

# Chemical Investigation of the Effluents of Selected Chemical Industries in NWFP (Pakistan)

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**Summary:** Samples of effluents were collected from the waste water drains of selected chemical industries, located at small industries estate Kohat Road Peshawar on monthly basis from November 1994 to October 1995. These samples were studied for physico-chemical properties and heavy metals like Pb, Ag, Cu, Zn, Fe, Cr, Cd, Mn and Ni using spectroscopic techniques. The results of our investigation are presented and discussed.

## Introduction

Water, in industries is polluted, not only because of carrying sewage produced by workers, but also because of its serving as a source or sink for heat or it may be involved in some chemical processes as a reactant, product or solvent.

The contribution of chemical industry to human welfare is in the form of wide range of chemicals used in drugs, cosmetics, plastics, synthetic fiber, paints cleaning agents and many other kind of consumer products. Unfortunately, most of the chemicals end up in the environment. A high proportion is sluiced down the sewers and ultimately find its way into rivers, lakes and oceans. Many of the chemical are highly toxic to living organism. Some of them find their way into the food chain, disrupting or impairing the natural biotic cycle, threatening population of organism with extinction and jeopardizing the quality of man's food supply [1-3].

A variety of methods are available for the determination of suspended solids, dissolved solids and heavy metals in water [4-9].

In this work, standard methods were used for sampling of the effluents and for measuring physico-chemical properties, like temperature, pH, total suspended solids and total dissolved solids. Heavy metals like Pb, Ag, Cu, Zn Fe, Cr, Cd, Mn and Ni were determined using flame atomic absorption spectrophotometry. The aim of this work was to find out the extent of water pollution if any, contributed by the release of selected chemical industries, located at small industries estate, Kohat Road, Peshawar.

## Results and Discussion

The results of physico-chemical properties and heavy metal analysis of soap, food, electroplating, chappal, plastic, marble, aluminum and packages industries located at small industries estate Kohat Road Peshawar, are given in tables 1-6. It was observed that temperature and pH of all of the effluent samples were with in the permissible range of NEQs and WHO except packages industry where pH was found below the permissible limit. This was probably due to the use of acidic chemicals in the processing of packages and release of the acids into

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Table-1: Investigation of the Effluents of Soap and Food Industries for Physico-chemical Properties

Industry/ Parameter	Drain Mouth mixing	Location				
		10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Soap Industry #1</b>						
Temperature °C	15	18	18	-	-	-
pH	7.5	7.3	7.2	-	-	-
TSS (mg/L)	175	200	210	-	-	-
TDS (mg/L)	506	508	510	-	-	-
<b>Soap Industry #2</b>						
Temperature °C	26	26	24	20	20	20
pH	7.1	7.1	7.1	6.9	7.0	7.0
TSS (mg/L)	142	104	103	168	166	126
TDS (mg/L)	1286	1238	1214	631	663	608
<b>Mixing into Main</b>						
<b>Drain 2</b>						
Temperature °C	21	21	21	20	19	19
pH	7.5	7.4	7.4	7.5	7.6	7.6
TSS (mg/L)	383	388	408	411	217	215
TDS (mg/L)	745	684	682	688	534	534
<b>Food Industry</b>						
Temperature °C	21	21	21	20	19	19
pH	7.5	7.4	7.4	7.5	7.6	7.6
TSS (mg/L)	383	388	408	411	217	215
TDS (mg/L)	745	684	682	688	534	534

Values given are means of determination from November 1994 to October 1995.

Table-2 Investigation of the Effluents of Soap and Food Industries for Heavy Metals (ppm)

Industry/ Parameter	Drain mouth mixing	Location				
		10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Soap Industry # 1</b>						
Fe	1.90	2.90	2.85	-	-	-
Cu	BD	BD	BD	-	-	-
Zn	0.19	0.27	0.25	-	-	-
Mn	BD	BD	BD	-	-	-
Cr	BD	BD	BD	-	-	-
<b>Soap Industry # 1</b>						
Fe	4.20	4.00	4.00	-	-	-
Cu	BD	BD	BD	-	-	-
Zn	1.35	1.30	1.30	-	-	-
Mn	BD	BD	BD	-	-	-
Cr	BD	BD	BD	-	-	-
<b>Mixing into main</b>						
<b>Drain #1</b>						
Fe	3.50	4.30	4.65	4.75	3.85	4.00
Cu	0.20	0.25	0.20	0.20	0.22	0.24
Zn	1.40	1.66	0.75	0.80	0.89	0.48
Mn	BD	BD	BD	BD	BD	BD
Cr	BD	1.00	1.00	1.30	1.50	1.60
<b>Mixing into Main</b>						
<b>Drain # 2</b>						
Fe	10.50	4.80	5.50	4.17	1.85	1.23
Cu	1.00	0.40	0.20	0.70	BD	BD
Zn	2.52	1.29	1.50	0.39	1.05	1.02
Mn	3.00	0.33	0.28	0.24	BD	BD
Cr	BD	BD	BD	BD	BD	BD

- Mean values,
- Below detection limit.
- Pb, Ag, Cd and Ni - BD in all of the samples studies.

