Evaluation of PAHs in Hydrocarbons Pollution, Biodegradation and Weathering Extent in Surface Sediments of the Kharg Island in the Persian Gulf

Mirvakili, H.S.[*], and Hadjizadeh Zaker, N.

Graduate Faculty of Environment, University of Tehran, P.O.Box 14155-6135, Tehran, Iran

ABSTRACT: Kharg Island as the most important oil export terminal of Iran has faced entrance of various oil materials, so it seems necessary to know about the amount of these marine oil pollutants and their origin in this area. Oil hydrocarbons has entered in this water body as a result of numerous human activities like extraction, refinement, transmission and export of raw oil or from natural and biologic resources. The oil contamination has damaged the environment according to the different decomposed level of compounds which exist in diverse oil pollutants. The concentration of polycyclic aromatic hydrocarbons using sediment sampling across the coast was determined and compared the obtained concentrations with previous values. The observed PAH concentrations were obtained in the range between 9 to 1230 ng/g and indicated the more focus of PAHs in the eastern region of Kharg Island coast. In addition to investigating the sediment oil pollution by PAHs, this paper has attempted to determine the origin of aromatic compounds by developing a set of indexes. These indexes suggested that PAH concentrations have obtained from the combustion origin of hydrocarbons in the sediments, and have entered to the coastal sediment of Island by active flares that burn the sour gas by oil around the coast.Indices developed also corroborate the presence of degraded oil residue, high relative biodegradation and a degree of weathering of hydrocarbons in the surface sediment of the area, which suggest a chronic input of oil-related hydrocarbons in the neighborhood of the study region.

Key words: Persian Gulf, Kharg Island, Oil pollution, Surface sediment, Aromatic hydrocarbon, Weathering

INTRODUCTION

Persian gulf is a sea at the margin of Indian ocean which makes way to Oman Sea and Indian Ocean through Strait of Hormuz with the width of 56 km. Gathering of industrial centers around Persian Gulf region has caused entering a huge amount of petroleum contaminations to this aquatic ecosystem and one of the most important contaminants that endangers the health of aquatics is petroleum contamination. The highest amount of these contaminations exists around the Kharg Island. Kharg Island is a coral anticline located within 28 km of the southern coast of Iran in Persian Gulf (Fig.1). This Island is the most important and biggest petroleum export terminal of the country and belongs to Boushehr province and is located within 57 km of North West of Boushehr province. This Island has length of approximately 8 km and a width of approximately 4 to 5 km and has a hot and humid climate. Great numbers of installations for extraction, processing and exporting of crude petroleum has surrounded the island and each year they produce all types of petroleum

contaminations in the precious coasts of this Island (Mirvakili, *et al.,* 2013).

The poisonous and collective properties of organic compounds in petroleum products can have destructive effects on the health of animals and plants life in the sea (Law and Klungsoyr, 2000). Because of low dissolution and hydrophobic nature of these organic compounds, they will absorb to sediment environments and will gather in the seabed sediments (Massoud *et al.,* 1996; Tolosa *et al.,* 2004).

Bacteria, Fungoid, Yeasts and other bottom-dweller micro-organisms are the main decomposing organisms of petroleum hydrocarbons in the sea environments (Mille *et al.,* 2007). These organisms will start to decompose the petroleum hydrocarbons in the forms of aerobic and anaerobic and with different speeds and will decompose them into basic compounds or more simple articles. Determining the level of weathering and the degree of observed hydrocarbons molecular destruction, is a proper index of freshness

*Corresponding author E-mail: hamideh.vakili@gmail.com

of the entered petroleum or an indication of existence of permanent or old sources of petroleum hydrocarbons in the region (Commendatore et al,2000; Massoud *et al.,* 1996).

An extensive collection of biological markers have been developed for determining the level of weathering and biological decomposition of observed petroleum stains in sediments (Gawad *et al.,* 2008; Tolosa *et al.,* 2009). Biological markers or biomarkers are complicated molecular fossils derived from live organisms. Biomarkers consist of a number of prominent hydrocarbon compounds including normal Phytane, alkanes, Pristane and Estranes with different numbers of carbon atoms, Hopane and so on, that have been developed for specific purposes (Gawad *et al.,* 2008; Tolosa *et al.,* 2004; Tolosa *et al.,* 2009). Variance range of these indexes in specified intervals, determines the properties of observed petroleum stains including the origin of PAHs, weathering level and biological decomposition.

