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Petroleum Exploration Potential Danger to the Environment

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Abstract

Some heavy metals are neurotoxic. For instance lead, mercury, nickel, zinc, cadmium, chromium and manganese. The commonest source of heavy metal pollution are industrial and mining activities, petroleum exploration, exploitation, processing and effluent management, atmospheric condensation and sewage disposal. Natural phenomena such as earthquake, landslides, tornadoes and cyclones have been implicated. Nuclear reactor accidents, and solid weapons sometimes discharge heavy metal pollutants, which constitute potential dangers to the environment.

Key words: *petroleum, sewage sludge, heavy metals, environment.*

Introduction

Pollution describes the introduction of foreign substances into the biosphere. As xenobiotics, some of these pollutants sometimes find their way into the human system through the food chain. In the body, they may undergo biotransformation, metabolism and excreted without the risk of toxicity depending on the chemical characteristics of the compound and the dose. However, some of the pollutants resist chemical and biological transformation and accumulate in the tissues, including the nerves, to cause toxicity. The adverse effects of these pollutants on the nerves give rise to neurotoxicity.[1]

Investigation of **heavy metal** contamination levels as well as their association types with substrates in **petroleum-contaminated** surface soil was carried out using modified sequential extraction method. In that way, remobilization capacity of metal cations, both in natural conditions and in accidents, has been studied. Moreover, partitioning of heavy metals, originating from spilt oil derivative, among surface soil substrates was estimated. Extreme contamination with **lead** was discovered, as well as the increased concentrations of **zinc** and **copper**. Oil-derived **Pb** and **Zn** were found to be distributed between carbonates and amorphous Feoxides, whereas **Cu** was found to be dominantly associated with amorphous Feoxides. Appreciable amounts of these metals were also found to be incorporated into more resistant structures. In petroleum-contaminated surface soil, substrates of **cadmium** are carbonates, whereas **nickel** has the great affinity toward hydrous Monoxides. Cd is proven to be the most mobile metal in oil-contaminated surface soil.[3]

Table 1 shows the mean concentrations of the heavy metals in fish and water. The mean Pb concentration was 0.3 ± 0.1 mg/L in water and 25.55 ± 1.2 mg/g in the fish. These were above the WHO safety standard of 1.5 mg/L and 0.01 mg/g respectively. The results indicated that the water and the fish were polluted based on WHO standards.. His work showed that tilapia was polluted with Pb having a bioconcentration of 68.36 mg/g.[4]

Table 1: Mean concentration of heavy metals in water and fish

Heavy metal	Water (mg/L)		Fish mg/g		Exon – Mobil Effluent (mean ± SD) mg/L
	Mean* (n=10)	WHO standard	Mean (n=10)	WHO standard	1.18 ± 0.09
Lead	0.3 ± 0.1	0.01	25.58 ± 1.2	1.5	1.18 ± 0.09
Manganese	0.14 ± 0.09	0.5	12.85 ± 0.66	2.5	0.29 ± 0.03
Chromium	0.53 ± 0.01	0.05	ND	0.15	0.04 ± 0.04
Cadmium	0.03 ± 0.01	0.005	0.38 ± 0.06	0.2	0.03 ± 0.03
Nichel	0.21 ± 0.01	0.1	1.9 ± 0.1	0.4	0.23 ± 0.27
Zinc	0.14 ± 0.02	3.0	6.65 ± 0.45	150	0.34 ± 0.03

Victims of Pb intoxication have been shown to manifest various forms of neurological syndrome such as lead palsy and lead encephalopathy, especially in children. Some of the clinical manifestations include muscular weakness, fatigue, which are more pronounced in the fingers, wrist, toes and forearm; clumsiness, ataxia, headache, insomnia, irritability, grandmal seizures and gait. The fatality rate of Pb neurotoxicity is about 25% while about 40% of the survivors have to live with neurological sequelae such as mental retardation, optic atrophy and cerebral palsy. The fish was polluted (25.58 ± 1.2 mg/g) against the WHO safety limit of 2.5 mg/g.

Cadmium occurs naturally in association with Pb, Zn, or Ni. The acute neurological effects of Cd toxicity manifests in the form of nausea and abdominal cramps, bloody diarrhea and vomiting, dizziness and chest pain.. The source of the Cd may be the petroleum processing and effluent discharge facility.

Zn is a neurotoxin. By its ability to chelate and deplete the neuronal concentration of glutathione (GSH), it causes neuronal cell death in a dose dependent manner. The water and fish were not polluted with respect to Zn, 0.14 ± 0.02 mg/L and 6.65 ± 0.45 mg/g; when compared with the WHO standards of 3.0 mg/L and 150mg/g respectively.