Table-3: Investigation of the Effluents of Electroplating, Chappal and Plastic Industries for Physic-chemical Properties

Industry/ Parameter	Location					
	Drain Mouth mixing	10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Electroplating</b>						
Temperature °C	25	25	25	24	24	22
pH	7.0	7.0	7.0	7.2	7.5	7.2
TSS (mg/L)	52	67	65	61	57	52
TDS (mg/L)	363	373	367	349	336	332
<b>Chappal</b>						
Temperature °C	25	25	24	26	24	22
pH	7.5	7.5	7.4	7.2	7.3	7.2
TSS (mg/L)	78	57	66	39	36	36
TDS (mg/L)	491	498	470	488	475	462
<b>Plastic</b>						
Temperature °C	32	31	29	28	26	25
pH	7.4	7.5	7.5	7.5	7.4	7.5
TSS (mg/L)	316	1435	1252	283	328	489
TDS (mg/L)	760	688	670	399	699	811

Table-4: Investigation of the Effluents of Electroplating, Chappal and Plastic Industries for Heavy Metals

Industry/ Parameter	Location					
	Drain mouth mixing	10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Electroplating</b>						
Cu	BD	BD	BD	BD	BD	BD
Zn	0.33	0.33	0.29	0.46	0.20	0.16
Fe	1.65	1.51	1.50	2.04	1.60	1.38
<b>Chappal</b>						
Cu	BD	BD	BD	BD	BD	BD
Zn	0.27	0.32	0.38	0.23	0.19	0.20
Fe	1.51	1.83	1.72	1.55	1.63	1.50
<b>Plastic</b>						
Cu	0.20	1.00	0.80	0.24	0.20	0.16
Zn	0.67	2.01	1.57	0.57	1.01	0.98
Fe	5.38	11.05	13.50	4.45	5.60	6.60

• Pb, Ag, Cr, Cd, Mn and Ni – BD in all of the samples studies.

wastewater drains. TSS values of many samples studied were higher but TDS-value of most of the samples were within the permissible range of NEQs. The highest value of TSS was found in the effluent samples of marble industry due to crushing of carbonate and sulphate rocks and highest concentration of TDS was observed in effluents of plastic industry.

Effluents of all of the industries studied showed that the concentration of Pb, Ag, Cd, and Ni was below the detection limit. All of the samples studied were found to have Fe and Zinc in varying concentration. The highest concentration of Fe and Zn were observed in the plastic (Table 3) and food industries (Table 1) respectively. Fe may be introduced by machines operation, corrosion, and iron paints, whereas Zn is probably contributed by Zn alloys, and food ingredients.

Effluents of the aluminum industry and main drain were found to have Cr in varying concentration. The highest concentration of Cr was found in the effluents of aluminum industry (Tables 6), which is probably contributed by the aluminum chromium alloys used in the industry.

## Experimental

### General Experimental

Polyethylene bottles, 250 ml, coming 240 digital pH meter and Philips flame atomic absorption Spectrophotometer, were used during this work.

### Chemicals, Reagents and Sampling

All chemicals used were of analytical reagent grade purity and were used without further purification. Samples of effluents were collected

Table-5: Investigation of the Effluents of Marble, Aluminum and Packages Industries for Physic-chemical Properties

Industry/ Parameter	Location					
	Drain mouth: mixing	10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Marble</b>						
Temperature °C	21	20	19	19	19	-
pH	7.4	7.5	7.2	7.2	7.2	-
TSS (mg/L)	4461	2124	2018	2010	2012	-
TDS (mg/L)	458	498	488	491	490	-
<b>Aluminum</b>						
Temperature °C	20	20	20	20	20	20
pH	10.8	10.5	10.5	10.7	11.2	11.4
TSS (mg/L)	100	115	488	245	665	610
TDS (mg/L)	534	527	518	515	518	527
<b>Packages</b>						
Temperature °C	20	20	20	20	20	20
pH	6.0	5.9	1.7	1.6	1.6	1.7
TSS (mg/L)	621	729	825	810	818	825
TDS (mg/L)	607	586	475	478	478	4800