In the current research, the aim is to study the general condition of PAH compounds in surface sediments of the kharg Island which is executed by sampling the coastal sediments in low depth. Moreover to determine the weathering degree, level of biological decomposition and freshness or non-freshness of the observed hydrocarbons, in addition to studying the general pattern of polycyclic aromatic hydrocarbons (PAHs) through analysis(Mirvakili, *et al.,* 2013).

Fig.1. Kharg Island location in The Persian Gulf

MATHERIALS & METHODS

In this research conducted in the beginning of 2012, with surface sampling from the sediments around the island in 11 different locations, the density rate of petroleum hydrocarbons in coastal sediments of the study region is determined. For the purpose of gathering proper data regarding scattering of petroleum contaminants in different areas and depth of coastal region under study, samples of sediments have been gathered from all the coastal areas throughout the Island and most of the samples have been gathered from locations near petroleum docks(Mirvakili, *et al.,* 2013).The locations of sampling stations and their specifications have been presented in figure 2. Sampling from surface sediments has been performed with Veen Grab Sampler with cross section of 250 cm3. While using of this sampler, 100 gram of seabed sediment with maximum thickness of 5 cm has been taken and has been packages and frozen in standard method of USEPA-SW-846. In this method the sediment samples will be preserved until reaching lab for measuring the existing hydrocarbon compounds. Due to more inclination of contaminants to accumulate in smaller sediment particles which is resulted from higher special level and absorption properties (Law and Andrulewicz, 1983), measuring the density of contaminants has been performed in small sediment particles. For this purpose the sediment particle sizes distributed in the standard method of ROPME (2000) and have been determined by physical sieve and its small particles (<63 mm) have been separated for measuring the content of organic substance.

The standard method of American Association of Environmental protection (USEPA-SW-846#3540C) named SOXHLET has been used for the purpose of extraction and preparation of petroleum hydrocarbons from the sediment phase. In this method sediment substances is mixed with anhydrous sodium sulfate and is extracted through a proper solution and by the use of Soxhlet device and then condensate from reading. We have used the gas chromatography device which is of flame ionization clearing type (GC-FID) type VARRIAN, model CP-38001 for measuring the condensation of hydrocarbon elements existing in sediments of aromatic and aliphatic compounds. The gas in this device has been set on flow rate of 1/1ml min -1 and pressure of 1 atmosphere and in a furnace with 40°C - 150°C for 10°C per minute. With using of this device, the density of PAHs compounds, the density of petroleum normal Alkanes with different numbers of carbons (Alkanes with 14 to 36 carbons n-C14, n-C36) and density of Phytane, Pristane were measured.

As it has been mentioned, for the purpose of determining the freshness or non-freshness of petroleum stain, estimation of molecular decomposition and weathering rate of observed hydrocarbons in sediments through biomarkers and developed indexes is necessary (Commendatore *et al.,* 2000).

For developing and creating these indexes, the distribution profile of normal Alkanes and density rate of Isoprenoid Alkanes and Soluble and insoluble

Fig. 2. Location of sediment samples of coastal stations in Kharg Island

fractions of aliphatic is used (Commendatore *et al.,* 2007).

Some of these indexes are as below:

The indexes for determining origin weathering and biodegradation in petroleum hydrocarbons are:
Ratio of n-C18/Phytane and n-C17/ Pristane is as follow. Pristine and Phytane as Isoprenoid alkanes, are branch aliphatic of petroleum. The ratios of these compounds to normal Alkanes with 17 and 18 carbons has been developed as a proper index for estimating the biological decomposition rate or molecular destruction of hydrocarbons in marine sediments. Due to the fact that normal Alkanes with 17 and 18 carbons (n-C17, n-C18) are compounds with easy decomposition and Isoprenoid of Phytane and pristine are having a rather lower decomposition, the low rate of these indexes indicate the high decomposition or molecular destruction of observed hydrocarbon, while higher rate of these indexes indicate a serious lack of decomposition and rather small molecular destruction of these compounds (Colombo *et al.,* 1989; Diez *et al.,* 2007; Ezra *et al.,* 2000).