The concentrations of total organic carbon (TOC), total petroleum hydrocarbons (TPH), and petroleum-related heavy metals were determined in sediment samples collected from eight stations along the coastal area in Kuwait. The TOC concentrations ranged from 5.21 to 24.89 mg/g dry sediment. The TPH concentrations were variable and ranged from 7.43 to 458.61 μg/g dry sediment. The highest TPH concentrations were found near the Shuaiba Industrial Area and in the Shuwaikh Port where both industrial and boating activities and land-based wastewater discharges are most common. Petroleum-related heavy metals, namely lead, nickel, and vanadium, were detected at all stations. The data support the premise that industrial wastewater discharges, waste and port activities are the major sources of pollution in the study areas. The concentration of TPH and TOC, carbonate content, and distance from the pollution sources were also investigated.

The levels of lead, cadmium, copper, zinc, aluminum, chromium, and iron in street dust, soil, and plants (in the Jordanian petroleum refinery) were determined using flame and graphite-furnace atomic absorption spectrophotometry. Major cations (Li^+, Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+}) and anions (F^-, Cl^-, NO_3^-, SO_4^{2-}, and Br^-) were also determined using suppression mode ion chromatography. Generally, higher levels of the heavy metals studied were found in street dust samples than in soil samples. On the other hand, except Cl^-, and Li^+ ions, other anions and cations showed higher concentrations in soil than in street dust samples. For plant samples, unwashed samples showed higher levels of heavy metals than their washed counterparts, indicating that dust fall is a source of heavy metal contamination.[2].Petroleum refineries and heavy metals:

From all kind of water such as process water different heavy metals should be removed.

The table below shows which heavy metals are mainly present :

Cd	Cr	Cu	Hg	Pb	Ni	Sn	Zn
++	++	+		++	+		++

The characterization of heavy metals in sewage sludge was investigated from six different wastewater treatment plants (WWTP)[1]. It was found that the total concentrations of Zn in Wujiacun (WJC) sewage sludge, and Cd and Hg in sewage sludge generated from all of the six different places are higher than Chinese regulation limit of pollutants for sludge to be used for agriculture.[1]

Concentrations of heavy metals (Cd, Pb, Cr, Ni, Zn and Cu) were measured in bottom sediments, water and Typha angustifolia and Potamogeton pectinatus in Sultan Marsh. Sultan Marsh is one of the largest and most important wetlands in Turkey, Middle East and Europe, embodying saline and fresh water ecosystems and providing a shelter for 426 bird species. The organs of T. angustifolia have a larger quantity of the measured elements than the P. pectinatus. Considerably higher contents of Cd were found rather than in helophytes (P. pectinatus) in submerged plant (=emergent, T. angustifolia) species. The percentage of Cd in plant tissues points to a certain degree of water pollution in Sultan Mash. Analyses of water, bottom sediments and plant samples indicated that the Marsh were polluted with Pb, Cd, and partly with Cu and Zn. All sampling sites in the study area basin are generally more or less polluted when compared with the control values. Strong positive correlation was found between concentrations of Pb in water and in plants. Ni and Pb were accumulated by plants at a higher rate from bottom sediments than from water. Leaves of T. angustifolia accumulated less heavy metal than the corresponding roots. There was a significant relationship between Cd concentration in samples of plants and water pH value. It has been found that the tissues of T. angustifolia accumulate more heavy metals than the tissues of P. pectinatus. Therefore, all plants can be used as a biological indicator while determining environmental pressures; however, T. angustifolia is proved more appropriate for such studies.

Crude oil has been with humans since pre-historic times; most obviously in Middle Eastern countries where it was used primarily for lamp oil and healing salves. However, with the evolution of machinery and technologies in the mid-19th century, its potential for heating, lighting and early medicines initiated a large-scale exploitation of petroleum. The spectrum of refined petroleum products has become so massive; this industry now touches all industries worldwide. In fact, petroleum products have become essential to every aspect of our daily lives.

- The first step is to convert the highly variable mixture of more than a thousand different
- chemicals in to crude oil to fuel and non-fuel by-products.
- The oil is then transported from wells by pipeline, truck, rail and tankers.
- Worldwide suppliers ship millions of barrels of crude to refineries which are frequently located on waterways close to industrialized cities that can sustain sizeable manufacturing and processing infrastructures and have a large workforce population.

