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Research Article

Measurement of PCB Compounds in the Persian Gulf (Southern Pars Area)

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ABSTRACT

Objective: The objective of this research is to examine PCB compounds in the Persian Gulf in the Southern Pars area. **Methods:** In the research, 3 stations were sampled: Asalouyeh Port, Kangan Site, Mehr Petro Kima Petrochemical. To sample water in the stations determined, one-liter sampling bottles of dark glass were used. In each station, samples were taken on three points. After recording sampling time and place, samples, with no adding any material, were transferred to the laboratory for measurements. PCB compound measurements were made by a GC-MAS apparatus. Limit of detection (LOD) was 71 pg/lit. One-way analysis of variance was used to compare PCB concentrations in water, as well as compare contamination rate in different stations. All above steps were performed by the SPSS software. **Results:** The results showed that average PCB compounds in Asalouyeh Port, Kangan Site and Mehr Petro Kimia Petrochemical, were 99.3, 105.5 and 110 Ng/L, respectively.

1.Introduction

In the recent decade, surface and underground water contamination through non-point sources has been considered as an important environmental issue. Today, increased exploitation of natural marine resources, development of oil industries and refineries, and municipal sewage and industrial wastewater discharge all lead to the entrance of chemical pollutants into aquatic ecosystems (Mills et al. 2005). One of the most important sea and ocean pollutants is hydrocarbon materials in petroleum. Petroleum consists of thousands of different chemicals in different physical forms (gas, liquid, solid), which are very dangerous for marine life; it contains a variety of linear alkanes and the injection of different materials in different steps for petroleum and gas refinery causes compound formations like Biphenyl (Albers, 2003). Aromatic compounds are one of the most

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important pollutants in petroleum and their effects on human health and environment is visible; as they would enter human food chain they could cause medical deficiencies and diseases like cancer (Clark and Finley, 1973). Due to their specific properties, these materials are added to petroleum oils to improve their properties. In a few recent decades, contamination from poly-chlorinated biphenyl compounds in water has been a concern as an environmental problem, which is due to their long-term effects and higher toxicity on public health of humans and other organisms. Poly-chlorinated biphenyl (PCB) compounds are chlorinated hydrocarbons of two benzene rings. After entering, this material is accumulated in adipose tissues in living organisms due to very high solubility in organic solvents; it is accumulated by this during food chain and enters human body through food consumption because of resistance to living factor decompositions etc (Esmaeeli Sari, 2002). The research aims to measure poly-chlorinated biphenyl (PCB) pollutant rates in industrial wastewater outputs into the Persian Gulf in the Southern Pars area.

2.Materials and Methods

The research was conducted in 2015 in the Southern Pars area, which 6 stations were determined for sampling including Asalouyeh Port, Kangan Site, Mehr Petro Kima Petrochemical, 4th Refinery in Southern Pasr, Taheri Port and Aria Sasol Polymer. Geographical coordinates of the sampling stations are presented in Table 1.

Table 1: The Geographic Coordinates of Stations Studied

Stations	Geographic coordinates
Asalouyeh Port	N 27°, 28', 25.9176" "E 52°, 36', 16.4016"
Kangan Site	N 27°, 40', 25.07166" "E 52°, 15', 23.9076"
Mehr Petro Kima Petrochemical	N 27°, 34', 6.6772" "E 52°, 32', 28.1928"
4th Refinery in Southern Pasr	N 27°, 31', 25.197" E 52°, 33', 38.664"
Taheri Port	N 27°, 43', 8.2194" "E 52°, 11', 7.602
Aria Sasol Polymer	N 27°, 32', 18.5964" "E 52°, 32', 59.2656"

2.1.Sampling

To sample water in the stations determined, one-liter sampling bottles of dark glass were used. First, bottles were washed in water in the area twice, and then filled with the same water. In each station, samples were taken on three points. After recording sampling time and place, samples, with no adding any material, were transferred to the laboratory for measurements.

2.2.Preparation of Samples

First, about one liter of water is poured into the decanter and 80 ml of n-hexane is added to it, then one milliliter of the PCB198 solution, PCB28 of the about 20 ng/ml concentration is used as domestic standard, is added to the contents in the decanter. Next, it is shaken three times for one minute. After two phases are formed, the lower (aquatic) phase is poured into another decanter and the upper (organic) phase is collected in a 250-ml flask. Again 80 ml of n-hexane is added to the contents in the decanter, and it is shaken. It is left to form the two phases. The volume of the lower (aquatic) phase is measured by a graduated cylinder, and the upper (organic) phase is collected in the flask. It is worth to mention that parameters of interest are collected in the organic phase. To prepare a blank, one milliliter of domestic standard is poured into the funnel of the decanter and extraction is performed.

2.3.Concentration

The sample is reached by a rotary evaporator to the volume of 10-15 ml, and then reached by dry and neat nitrogen gas of 99.999% grade to one ml. The rotary evaporator is required to be set to 90 revolutions per minute and bath temperature does not exceed $30^{\circ}C$.