Ratio of hydrocarbons with low molecular weight to hydrocarbons with high molecular weight (LMW/HMW): This index is defined as the ratio of the density of total normal Alkanes with low numbers of carbons (<20) to the density of total normal Alkanes with high numbers of carbons (>20).

For research on the oil freshness in environment, the high amount of this index is an indicator of the presence of fresh oil. Ratios near to 1 for this index with observance of high density of aliphatic soluble hydrocarbons, indicates the freshness of observed oil hydrocarbons in sediments. Then the existence of high densities of compounds with high numbers of carbon indicate the entrance of heavy and non-fresh oil or the presence of remaining oil in the region (Gearing *et al.,* 1976).

Weathering index (WI): Lack of presence of light and volatile compounds indicate physical weathering in oil stain, while high existence of easily decomposable and volatile compounds in an area indicate the production of fresh petroleum in the region. Weathering index which is an estimation of the rate of decomposition of entered hydrocarbons to the environment is defined as the ratio of the total Alkanes with 8,10,12,14 carbons to alknanes with 22,24,26,28 carbons [23] and also in terms of the ratio of normal alkanes with 15,16,17,18 carbons to normal alkanes with 25,26,27,28 carbons (Short and Heintz, 1997).

Lower amount of these ratios indicate high weathering of petroleum stain observed in sediment

while high rate of this index indicate the presence of more fresh petroleum compounds in the region. The amount of weathering index in so much weathered remaining petroleum is little and around 0 to 0.3, while for normal weathered petroleum is around 0.3 to 6.3 (Wangs and Fingas,1994).

Weathering ratio (WR): This ratio has been presented as the index of weathered petroleum observance in area sediment in the form of (n-c23-34) / (n-c11-22) (Kennicut.M.C, 1988).The low amounts of this ratio (0.5 -1) indicate lack of weathering of observed remaining petroleum in sediments, while high amounts of it (5-12) indicate high weathering of oil hydrocarbons.

To determine the origin of polycyclic aromatic hydrocarbons, some indexes are as below:

The indexes for determining origin by polycyclic aromatic hydrocarbons are as follow: PAHs consists an extensive group of chemical polluters of environment. They can be shown in environment with a variety of processes (Neff *et al.,* 1979).

In marine ecosystems, PAHs can be destructed through photo-oxidation in surface layer of water and microbe activities in sediments. But the simultaneous presence of PAHs in sediments shows that phenomena of density is dominant on destruction processes in sediment environments (Smith and Lery, 1990).

As per chemical – physical distribution behavior of PAHs and in order to evaluate the numerous origins of these polluters, molecular indexes have been developed (Baumard *et al.,* 1998).

Aromatic compounds are divided into three groups according to their heaviness:

1st group) two and three rings aromatic compounds: naphthalene (NAP), acenaphthylen (AC), Fluorite (FLU), phenanthrene (PHE), anthracene (ANT),

 2nd group) aromatic compounds with 4 rings: fluoranthene (FLUO), pyrene (PYR), Benzo (A), anthracene (BaA), Chrysene (CHR),

 3rd group) aromatic compounds with 5 and 6 rings: Benzo (b), fluoranthene (BbF), Benzo (k), fluoranthene (BkF), Benzo (a), pyrene, dibenzo (a,h), anthracene and benzo (ghi), pyrene.

Ratios of PAHs which are having near molecular weight to each other are indexes for determining the origin of aromatic compounds. In this regard, Yanker and colleagues in 2002 provide the ratio of Benzo (a) anthracene and chrycene (BaA/BaA+Chry). This ratio for petroleum polluters is less than 0.4 and for pyrolytic origin is more than 0.4.

Sprovieri and colleagues in 2007 reports 0.5 instead of 0.4 as the separating point of petroleum origin from pyrolytic origin (Sprovieri *et al.,* 2007). But other researchers state that this ratio for petroleum origin is

less than 0.2 and for pyrolytic origin is more than 0.35 and in the range between them, the origin of pollution is mixed (Gawad *et al.,* 2008; Mille *et al.,* 2007).