Vital to refinery operations are a series of supporting operations that include chemical recovery plants, specialized tool and service companies, bulk storage areas and transportation terminals. Wastewater and other treatment facilities, in turn, produce second and third level by-products that include some hazardous materials, heavy metals, oil, chemical coagulants, and small contaminant particles suspended in the water and used or processed lime. For a number of products, the materials to produce them come from a variety of refining processes and treatments that remove impurities from raw (crude) oil and break down the molecular structure to form other by-products.

The results of these processes include the following operations:
Pretreatment operation: In this first procedure, the crude is put through a process that removes corrosive salts and heavier impurities. The result produces a gas, a liquid and solids: air (primarily oxygen and nitrogen), water (hydrogen and oxygen) and a thick sludge of heavy metals, petroleum laden sand and clay residues and liquefied oil and paraffins (waxes). Early in the history of the refinement industry and with no understanding of the risk involved, this "sludge" was often used as landfill around the physical plant.
Distillation: With the application of heat, the crude separates out into various by-products according to their individual boiling points. While few solid wastes are produced during this operation, before release, the relatively enormous quantities of wastewater must be pH corrected, then treated for sulfides, and chlorides, as well as chemical and biological oxygen demand and suspended solids.
Conversion: Through any of three processes in this phase, (decomposition, unification or alteration), the products of the distillation stage are converted into their final form. It is this stage where such pollutants as oily residues and metals, oily wastewaters, chemical wastes and air emissions are produced.

Environmental Contaminants

There are a huge number of environmental contaminants associated with this industry: organic compounds, heavy metals, gases, and acids. The following groupings highlight their more well-known members. In addition, there are pesticides and PCB-containing oils.

METALS and metal-containing compounds:

Antimony - Sb
Barium – Ba
Cadmium - Cd
Cobalt – catalyst - Co
Iron –Fe
Manganese - Mn
Nickel – catalyst - Ni
Silver - Ag
Arsenic –As
Beryllium -Be
Chromium – Cr
Copper - Cu
Lead - Pb
Mercury - Hg
Selenium – Se

Defining the Need for Environmental Insurance

From one base product (crude oil), the petroleum refinery and its supporting operations produce more types of potentially hazardous organic compounds, chemicals, gases and heavy metals than any other single industry. Because petroleum and its by-products are highly volatile and/or toxic, and the various processes of refinement are complex, this industry has perhaps the highest risk for environmental exposures.

- An inadequate or outdated environmental risk management plan that does not include a comprehensive site plan, identify all risks, include a history of all past activities, all owners, all equipment, the condition and location of all underground storage tanks and pipelines.
- Ground water and surface water pollution from fuel repositories with failing secondary containers, heavy metals, chemical coagulants, historic sludge pools, buried asbestos or chemical leaks and an inadequate wastewater management system.
- Massive oil spills into the ocean and subsequent loss of marine life, water birds and coastal wildlife due to tanker accidents, inadequate containment, or untrained personnel that results in massive financial outlay to cleanup environmental pollution coupled with wildlife restoration efforts.
- Blowouts occurring at the oil well heads on rigs release huge amounts of oil and gas into the ocean.
- Soil contamination from aged and failing storage equipment, electrical components leaking PCBs, buried asbestos, on-site spills of corrosive acids, heavy metals, solvents, or pesticides (to highlight just a few) along with inadequate containment vessels and pipelines.
- Air pollution from petro-chemical gas emissions, poor containment, inexperienced or inadequately trained transfer personnel and an inadequate safety relief system.
- Hazardous and/or toxic substances spilled, leaking or exploding during transportation.
- Fires and explosions from volatile chemicals produced by the refinery and ejection of any number of toxic substances into the air.

Conclusions

In the course of a petroleum refinery's daily operations there are significant exposures to environmental loss. Petroleum refineries also face intense public scrutiny on both a local and national level with regards to their environmental "consciousness." With the correct environmental risk management program in place, refineries can help to minimize the damage that an environmental liability can bring.

The work has provided some data and information that may be useful for such studies and policy formulation. There is the need for regular public health checks on the level of heavy metals among the community.

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Pericol potențial al exploatării petrolului asupra mediului

Rezumat

Unele metale grele sunt neurotoxice. De exemplu plumb, mercur, nichel, zinc, cadmiu şi mangan. Sursa cea mai comună a poluării cu metale grele sunt activități industriale, exporarea, exploatarea, procesarea petrolului şi gestionarea apei uzate, condensarea atmosferică şi evacuarea apelor menajere. Fenomenele naturale precum cutremurele, alunecările de teren, tornadele şi cicloanele fiind implicate. Accidentele reactoarelor nucleare şi uneori armele masive evacuează poluatori cu metale grele care constituie pericole potențiale asupra mediului.