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Quality Assessment of Effluents from Various Industries at Vicinity of Rawalpindi and Islamabad

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Abstract: The effluents samples of industries like, oil refinery, textile mills, soap and detergent, hydrogen oil and rubber industry were analyzed for pH, conductivity, hardness, alkalinity, chemical oxygen demand, total dissolved solids, nitrate, nitrite, phosphate and cations like calcium, magnesium, sodium and potassium. Similarly trace metals, were also analyzed from the effluent samples with help of the atomic absorption spectrophotometer. The results revealed that effluent samples from all industries consist of higher concentration level of metal ions as well as physico-chemical parameter as compared to the limits recommended by WHO. It was observed that in the most of cases the concentration level of metals and other parameters has crossed the limits given by NEQS.

Key words: Metal, effluents, pollution, Rawalpindi, physico-chemical parameter

Introduction

In many areas of Pakistan especially in big cities, the industrial units are established without environmental impact assessment (EIA) and environmental management and planning (EMD). Islamabad which was formerly considered as one of the beautiful city in the world, now got enough pollution in both air and water due to increase in number of industries. The industrial pollution is a major problem in all big cities of Pakistan. However, severe problems are arising in Karachi, Lahore, Faisalabad, Sheikupura, Kasur, Multan, Hyderabad, Peshawar, Rawalpindi and Islamabad. (Ambreen, 1993). There are number of industries functioning in Rawalpindi and Islamabad, like oil refinery, textile mills, marble crushing units flour mills, soap and detergent, hydrogenated oils, automobiles, steel and electroplating and rubber industries. The effluents discharge by these industries consist of organic, inorganic chemicals and toxic metals (Irshard *et al.*, 1997). Furthermore the industries and factories dump their solid and liquid wastes in space adjacent to their sites, sewer, nullahs, streams which are mixed with ground water. The waste water discharged by different industries joins fresh water of rivers and canals, where as formers use these water for irrigation purposes. The heavy and trace metals present in polluted water enter into human body through food chain and may causes adverse effects (Stein *et al.*, 1990). Keeping in view the adverse effects of metals on health of human and animals. This study was undertaken with following objectives:

- To assess the level of metal ions in industrial effluents
- To assess the level of physico-chemical parameters of effluents
- Quality assessment of effluents for irrigation purposes.

Materials and Methods

The effluents (waste water) samples from different industries oil refinery and textile mill (Rawalpindi) hydrogenated oil, soap and detergent and rubber (Islamabad), were collected from January to December, 2000. All the samples were collected in triplicates and analyzed for various parameters in respective laboratories of Quaid-I-Azam university Islamabad and University of Arid Agriculture, Rawalpindi.

The temperature of waste water was noted above the surface at the time of collection. The pH of effluent samples were recorded with pH meter in the laboratory. Total solids were determined by evaporating the known volume of well mixed samples and weighing the residue after drying at 105 ^{0}C. The chemical oxygen demand was estimated by micro chromate oxidation method (Alen, 1989). The alkalinity and hardness were evaluated by titration and conductivity was measured with (Jenny Model 4070) conductivity meter.

Sulphuric acid (0.8 ml) was added into this samples (1 L) at the time of collection and filtered just before analysis of metals. Metal ions sodium, potassium and magnesium were determined by air, acetylene flame atomic absorption spectrometer after necessary dilution using the recommended standard conditions. Trace metals copper, chromium, cadmium, cobalt magnesium, nickel, lead, zinc, iron and arsenic were determined using atomic absorption spectrometer after concentration by complexation with 2- acetyl pyridine phenythioisosemicarbzone (APPT) and subsequent solvent extraction (Khuhawar and Mastoi, 1996).

The data was analyzed statistically and LSD at 5% probability level was determined as described by Steel and Torrie (1980).

Results and Discussion

The results of physico-chemical parameters and trace metals analysis of effluent samples showed that the pH of various effluents varied from industry to industry and ranging acidic to alkaline within the range 8.5-9.7 (Table 1). The hardness was highest (604.743 mg L^{-1}) in effluent sample from textile mill. The highest level of conductivity 3050.11 uS/cm was obtained from effluent samples of oil refinery.

Total dissolved solid (TDS) was high in oil refinery (3715.895 mg L^{-1}) as compared to effluent samples from other industries.

The highest values of chemical oxygen demand (COD) was 2424.193 mg L^{-1} found in the effluent samples of textile mill. Higher value of alkalinity (114.700 mg L^{-1}) was observed in the effluent samples from oil refinery and are due to presence of excess amount of CO_3 and HCO_3 in effluent samples. The highest values of phosphate (2.567 mg L^{-1}) observed in effluent samples of textile mill followed by soap and detergent (2.448 mg L^{-1}). The higher values of nitrite (2.667 mg L^{-1}) was found in effluent samples of soap and detergent and nitrate (12.304 mg L^{-1}) in the effluent samples from textile mill. Higher concentration of Na, Ca, K and Mg obtained from effluent samples were in the order of 235.912, 190.664, 162.733 and 98.345 mg L^{-1} respectively from effluent samples of various industries (Table 1).

Trace metal ions (Cr, Cd, Mn, Fe, Co, Cu, Ni, Zn, As, Pb) were determined in the effluent samples with the help of atomic absorption spectrometer (Table 2). Higher values of Fe was found in the effluent of textile mill followed by soap and detergent and oil refinery, where as the concentration level of Fe in the effluents of hydrogenated oil and rubber industries were low but above the permissible limit (Table 2) recommended by Anonymous (1995).