Gawad and colleagues in 2008 provide another index. This index is the ratio of indeno (1,2,3-cd) pyrene to benzo (ghi) perylene + indeno (1,2,3-cd) pyrene. Ratio of IP/(IP+BghiP) is less than 0.2 for pollutions originated from petroleum and is more than 0.5 for pollutions originated from wood burning, coal and … and between these two values the pollution is originated from pyrolytic of petroleum substances (Gawad *et al.,* 2008).

Thermodynamic resistance of phenanthrene is more than anthracene, therefore in pollutant substances with petroleum origin Phen/Ant is so much high, but in cases of pollution with pyrolytic origin this ratio is smaller (Bouloubass *et al.,* 2001). Then if this ratio is more than 15, confirms that pollution originated from petroleum (Readman, 2002).

However; pyrolytic processes with high temperature, produces PAHs with ratio of Phen/Ant smaller than 10 (Tolosa, 2004). This value for crude oil varies between 40 and 70 (Fang *et al.,* 2003).

Chrystene and Benzo (a) anthracene are derived from pyrolytic processes of organic substances in high temperature,with ratio of Chry/BaA less than 1.

Some other researchers use ratio of Ant/(Ant+Phen), which is less than 0.5 (or 0.1) for pollution with petroleum origin and more than that for pyrolytic origins (Sprovieri *et al.,* 2007; Mille *et al.,* 2007).

For estimating the pollution origin, one can use the density ratio of PAHs with low molecular weight to density of PAH with high molecular weight as the first index of origin because the pollutions with petroleum origin have been specified based on light PAHs (aromatics with 3 and 4 rings. In this index if the value of ratio is less than 1, it indicates pollution with pyrolytic sediment origin and if the ratio value is bigger than 1, it means that the environment has been polluted by a petroleum origin.

RESULTS & DISCUSSION

Density of polycyclic aromatic hydrocarbons (PAHs) in sediment samples are as follow: Polycyclic aromatic hydrocarbons (PAHs) in fact refer to the set of annular hydrocarbons present in crude oil which consists of so much complicated compounds of hundreds of aromatic hydrocarbons. The compounds which are resulted from incomplete burning and oxidation of organic substances especially fossil fuels, have severe environmental consequences such as poisoning the living environment of creating cancer as well as genetic mutation (Law and Klungsoyr, 2000).

The density of 16 studied compounds of polycyclic aromatic hydrocarbons in sediment samples of specified stations in Kharg Island has been obtained 9.7 -1229.7 ng/g (Table1). The highest amount is in station 6 in the north-east corner of the Island and the lowest amount is in station 4 located in northern part of T dock. In stations 2 and 3 which are near to T dock in the east side of the Island, due to low depth and high weathering in region, in samples the rate of PAHs have not been presented and have been reported as unspecified. As per sediment quality guideline, NOAA, the density of $\sum$ PAHs compounds is more than 4000 ng/g which indicate severe pollution and the poisoning condition of the sediment environment, while the amounts less than 100 ng/g indicates non-pollution of the region to polycyclic aromatic compounds (Long *et al.,* 1995).

Baumard et al.(1998a) with classifying the condition of sediment pollution to PAH compounds, have classified samples with density of 100 – 1000 ng/g in groups of sediment with low to medium pollution and have put sediments with density more than 5000 ng/g in high polluted sediments. Notar et al., have reported PAHs density of 250- 500 ng/g as low to medium pollution and PAHs density more than 500 ng/g as high pollution (Notar *et al.,* 2001). In the current study, in all the stations except station 6, the total density of PAHs compounds is less than 100 ppb. It can be said that except station 6, which is so much polluted due to the existence of high rate of PAHs, the other 10 stations indicate a low environmental pollution.

In fact most of the variances intervals of TPAHs in the gathered samples in Kharg Island are equal to 9.7- 46.7 ng/g and only in station 6 it is equal with1229.7 ng/g.

Around Persian Gulf, the density of these polluter compounds, is in the range of observed density in the sediments of Kuwait coasts (Beg *et al.,* 2003; 5.56-1333 ng/g), and is less than the existing amount of the same in UAE coastal areas (Gawad *et al.,* 2008; 5000-1022000 ng/g).

