Chemical Investigation of the Effluents of Selected Industries of NWFP, Pakistan

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Summary: 150 samples of effluents were collected from the drain mouths and at different distances from the waste water drain for physico-chemical properties and heavy metals like Pb, Ag, Cu, Zn, Fe, Ca, Cr, Cd, Mn and Ni, using spectroscopic techniques. The results of our investigation are presented and discussed.

Introduction

In addition to its function in carrying off sewage produced by workers, water plays two main roles in manufacturing industries, it may serve as a source or sink for heat or it may be directly involved in some chemical processes as a reactant, product or solvent. Depending on the type of industry, a wide variety of hazardous substances may be dissolved, suspended or adsorbed on suspended particles in its effluents.

There are different types of water pollution. Among these are acid mine drainage, thermal pollution, effluents from petroleum refining and oil spills, radioactive materails, solids, and acids resulting from air pollution control, spent pickle liquor, effluents associated with steel production and contamination from other metal processing. Sulfuric acid is widely used in a great many chemical processes as well as in the manufacture of rubber and

plastics. The same is true of NaOH, used in vegetable processing. Food processing also release high concentration of BOD, often in the form of objectionable materials, such as blood, entrails, grease and fat or hair, which degrade slowly. Small quantities of a variety of metals are released by almost every industry. Since many of them are toxic and relatively little is known about their cycling in the biosphere, they constitute a real problem [1-4].

A variety of methods are available for the determination of suspended solids dissolved solids and trace metals, reported in this paper [5-11].

Results and Discussion

In this paper, effluents of Match factories, Marble, Ceramics, Paper and Board and Ghee industries were investigated for physico-chemical properties like pH, temperature, TSS, TDS and heavy metals like Pb, Cu, Zn, Cd, Fe, Cr, Ca, Mn and Ni. As can be seen from Tables 1-6, the effluents of match factories were found to have higher concentration of TDS, Zn, Fe, Cr, and Mn. The effluents of ceramics industries were found to have higher concentration of TSS, amongst all the industries studied. The presence in high concentration of Zn, Fe, Cr and Mn in the effluents of Match industries is because of using Fe_2O_3 and ZnO as filler, $K_2Cr_2O_7$ as oxidising agent and MnO_2 as a catalyst respectively. We believe that Cr is present in the efluents of Match factories as Cr(VI) which is highly undesirable.

Among the Match factories, as can be seen from Table-1, Match factory-4, liberates higher concentration of TSS, TDS, Zn and Ca in its effluents which may be due to its defective technology. The effluents of Match factory-2 shows a higher concentration of Cr, which may be due to defective handling of $K_2Cr_2O_7$.

As can be seen from Table-5, the ghee mills release liberate Ni at its drain mouth in higher concentration than the NEQS which is undesirable, Ni is dumped into the effluents, because of its use during hydrogenation process and defective filteration. Table-6 shows, the chemical investigation of the effluents of main drain of SDA, industrial state. As shown in this table, the concentrations of all of the pollutants except Fe, are in permissible limits, showing that nature takes care itself of the effluents of the industries, not allowing them to flow into rivers, canals and finally entering into the food chain of animals and humans.

Experimental

Apparatus and instruments

Corning, 240 digital pH meter and Philips flame atomic-absorption spectrometer PU-9100X, were used during this investigation.

Table-1: Investigation of the Effluents of Match Factories for Physicochemical Properties

Match Factory	Location					
	Drain Mouth	10` from D.Mouth	30` from D.Mouth	50` from D.Mouth	70` from D.Mouth	100` from D.Mouth
Factory 1						
Temperature °C	20	20	19	18	18	18
pH	7.17	7.75	7.46	7.48	7.27	7.50
TSS (mg/l)	127	184	2182	223	1023	140
TDS (mg/l)	684	744	882	604	564	580
Factory-2						
Temperature °C	14	13	13	13	-	-
pH	7.52	7.52	7.41	7.35	-	-
TSS (mg/l)	118	70	200	210	-	-
TS (mg/l)	578	686	830	832	-	-
Factory-3						
Temperature °C	18	18	17	17	17	17
pH	7.25	7.36	7.35	7.42	7.35	7.36
TSS (mg/l)	20	12	50	15	30	15
TS (mg/l)	1466	514	590	506	540	530
Factory-4		mixing with 3				
Temperature °C	20	19	18	18	18	18
pH	7.44	7.46	7.46	7.45	7.48	7.45
TSS (mg/l)	2470	990	1084	492	752	745
TS (mg/l)	2028	2528	2574	2204	2490	2310

