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Study on Waste Waters of Metal Finishing Industries around Lahore Metropolitan Area

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Study was undertaken on the wastewater samples from metal finishing industries of Lahore metropolitan area for the evaluation of metallic impurities. The metal finishing industry was classified into three categories i.e. medium scale, small scale and cottage scale industry. About 93 wastewater samples were collected from various metal finishing industries around Lahore metropolitan area. In addition to toxic elements like cadmium, nickel and zinc the other parameters such as hydrogen ion concentration (pH), Electrical Conductivity (EC) and Total Dissolved Salts (TDS) were also determined.

Key words: Hazardous industrial waste, Pollution, Cation, Anion, TDS, EC, pH and Toxic metals.

Introduction

Increased industrialization on one hand and exploding population on the other, the demand of water supply has been increasing tremendously (Khan and Fayyaz Mahmood 1987). Moreover, sewage, industrial wastes and a wide array of synthetic chemicals pollute considerable part of this limited quantity of water. The menace of water-borne disease and epidemics still threatens the well being of population, particularly in under-developed and developing countries. For that reason, it is now universally being realized that any future developmental activity has to be viewed in the light of its ultimate environmental impact. Thus the quality as well as the quantity of clean water supply (Nikumbh *et al* 1998), WHO standards by (Mandel and Shiftan 1981) for drinking water is of vital significance for the welfare of mankind.

Experimental

The study comprises the followings steps:

(i) About 93 wastewater samples from various metal finishing industries around Lahore metropolitan area were collected.

(ii) The chemical parameters (Arthur 1961) e.g., Hydrogen ion concentration (pH), Electrical Conductivity (EC), Total Dissolved Salts (TDS) of the collected samples of waste water of metal finishing industries around Lahore metropolitan area.

(iii) Estimated the concentration of toxic metals of the collected samples of wastewaters of metal finishing industries around Lahore metropolitan area by Atomic Absorption Techniques (Reynolds and Aldous 1970) using the Hitachi Z-8000 A. A. with flame and graphite atomization systems.

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(iv) To interpret and evaluate the results with respect to metal pollution.

Results and Discussion

These industrial set up have not made any proper arrangement for the pre-treatment of the waste water. At numerous electroplating shops and the workers engaged in electroplating are exposed to very toxic fumes, especially in places where nitric acid is also used in one of the pre-treatment steps. During the sample collection, it was revealed that sickness leaves are very high and the people of those localities generally do not keep good health due to both the toxic fumes and contaminated wastewater. Most of these plating shops are located in slums and colonies inhabited by the lowincome group.

Metal finishing, which is the most important step of finishing industry, can be easily classified into three categories. (a) Medium scale industry, well organized having trained and skilled workers running the show, for example, Happy Agricultural Industry, a big vendor for the Automibile Industry, Rustam and Sohrab Cycle works Shahdra, Lahore, manufacturing motor cycles; bicycles, Treet Corporation Lahore a leading manufacturing of shaving blades.

(b) Small scale Industry catering to the needs of surgical goods, household items, small engineering items like nuts and bolts particularly again for the automobile industry, electrical fan industry, washing machine manufacturers, toys, miscellaneous.

(c) Cottage Scale industry established in small shops and in own residences, carrying out metal finishing jobs for artificial jewellery, optical frames, fasteners, chains, etc.

The waste water produced during electroplating process may come through 1-7 important steps:

(1) Surface cleaning. Greases of mineral oil are removed by emulsification with alkali mixture containing NaOH, Na_2CO_3, Na_3PO_4 and Na_2SiO_2, etc. or with the help of solvents such as benzene trichloroethylene. Water is discharged directly into the drains without any pre treatments, though it contains zinc, iron, phosphate etc. in it.

(2) Pickling or stripping. The degreased base metal is then treated with H_2SO_4 or HCL to remove scales and rust. This wash water and the spent pickle liquor (containing ferrous sulphates and unused acids) from the waste effluent. It has already proved that these elements through the irrigation system ends up in agricultural produce, eaten either by the human beings or cattle and eventually ending up in the human bodies.