Specifying the origin of polycyclic aromatic hydrocarbons (PAHs) in sediment samples: PAHs compounds can be from three different origins of petrogenic/fossil PAHs; pyrolytic PAHs and natural resulted from diagenetic PAHs (Wakeham *et al.,* 1980).

In this study for determining the origin and nature of PAHs existing in coastal sediments of Kharg Island, the available indexes are used. By evaluating the index of BaA/(BaA+Chry) in all the station samples in the Island, the 0.5 to 1 range have been obtained for this index, i.e. all the case were either 0.5 or 1. All the obtained values for this ratio are higher than 0.35 and this indicate that aromatic hydrocarbons in all the sediments of the region and in all the samples have a pyrolytic origin.

The other index in determining origin of the aromatic hydrocarbons pollution, is the ratio of IP/(IP+BghiP), which in this experiment is in the range of 0.5 to 0.88. This index is bigger than 0.5 in all the specified stations in coastal line of Kharg Island which indicate that petroleum hydrocarbons pollution in sediment is originated from wood and coal pyrolytic.

Ratio of phenanthrene to anthracene compounds (Phen/Ant) is another index for determining the hydrocarbon origin and in this project; it varies between 0 and 3.86. This ratio in all the stations have a value smaller than 10 and this is an indication of pyrolytic origin of this group of hydrocarbons in the region. Also chry/BaA index values are smaller than 1 in all the samples in the study region.This is an indication of pyrolytic origin of polycyclic aromatic hydrocarbons in the sediments. In order to have a petroleum origin of the pollution, this index should be bigger than 1. The range of Ant/(Ant+Phen) ratio in coastal line sediments is between zero to 1, which is only having smaller value than 0.1 i.e. zero in station 10 which indicate a fossil petroleum origin. The reminding stations have values bigger than 0.1 which indicate a pyrolytic origin for hydrocarbons.

The ratio of total light PAHs (2 and 3 rings) to the total heavy PAHs (4, 5, and 6 rings) is also used as an index for determining the origin of PAHs. The value of this index in sediments of the study area varies between 0.3 and 1.33. In most of the stations this value is smaller than 1 and hence point to the pyrolytic origin of PAHs and in stations 7, 8 and 11, this ratio is bigger than 1 and it means petroleum origin of polycyclic aromatic hydrocarbons of the region's sediments.

Table1. The PAHs concentration in sediment sampling stations

Stations											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
PAHs (ng/g)	16.49	11.2	12	9.7	19.2	1229.7	15.6	46.7	15	12.3	14.5

This research indicate that by this developed indexes we can find out that observed aromatic hydrocarbons in the sediments near the shore of Kharg Island mainly have pyrolytic origin with less petroleum origin in them. This dominancy of pyrolytic origin can be resulted from activity of tens of flares in petroleum installations throughout the Island which are responsible for burning of sour gas which is found with oil. Weathering level and degree of hydrocarbons molecular degradation is as follow: the condition of weathering and level of molecular destruction of petroleum hydrocarbons is determined by discussed indexes that have been observed in the study region. According to mentioned values in Table 2, how the weathering or freshness levels of coastal sediments of the Kharg Island are is acquired.

The density of normal alkanes in table 3 that are used to define the values of indexes Quantities evaluation of the n-C17/Pristine and n-C18/Phytane ratios which indicates the relative rate of biological decomposition or molecular destruction of hydrocarbons that have been observed in surface sediments, varies in the range of 0.74 to 29.5 for n-C17/Pristane and 0.64 to 6 for n-C18/Phytane in this study (Table2). Due to the low values of these ratios in most of the study sediment stations, these indexes indicate the non-freshness of petroleum stains existing in sediments and high level of molecular destruction and biological decomposition of observed hydrocarbons. n-C17/Pristane ratio has a high value equal to 29.5 only in station 10 that is located in south west of the Island and it is so much lower in other stations, like the values

of n-C18/Phytane which is an indication of weathering and oldness of existing petroleum in sediments.