2.4.F1

To remove this fraction, 65 ml of hexane is poured into the column. The solvent flow rate should be neither highly continuously nor highly slow. When 0.5 to 1 ml of hexane is above the column, we close the valve of the burette. During this step, the container under the column contains the F1 fraction, which includes OCs like HCB and OP DDE, PP, aldrin and hepta chlorine.

2.5.Analysis

Measurement of PCB compounds was made by the GC-MAS apparatus (Younglin GC-MS6900 model) with the Agilent DB-5MS Ultra Inert column (5% narrow column in 30 m length, 0.25 ml film thickness and 0.5 ml internal diameter). Limit of detection (LOD) was 71 pg/lit. In this method, the F1 fraction obtained from the clean-up step was concentrated and injected into the apparatus. The temperature program used for analysis was based on Moopam's method (1999). Apparatus injection was made by scan materials.

2.6.Statistical Analysis

To compare PCB concentrations in water, as well as compare contamination rate in different stations, one-way analysis of variance was used. Significance level was considered as 0.05 for statistical testing. All above steps were performed by the SPSS software, and respective charts were plotted by excel.

3.Results

PCB Compound Concentrations in the Stations Studied

The concentration of 9 PCB compounds in water samples from the study stations was measured.

The results related to average concentration and standard of deviation of the compounds in each station are presented in Table 2.

Table 2: The Concentration of PCB in the Asalouyeh Port (µg/L) (Mean±SD)

SD	Mean	Asalouyeh Port	
0.02	0.70	PCB۱۸	1
0.03	1.60	PCB۲۸	2
0.25	5.10	PCB۳۱	3
0.26	7.10	PCB٤٤	4
0.34	6.30	PCB٥٢	5
0.26	15.10	PCB۱۰۱	6
0.35	10.20	PCB۱۳۸	7
0.15	25.10	PCB۱٥۳	8
0.26	28.10	PCB۱۸۰	9

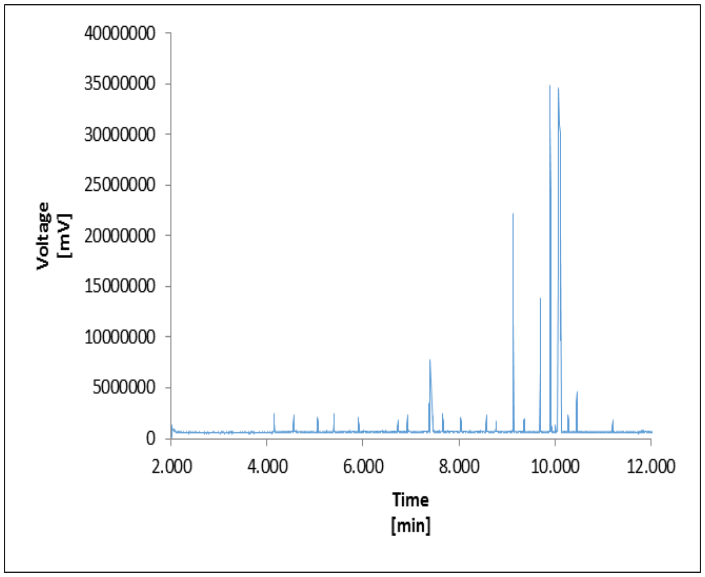

Figure 1 : The Chromatogram of GC - MS device of water samples in the Asalouyeh port

Table 3: The Concentration of PCB in the Kangan Site (µg/L) (Mean±SD)

SD	Mean	Mehr Petro Kima Petrochemical	
0.13	1.20	PCB_{18}	1
0.17	2.30	PCB_{28}	2
0.06	5.90	PCB_{31}	3
0.08	7.90	PCB_{44}	4
0.125	8.10	PCB_{52}	5
0.07	16.20	PCB_{101}	6
0.08	12.40	PCB_{138}	7
0.03	26.70	PCB_{153}	8
0.06	30.10	PCB_{180}	9

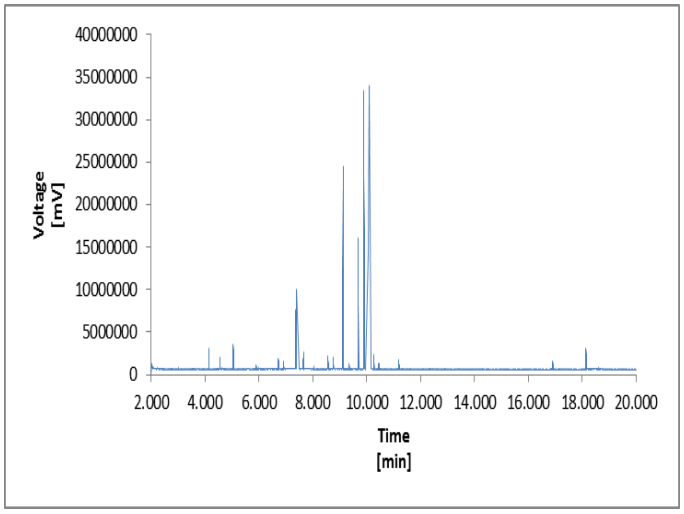

Figure 2: The Chromatogram of GC- MS device of water samples in the Kangan Site

Table 4: The Concentration of PCB in the Mehr Petro Kima Petrochemical (µg/L) (Mean±SD)