Table-2: Investigation of the Effluents of Match Factories for Heavy Metals (ppm)

Industry	Location					
	Drain Mouth	10` from D.Mouth	30` from D.Mouth	50` from D.Mouth	70` from D.Mouth	100` from D.Mouth
Factory 1						
Zn	4	3.3	13	4.8	14	4.5
Fe	1.5	3.6	16	5.5	13	2.45
Ca	60	80	75	68	62	70
Cr	1.8	2	4.9	0.68	3.4	B.D*
Mn	0.1	0.18	1.1	0.25	0.5	0.22
Factory-2						
Zn	2.3	3	5.8	4.3	-	-
Fe	2.2	2.4	3.25	2.1	-	-
Ca	60	56	60	62	-	-
Cr	3.7	6.7	5.45	4.38	-	-
Mn	0.1	0.1	0.15	0.18		
Factory-3						
Zn	12.5	3.7	2.7	2.7	2.5	2.6
Fe	2	2	2	2	1.4	1.28
Ca	76	60	60	60	52	65
Cr	B.D	B.D	B.D	B.D	B.D	B.D*
Mn	0.16	0.1	0.1	0.1	0.1	0.12
Factory-4		mixing with 3				
Zn	22	26	24.5	20	22	20
Fe	1.4	1.3	1.3	1.6	8.4	2.1
Ca	115	76	77	65	70	65
Cr	1.14	1.1	0.58	0.14	0.3	B.D*
Mn	0.54	0.4	0.35	0.24	0.29	0.32

B.D*:- Below detection limit.

Table-3: Investigation of the Effluents of Marble, Paper and Ceramics Industries for Physicochemical Properties.

Industry	Location					
	Drain Mouth	10` from D.Mouth (mixing with main drain)	30` from D.Mouth	50 from D.Mouth	70` from D.Mouth	100` from D.Mouth
Marble						
Temperature °C	17	17	12	12	12	12
pH	8.3	7.31	7.24	7.25	7.23	7.26
TSS (mg/1)	674	136	24	14	25	40
TDS (mg/1)	356	710	730	678	685	672
Paper						
Temperature °C	24	24	24	24	23	23
pH	7.52	7.5	7.5	7.5	7.25	7.52
TSS (mg/1)	858	844	367	78	596	235
TDS (mg/1)	598	504	584	520	488	504
Ceramics						
Temperature °C	21	21	20	20	20	20
pH	8.5	8.3	8.3	8.35	8.38	8.32
TSS (mg/1)	2640	2519	2681	2561	4570	2660
TS (mg/1)	518	420	584	526	506	450

Chemicals and reagents

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

Sampling

Samples of the effluents were collected from the drain mouth at different distances from the drain mouth, at the mixing of drains and at different distances from the mixing of drains, of different industries. These samples were collected in 250 mL polyethylene bottles.

Procedure

Temperature of each sample was measured on the spot, whereas pH of each sample was recorded in laboratory using corning 240 digital pH meter.

Table-4: Investigation of the Effluents of Match, Marble, Paper and Ceramcis Industries for Heavy Metals (ppm)

Industry	Location					
	Drain Mouth	10` from D.Mouth (mixing with main drain)	30` from D.Mouth	50` from D.Mouth	70` from D.Mouth	100` from D.Mouth
Marble						
Zn	0.8	3.6	4.0	4.0	3.9	3.8
Fe	1.7	2.4	2.0	2.7	2.4	2.2
Ca	220	65	70	72	75	72
Cr	8.0	0.6	0.3	0.25	0.18	0.14
Mn	0.30	0.38	0.38	-	0.35	0.43
Paper						
Zn	1.5	1.4	0.7	0.8	0.8	1.0
Fe	2.5	2.4	2.6	2.3	2.8	6.5
Ca	85	87	80	75	73	150
Cr	B.D*	B.D*	B.D.*	B.D*	B.D*	B.D*
Mn	0.26	0.31	0.2	0.15	0.13	0.14
Ceramics						
Zn	0.9	0.9	1.0	1.10	1.2	1.2
Fe	2.4	3.0	2.6	4.0	2.3	5.2
Ca	100	65	75	70	98	65
Cr	B.D*	B.D*	B.D*	B.D*	B.D*	B.D*
Mn	0.2	0.15	0.16	0.12	0.2	0.12

*BD = below detection limit

Table-5: Investigation of the Effluents of Ghee Mills for Physicochemical Properties