The existing ratios of LMW/HMW in all the sampling stations which varies in the range of 0.29 to 32, and it can be concluded that only in station 1 the value of this ratio is equal to 0.29 that is less than 1, hence it has fresh petroleum and low levels of biological decomposition of hydrocarbons and the other stations (stations 2 to 11) that their values are bigger than 1, have weathered petroleum with high level of biological destruction. And since only one sample do not have an acceptable conclusion; this index also can indicate the existence of weathered and old petroleum.

Furthermore the values of weathering index (WI) in sediment samples of the coastal line in Kharg Island are in the range of 0.113 to 15.3. This value is between 0.3 to 6.3 in most of the stations, which is an indication of weathered petroleum (sediments of stations 5, 6,7,8,9 and 10). In station 1, this index is equal to 0.113, i.e. less than 0.3 which indicates high weathered petroleum and only two stations (2 & 11) have higher values than 6.3 and it is impossible to determine the weathering rate in these locations. The values of weathering ratio (WR) are also studied in all the sediment samples and it is obtained less than 0.5. Therefore this index cannot determine the weathering rate of existing hydrocarbons in sediments of the Island. On this basis most of the sediment samples of the Island have old sources of hydrocarbons and high weathering of leaked hydrocarbons. And there are indications of the entrance of fresh petroleum polluters in a small number of stations.

Table2. Index quantities calculated for sediment sampling stations

Stations	LMW/HMW	n-C17/Pristine	n-C18/Phytane	WI	WR
1	0,29	11.5	3.5	0.113	0.2
2	1.9	0	0	15.3	0.027
3	0	0	0	0	0
4	0	0	0	0	0
5	32	1.5	1.12	5.3	0.027
6	2.55	2.95	4.7	2.6	0.07
7	1.27	1.9	2.4	4.4	0.13
8	4,9	2.5	1.7	4.5	0.09
9	13	0.74	0.64	6.1	0.03
10	1.6	29.5	5	0.9	0.07
11	1.34	6.5	6	7.5	0.5

Table3. Normal Alkanes Concentrations in Kharg Island Coastal Sediments (µg/g)

Stations	1	2	3	4	5	6	7	8	9	10	11
C11	0	0	0	0	0	0	0	0	0	0	0
C12	0	2.41	0	0	0	0	0	0	0.04	0	0
C13	0	1.2	1	2.5	0.42	0	0	0	0.5	0	0
C14	0.05	1.17	1.1	3	0.53	0.16	0.07	0.1	0.5	0.07	0.12
C15	0.004	4.03	3.9	5.9	1.37	0.04	0	0.14	0.59	0.02	0
C16	0.04	7.63	7.6	6.2	1.11	0.01	0.01	0.01	0.01	0.12	0.1
C17	0.23	0.02	0.02	1.7	1.69	0.59	0.19	0.25	0.87	0.59	0.13
C18	0.07	6.44	15.9	18	1.55	0.47	0.12	0.26	0.84	0.1	0.12
C19	0.17	12.69	11.4	9.5	0.18	1.12	0.02	0.02	0.12	0.22	0.03
C20	0	12.51	10.3	10.8	0	0	0	0	0	0.07	0
C21	1.53	16.4	11.8	8.5	0	0.68	0.24	0.07	0.13	0.55	0.27
C22	0	0.004	0.004	0	0.03	0.03	0	0.01	0.04	0.02	0
C23	0	0	0.002	0	0	0.04	0.02	0.02	0	0.03	0.27
C24	0.06	0.14	0.06	0	0.06	0.02	0.01	0.004	0.04	0.01	0.008
C25	0.29	1.24	1.7	2.2	0	0.08	0.03	0.03	0	0	0.04
C26	0.006	0.06	0.006	0.006	0.004	0.004	0.002	0.002	0.008	0.008	0.004
C27	0.002	0.09	0.002	0.008	0.004	0.004	0.002	0	0.01	0.01	0.04
C28	0.006	0.03	0.006	0.02	0.006	0.008	0.004	0.006	0.008	0.02	0.004
C29	0.03	0.16	0.03	0	0.04	0.04	0.004	0.008	0.02	0.03	0.008
C30	0	0.01	0	0	0.002	0	0.002	0	0	0	0
C31	0.008	0.003	0.008	0.008	0	0	0.002	0.002	0	0.002	0.004
C32	0.002	0.01	0.002	0.003	0.004	0.004	0.002	0.002	0.004	0.004	0
C33	0	0	0	0	0.06	0.004	0.002	0.002	0.006	0.006	0.008
C34	0.006	0	0.006	0	0.002	0.02	0.002	0.002	0.002	0.004	0