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Table 1: Physico-chemical analysis of the effluents of various industries located vicinity of Rawalpindi and Islamabad

Parameters	Textile mill	Oil refinery	Hydrogenate oil	Soap and detergent	Rubber industry	LSD (0.05)	NEQS
Temp. (°C)	42.5	43.6	43.5	41.6	44.5	1.2	40
pH	9.5	8.5	8.5	8.6	9.7	NS	6-9
Conduct. (UScm^{-1})	2074.383	3050.111	1243.020	2377.486	1711.915	2932	-
TDS (mg l^{-1})	3669.281	3715.895	2626.141	3466.188	188.184	NS	3500
COD (mg l^{-1})	2424.193	295.053	341.321	168.188	188.184	NS	150
Alkalinity (mg l^{-1})	104.434	114.700	111.662	89.648	95.809	95.5	-
Hardness (mg l^{-1})	604.743	587.222	354.795	586.550	596.113	NS	500
Phosphate (mg l^{-1})	2.567	1.981	2.303	2.448	1.092	2.4	-
Nitrite (mg l^{-1})	2.361	2.534	2.556	2.667	1.092	NS	-
Nitrate (mg l^{-1})	12.304	12.277	11.195	11.490	10.017	NS	-
Calcium (mg l^{-1})	74.470	76.843	190.664	72.795	72.452	NS	-
Magnesium (mg l^{-1})	45.934	79.353	98.345	59.435	55.473	NS	-
Sodium (mg l^{-1})	116.845	119.553	231.257	235.912	110.016-	105.6	-
Potassium (mg l^{-1})	84.153	97.721	156.244	162.733	82.191-	NS	-

Table 2: Trace metals concentration (mg l^{-1}) of various industries located in vicinity of Rawalpindi and Islamabad

Metals (mg l^{-1})	Textile mill	Oil refinery	Hydrogenate oil	Soap and detergent	Rubber industry	LSD (0.05)	NEQS
Cr	1.152	1.594	0.124	0.193	0.292	0.02	2.0
Mn	1.944	0.538	0.156	0.317	0.464	0.01	1.0
Fe	7.461	3.728	3.645	5.052	1.015	0.001	-
Co	2.571	0.152	0.214	0.152	0.176	NS	1.0
Ni	3.501	2.239	6.369	1.989	0.377	0.01	1.5
Cu	4.413	3.771	1.092	1.772	2.263	NS	1.0
Zn	4.691	1.572	2.190	2.436	0.503	NS	1.0
As	0.812	0.191	-	0.078	0.097	NS	5.0
Cd	1.708	2.409	0.157	0.149	0.120	0.001	0.1
Pb	0.761	5.132	-	0.198	0.763	0.002	0.5

COD = Chemical oxygen demand, NEQS = National environmental quality standard, NS = Nonsignificant.

Higher concentration of Zn was observed in the effluent samples of textile mill followed by soap and detergent and hydrogenated oil, where as lower concentration of Zn was observed in the effluent samples of oil refinery and rubber. Zinc is an essential and beneficial micronutrient in human growth.

Higher concentration of copper was observed in the effluent samples of textile mill followed by rubber as compared to all other effluent samples. Copper is a micronutrient and concentration of Cu in drinking water is higher than soft water and will not be considered harmful if the pH is within the normal limits. In all effluent samples analyzed higher concentration of Pb was observed in oil refinery. Higher concentration of Pb may causes toxic effects in digestive system of aquatic organism after digestion. Lead has no essential role in human metabolism. Furthermore it was reported by Manahan (1991) that higher concentration of Pb may cause human behavior abnormalities. Analysis of effluent samples showed higher concentration of Cd in oil refinery where as all other samples contained lower amounts of Cd (Table 2). Cadmium accumulate in the kidneys of the mammals and can cause kidney dysfunction. Furthermore water born cadmium is toxic to many fish (Jaffer *et al.*, 1986). Higher concentration of Cr was observed in the effluent samples of oil refinery followed by effluent samples from textile mill, soap and detergent, hydrogenated oil and rubber industries. Higher concentration of Cr in water may create certain toxic effects in fish growing in this water. Cr has been indicated as toxic to plants in the range of 1-5 mg l^{-1} (Irshad *et al.*,1997).

Analysis showed higher concentration of Ni in hydrogenated oil followed by textile mill and soap and detergent oil. Nickel is essential trace element but is highly harmful to the survival and productivity of aquatic animals and its higher concentration may effect fish population (Jaffar *et al.*, 1986), where as the concentration level of Co, Mn and As were low but above the permissible limit (Table 2) in all effluent samples.

As the result indicates that higher concentration of pH, COD, TDS and conductivity are higher than permissible limit (Table 1). The concentration levels of metals like Pb, Cd, Cr, Zn and As which considered as non essential metals and could create toxic effects if cross their permissible limits (Mastoi *et al.*, 1997). Results obtained in this study revealed that the concentration of heavy and trace metals, major cations and the physico-chemical parameters were high in all effluent samples analyzed. These higher concentration will create toxic effects in aquatic organism, when joins into fresh water of stream or rivers (Gulfraz *et al.*, 2001). The higher concentration of these parameters may be mixed up with underground water after leaching and may causes a number of water born diseases. Therefore it is suggested that effluent (domestic and industrial) must be treated so that heavy toxic metals either remove or their minimize before discharge into fresh water of stream, lakes or rivers etc.

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