	Location					
	Drain Mouth	10` from D.Mouth	30` from D.Mouth	50` from D.Mouth	70` from D.Mouth	100` from D.Mouth
Temp. (°C)	24	24	23	23	23	22
pH	8.14	8.14	8.18	8.22	8.3	7.9
TSS (mg/1)	390	50	5	6	2	33
TDS (mg/1)	426	428	362	392	400	448
Zn(ppm)	B.D*	B.D	B.D	B.D.	B.D.	B.D.
Ca(ppm)	90	65	57	42	44	46
Cr(ppm)	B.D.	B.D	B.D	B.D	B.D	B.D
Mn(ppm)	0.2	0.2	0.28	0.3	0.29	0.1
Ni(ppm)	0.34	0.34	0.30	0.2	0.17	0.3
Fe(ppm)	2.3	2.3	8.0	9.5	3.8	3.8

B.D* = Below detection limit.

Table-6: Investigation of the Effluents of Main Drain of SDA for Physicochemical Properties.

	Location					
	Main Drain near Rehman Industries	10` from D.Mouth	30` from D.Mouth	50` from D.Mouth	70` from D.Mouth	100` from D.Mouth
Temp. (°C)	19	19	19	18	18	18
pH	7.95	7.95	7.95	7.72	7.9	7.9
TSS (mg/1)	69	121	100	115	121	90
TDS (mg/1)	428	384	388	375	368	385
Zn(ppm)	B.D*	B.D	B.D	B.D	B.D.	B.D
Fe(ppm)	4.7	2.0	3,.0	3.0	1.6	2.4
Ca(ppm)	93	68	90	100	92	85
Cr(ppm)	B.D	B.D	B.D	B.D	B.D	B.D
Cd(ppm)	B.D	B.D	B.D	B.D	B.D	B.D
Mn(ppm)	B.D	B.D	B.D	B.D	B.D	B.D
Ni(ppm)	B.D	0.18	0.2	0.18	0.14	0.12

B.D* = Below detection limit.

Determination of total dissolved solids (TDS)

Ignited an evaporating dish for one hour at 550°C, cooled it in a desiccator and measured its mass. Filtered a volume, somewhat in excess of 100 cm^3 of well mixed sample under vacuum through whatman 540 filter paper. Maintained the vacuum for at least three minutes after filteration is complete, to remove as much water as possible. Transferred 100 cm^3 of the filtrate to the prepared evaporating dish and evaporated to dryness on hot plate. Cooled in desiccator. Dried the residue in an oven at 180°C for at least one hour. Cooled in desiccator and measured the mass.

Total dissolved solids (mg/dm^3) = $(m_1-m_2)x1000/V$

where

m_1 = is the mass of dried residue and dish in mg.

m_2 = is the mass of perpared dish in mg.

V = is the volume of filtered sample in cm^3.

Determinatio of total suspended solids (TSS)

Dried a Whatman 540 filter paper in an Oven at 105°C for 1 hour, cooled in a desiccator and measured its mass immediately before use. Assembled the filteration apparatus with Whatman 540 filter paper in position. Transferred 100 cm^3 of well mixed sample to the filter funnel, applied vacuum and washed the residue with three successive 20 cm^3 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.

Total suspended solid (mg/dm^3) = $(m_1-m_2)x\ 1000/V$

where

m_1 = is the mass of filter paper with residue in mg.

m_2 = is the mass of dried filter paper in mg.

V = is the sample volume in cm^3.

Determination of heavy metals

100 cm^3 of the unfiltered well mixed sample was taken in a breaker to which 10 mL of concentrated HNO_3, HCl mixture (1:3) was added. This mixture was evaporated, to 100 mL and then subjected to flame atomic absorption spectrometer PU 9100x for determination of metals, like Pb, Ag, Cu, Zn, Fe, Ca, Cr, Cd, Mn, and Ni, under the following operating parameters.

Metals	Wavelength (nm)	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	0.2
Ca	422.7	06	0.5
Cr	357.9	12	0.5
Cd	228.8	08	0.5
Mn	279.5	12	0.5
Ni	232	15	0.2

The flame used was air acetylene flame.

Conclusion

Amongst the industries studied Match facotires were found responsible for polluting the industrial effluents with Zn, Fe, Cr, Mn and TDS. Ceramics industries increase the concentration of total suspended solids, whereas ghee mills pollude water with Ni. Control measures for the decrease in concentration of Zn, Fe, Cr, Mn and TDS in the effluents of Match industries, TSS in the effluents of ceramics and Ni in the effluents of ghee mills are suggested.

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