CONCLUSION

Because of different effects of hydrocarbon compounds with biologic or petroleum fossils origin in marine environment pollutions, evaluating the nature and origin of the entrance of these polluters into seas have gained special attention to itself in recent years. In the current paper, evaluating the current condition of aromatic hydrocarbons density in sediments of Kharg Island has been determined.By sampling surface sediments in the Kharg Island and near the shore through comparison of the obtained densities with the available guidelines and standards, the pollution of this region were determined by polycyclic aromatic hydrocarbons (PAHs). Also the profound studies about the level of molecular destruction and biological decomposition of observed pollutants have been performed. Because of obtaining the samples near the coastal line and in shallow depth which results in weathering of the sediments, the density rate of polycyclic aromatic hydrocarbons is not so considerable and it can be said that the amount of PAHs

pollution is relatively low. In most of the stations, this pollution can be ignored and only in one of the stations this is considerable.

Evaluating the general status of polycyclic aromatic hydrocarbons observed in coastal sediments of Kharg Island by the indexes derived from different researches of scholars, indicates the general pyrolytic origin of hydrocarbons in the sediment samples as well as the fact that the amount of hydrocarbons with petroleum origin are rare in the region sediments and only exists in some of the stations. Dominancy of pyrolytic origin of hydrocarbons in sediments can be for abundant flares that burn the gas which comes with oil in petroleum installations of Kharg Island. Also it can be from ships activities in the region. In this research it has been observed the prolonged and old presence of petroleum hydrocarbons in sediments with the development of a set of quantity indexes, and the molecular destruction and high level of biological decomposition of the surface sediments is realized in

the most of stations in this region. Only in a limited number of stations, the effects of the new oil are found.

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REFERENCE

Baumard, P., Budzinski, H., Mchin, Q., Garrigues, P., Burgeot T. and Bellocq, J. (1998a). Origin and bioavailability of PAHs in the Mediterranean Sea from mussel and sediment records. Estuarine, Coastal and Shelf Science, **47**, 77–90.

Beg, M. U., Saeed, T., Al-Muzaini, S., Beg, K. R. and Al-Bahloul, M. (2003). Distribution of Petroleum Hydrocarbon in Sediment from Coastal Area Receiving Industrial Effluents in Kuwait. Ecotoxicology and Environmental Safety, **54**, 47–55.

Boulobassi, I. and Saliot, A. (1993). Dissolved particulate and sedimentary naturally derived polycyclic aromatic hydrocarbons in a coastal environment. Geochemical significance, Mar. Chem., **42**, 127–143.

Colombo, J. C., Pelletier, C. H., Brochu, M. and Catoggio, J. A. (1989). Determination of hydrocarbon sources using n-alkane and polyaromatic hydrocarbon distribution indexes. Case study. Rio de La Plata Estuary, Argentina. Environmental Science and Technology, **23**, 888-894.

Commendatore, M. G., Esteves, J. L. and Colombo, J. C. (2000). Hydrocarbons in Coastal Sediments of Patagonia, Argentina, Levels and Probable Sources, Marine Pollution Bulletin, **40**, 989-998.

Diez, S., Jover, E., Bayona, J. M. and Albaiges, J. (2007). Prestige oil spill III. Fate of heavy oil in the marine environment. Environ. Sci. Technol, **41**, 3075–3082.

Ezra, S., Feinstein, S., Pelly, I., Bauman, D and Miloslavsky, I. (2000). Weathering of fuel oil spill on the east Mediterranean coast, Ashdod. Israel, Org. Geochem, **31**, 1733– 1741.

Gawad, E. A., Al-Azab, M. and Lotfy, M. M. (2008). Assessment of the Oil Pollution Extent in the Offshore Sediments, Abu Dhabi, UAE, Australian Journal of Basic and Applied Sciences, **2 (3)**, 617-631.