SD	Mean	Kangan Site	
0.13	1.10	PCB_{18}	1
0.14	1.80	PCB_{28}	2
0.10	5.50	PCB_{31}	3
0.20	7.40	PCB_{44}	4
0.13	7.40	PCB_{52}	5
0.10	15.90	PCB_{101}	6
0.10	11.60	PCB_{138}	7
0.10	25.80	PCB_{153}	8
0.10	29.00	PCB_{180}	9

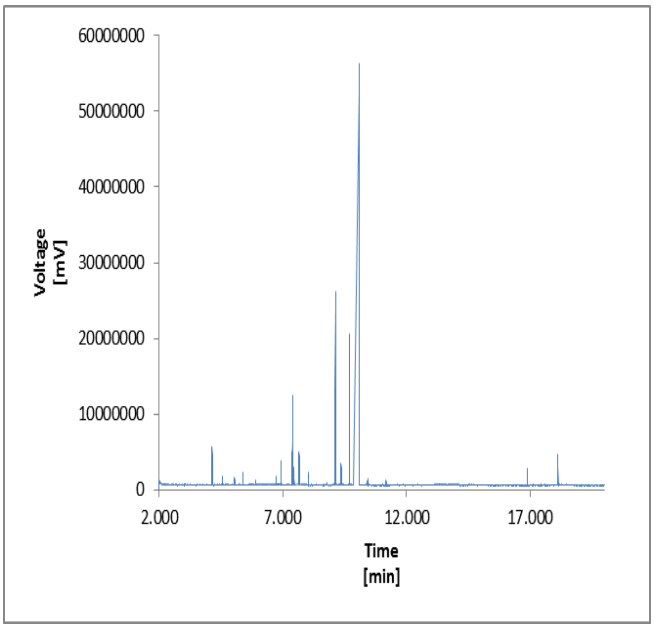

Figure 3: The Chromatogram of GC -MS device of water samples in the Mehr Petro Kima Petrochemical

4.Discussion and Conclusions

Among the 3 stations studied and monitoring PCB compound accumulations, in average wastewater outputs associated with the Aria Sasol Polymer and its surrounding oil industries and facilities are higher than that in international standards. Chemical and oil leaks caused by cooling system corrosions; hydraulic oil and fuel oil discharge; ballast water discharge from ships, tankers, vessels and greyhounds; fuel discharge on fuel smuggling; spillage; and the lack of management of residues from insulators and asbestos having PCB compounds are considered as the main pollution causes in the area. It is worth to mention that the identified pollution causes can be tracked in specified times, and measures can be taken to reduce and remove these compounds. In this point, it can be implied that management of residues from these compounds in the Persian Gulf is required more than before because among neighboring countries like Qatar, UAE, Saudi Arabia, Bahrain and Oman, the contamination rate of these compounds has been reported less.

It should be mentioned that the International Oil Pollution Prevention Certificate should be considered as an index. With regard to 1,729,078,000 tons of hot wastewater from different oil industries and their wastewater outputs, in particular the Aria Sasol Polymer, annually, it is estimated that the Aria Sasol Polymer and its surrounding oil industries have very high contribution and the rest is associated with other industries and complexes. The temperature of output wastewater from the Aria Sasol Polymer differs 4 to $7^{\circ}C$ from that of sea water. The allowed limit, however, for hot sewage discharge into receiving aquatic media must not exceed $3^{\circ}C$, which the dangerous effects of pollutants like PCBs on marine ecosystems and finally humans would further emerge. Due to a lot of different refinery industries, petrochemical industries and their related industries in the area, PCB-producing sources have been exacerbated; oil sources can not only be considered as the ones producing this pollutant. The amount of the pollutant in marine environments can be reduced by optimizing fuel oil collection, properly fueling vessels and greyhounds, continuously monitoring ports, reducing industrial wastewater outputs, and treating wastewater outputs through the DDAF system or OIL-DISK system.

5.Suggestions and Solutions

1. Managing PCB residues according to international standards;
2. Reducing industrial wastewater discharge output in refineries and petrochemicals;
3. Studying or examining contamination caused by these compounds, and their removal methods to protect marine sources;
4. Controlling and non-spreading these types of residues in marine environments;
5. Properly collecting residues from the compounds and their removal.

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