Table-6: Investigation of the Effluents of Marble, Aluminum and Packages Industries for Heavy Metals

Industry/ Parameter	Location					
	Drain Mouth mixing	10m from drain mouth (or mixing)	20m from drain mouth (or mixing)	30m from drain mouth (or mixing)	40m from drain mouth (or mixing)	50m from drain mouth (or mixing)
<b>Marble</b>						
Cu	1.90	2.70	2.50	2.60	2.58	-
Zn	0.60	0.67	0.70	0.33	0.33	-
Fe	0.0	BD	BD	BD	BD	-
<b>Aluminum</b>						
Cu	4.50	8.65	9.65	7.65	7.90	7.00
Zn	1.10	1.10	1.50	0.67	1.20	1.00
Fe	1.60	2.20	2.30	BD	BD	BD
<b>Packages</b>						
Cu	2.22	2.13	3.00	3.30	3.90	3.70
Zn	0.92	0.88	1.75	0.30	1.70	1.70
Fe	BD	BD	BD	BD	BD	BD

\* Pb, Ag, Cr, Cd, Mn and Ni – BD in all of the samples studies.

from the drain mouth, at different distances from the drain mouth, the mixing of drains and at different distance from the mixing of drains of selected industries. Sampling was done on monthly basis from November 1994 to February 1996. These samples were collected in 250 ml polyethylene bottles already washed with deionized distilled water.

#### Procedure

Temperature of each sample was measured on the spot, where as pH of each sample was recorded in laboratory, using coming 240 digital pH meter.

#### Determining of Total Dissolved Solids (TDS)

Heated an evaporating dish for one hour at 500°C, cooled it in a desiccator and measured its mass. Filtered a volume somewhat in excess of 100 cm<sup>3</sup> of well mixed sample under vacuum through Whatman

540 filter paper. Maintained the vacuum for at least three minutes after filtration is complete, to remove as much water as possible. Transferred 10 cm<sup>3</sup> of the filtrate to the prepared evaporating dish and evaporated to dryness on hot plate. Cooled in a desiccator. Dried the residue in an oven at 180°C for at least one hour. Cooled again in a desiccator and measured its mass. Total dissolved solids were calculated as given belows:

$$\text{Total dissolved solids (mg/dm}^3\text{)} = \frac{m_1 - m_2}{V} \times 100$$

Where

$m_1$  = is the mass of dried residue

$m_2$  = is the mass of prepared dish in mg.

$V$  = is the volume of filtered sample in cm<sup>3</sup>.

*Determination of Total Suspended Solids (TSS)*

Dried a Whatman 540 filter paper in an oven at 105°C for one hour, cooled in a desiccator and measured its mass immediately before used. Assembled the filtration apparatus, with Whatman 540 filter paper in position. Transferred 100 cm<sup>3</sup> of the well mixed sample to the filter funnel, applied vacuum and washed the residue with three successive 20 cm<sup>3</sup> portions of distilled water. Removed the filter paper, dried in an oven at 105°C for one hour, cooled in a desiccator and measured the mass.

$$\text{Total suspended solid (mg/dm}^3\text{)} = \frac{m_1 - m_2}{V} \times 100$$

where  $m_1$  = is the mass of dried residue

$m_2$  = is the mass of prepared dish in mg.

V = is the volume of filtered sample in cm<sup>3</sup>.

*Determination of Heavy Metals*

Unfiltered well mixed sample (100 cm<sup>3</sup>) was taken in a beaker, to which 10 ml of concentrated HNO<sub>3</sub> and HCl (1:3) was added. This mixture was evaporated to 100 ml and then subjected to flame atomic absorption determination of metals, under the following operating parameters.

Metals	Wavelength	Lamp current (m. amperes)	Band pass (nm)
Pb	217	10	0.5
Ag	328.1	04	0.5
Cu	324.8	05	0.5
Zn	213.9	10	0.5
Fe	248.3	15	0.5
Cr	357.9	12	0.5
Cd	228.8	08	0.5
Mn	279.5	12	0.5
Ni	232	15	0.5

The flame used was air acetylene flame.

**Conclusions**

Amongst the industries studied, marble industry was found responsible for polluting the industrial effluents with TSS. Plastic industry increased the concentration of Fe whereas food and aluminum industries polluted the industrial effluents with Mn and Cr, respectively. Control measures are suggested for reducing the release of TSS, Fe, Mn and Cr by the respective industries, in their effluents.

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