Gearing, P., Gearing, J., Lytle, T. F. and Lytle, J. (1976). Hydrocar- bons in 60 northeast Gulf of Mexico shelf sediments. Geochimica et Cosmochimica Acta, **40**, 1005-1017.

Kennicutt, M. C. (1988). The effect of biodegradation on crude oil bulk and molecular composition. Oil Chem Pollut, **4**, 89– 112.

Law, R. and Andrulewicz, E. (1983). Hydrocarbons in water, sediment and mussels from the southern Baltic Sea. Marine Pollution Bulletin, **14**, 289–293.

Law, R. J. and Klungsoyr, J. (2000). The analysis of polycyclic aromatic hydrocarbons in marine samples. International Journal of Environment and Pollution, **13**, 262–283.

Long, E. R., MacDonald, D. D., Smith, S. L. and Calder, F. D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management, **19**, 18–97.

Massoud, M. S., Al-Abdali, F., Al-Ghadban, A. N. and Al-Sarawi, M. (1996). Bottom sediments of the Arabian Gulf–II, TPH and TOC contents as indicators of oil pollution and implications for the effect and fate of the Kuwait oil slick. Environmental Pollution, **93**, 271–284.

Mille, G., Asia, L., Guiliano, M., Malleret, L. and Doumenq, P. (2007). Hydrocarbons in Coastal Sediments from the Mediterranean Sea (Gulf of Fos Area, France). Marine Pollution Bulletin, **54**, 566- 575.

Mirvakili, H.s., Zaker, N.H. andImani, F. (2013).Evaluation of Oil Pollution and Origin in Surface Coastal Sediments of Kharg Island in the Persian Gulf.Coastal Research, Special Issue No. 65, 93-98, ISSN 0749-0208.

Neff, J. M. (1979). Polycyclic Aromatic Hydrocarbons in the Aquatic Environment-Sources, Fates and Biological Effects. Applied Science Publishers, London, pp 262.

Notar, M., Leskov-Sek, H. and Faganel, J. (2001). Composition, Distribution and Sources of Polycyclic Aromatic Hydrocarbons in Sediments of the Gulf of Trieste, Northern Adriatic Sea. Marine Pollution Bulletin, **42 (1)**, 36-44.

Readman, J. W., Fillmann, G., Tolosa, I., Bartocci, J., Villeneuve, J. P,. Cattini, C. and Mee, L. D. (2002). Petroleum and PAH contamination of the Black Sea. Marine Pollution Bulletin, **44**, 48–62.

ROPME, (2000). Integrated Coastal Areas management: guidelines for the ROPME region. ROPME/GC-10/001. Kuwait, Regional Organization for the Marine Environment.

Short, J. W. and Heintz, R. A. (1997). Identification of Exxon Valdez oil in sediments and tissues from Prince William Sound and the northwestern Gulf of Alaska based on a PAH model. Environmental Science and Technology, **31**, 2375-2384.

Sprovieri, F. and Pirrone, N. (2008). Spatial and temporal distribution of atmospheric mercury species over the adriatic sea, Environ: Fluid Mech., **8 (2)**, 117–128.

Tolosa, I., Mora, S., Sheikholeslami, M.R., Villeneuve, J. P., Bartocci, J. and Cattini, C. (2004). Aliphatic and aromatic hydrocarbons in coastal Caspian Sea sediments. Marine Pollution Bulletin, **48**, 44–60.

Tolosa I., Mesa-Albernas, M. and Alonso-Hernandez, C.M. (2009). Inputs and Sources of Hydrocarbons in Sediments from Cienfuegos Bay, Cuba. Marine Pollution Bulletin, **58 (11)**, 1624-1634.

Wang, Z. and Fingas, M. (1994). Study of the Effects of Weathering on the Chemical Composition of a Light Crude Oil.17 Arctic and Marine Oil Spill Program Technical Seminar, Ottawa, Environment Canada, **1**, 133-171.

Wakeham, S. G., Schaffner, C. and Giger, W. (1980). Polycyclic aromatic hydrocarbons in recent lake sediments: II. Compounds derived from biogenic precursors during early diagenesis. Geochim. Cosmochim. Acta, **44**, 415–429.