part of Shatt Al-Arab River, as an air pollutants during rain, and illegal transportation of crude oil throught the river. Moreover, most of studies revealed that levels of petroleum hydrocarbons were comparable to those observed elsewhere. Consequently, the levels of petroleum hydrocarbons in the exchangeable and residual phases

of the sediments are greater than in the dissolved and particulate phases of water, indicating that petroleum hydrocarbons in the Shatt Al-Arab river are transferred towards the Arabian Gulf mostly by sediments.

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