(3) Platting. The pickled articles are electroplated in electrolytic cells containing plating baths as desired. The plating baths may be acidic or occasionally alkaline. Cyanides are gene-rally used in plating baths as they are good oxide solvents and yield brighter and less porous plates.

Among the plating waste cyanides concentrates and spent chromate bath, wastewater has received particular attention due to their toxicity. Apart from them, spent plating bath liquors from cadmium, lead, zinc, copper, and nickel plating operations, spills over, floor washes containing the above toxic chemicals and other compounds also from waste effluent from electroplating industry.

In Lahore and Gujranwala divisions, five zones (Dahrampura area and Chabucha place are rich of artifical jewellery skills). For artificial Jewellery the cadmium plating is often required as an ore-treatment. Misrishah, this zone is famous for the electroplating of general type hardware. Small to medium scale electroplating articles are also treated with zinc coating as a pre-treatment step. Some time gold and silver-plating of sophisticated articles were also carried out bright nickel, zinc plating. Singpura and Gore Shah Road are known for electroplating of auto parts with nickel and zinc. Baughman Pura, Crown Park and Sehar Road is famous for electroplating and bright nickel and cadmium plating of auto parts, Hardware and others miscellaneous jobs. Kot Khawaja Saeed is famous for electroplating of cadmium and nickel of hardware, bicycle parts, turbine parts, water and sanitary parts.

Most of the shops invoved in electroplating components were automobile industry which were engaged in electroplating of bright nickel and chromium only, whereas other who are producing house hold components, chains, fasteners were involved in the electroplating of mostly bright zinc on their deposits from the zinc cyanide baths. Shops involved in electroplating of decoration pieces, were using electroplating baths based on zinc cyanide and copper cyanide, highly poisonous and lethal chemical but ever using no specific safety measures and were rather astonished to see our representative using safety gadgets like gloves and boots.

(4) Hydrogen ion concentration (pH). The pH of the wastewaters of metal finishing industries Table 1 varies from very acidic to very alkaline, <1 for acidic to >10 for alkaline. However, the pH values of most of the samples falls around 7, which is neutral. Some of the samples from Zone-1 area show very alkaline conditions. The dangerous part of this data may be the lower pH values of a few samples from Zone-1, Zone-3, Zone-4 and Zone-5. Electrical Conductivity (EC) and Total Dissolved Salts (TDS).

The electrical conductivity of a solution is a direct measure of the total dissolved salts present in that solution. The values of EC vary from 375 uS/cm to 81m/cm. The TDS of wastewater samples from metal finishing industries from Lahore metropolitan varies from <1% to >11%. The higher values of TDS come from Zone-1 and Zone-4 in Table 1.

(5) Monitoring of zinc. The concentration of zinc (KanKyo Senta Nenpo 1999) varies from (0.01 ppm to 15.84 ppm) Table 2 in the wastewater samples of Zone-1, Zone-2, Zone-3 and Zone-4. The permissible limit of the discharge of zinc metal into the hydrosphere from metal finishing industries is about 4.2 ppm as set by US Federal EPA department. It is clear from this figure that many of the samples show higher degree of zinc discharge in the environment through wastewaters of metal finishing industries.

(6) Monitoring of cadmium. The concentration of cadmium (Jia *et al* 1997) varies from (0.08 ppm to 24 ppm) Table 2 in the wastewaters samples of Zone-4 and Zone-5. The permissible limit of the discharge of cadmium metal into the hydrosphere from metal finishing industries is about 1.2 ppm.

(7) Monitoring of nickel. The concentration of nickel (Johnson and Magnus 1998) varies from (0.06 ppm to 26.30 ppm) Table 2 in the wastewater samples of Zone-4 and Zone-5. The permissible limit of the discharge of nickel metal into the hydrosphere from metal finishing industries is about 4.1 ppm as set by US Federal EPA department.

Conclusion

The data for hydrogen ion concentration (pH) of 93 wastewater samples of metal finishing industries reveals that samples from Zone-1, Zone-3, Zone-4 and Zone-5 show lower pH values due to corrosive acids used for as pre-treatment thus tend to attack the cemented walls of the main holes and may cause the blockage of sewer systems in the city.

Table 1
TDS of waste water samples from metal finishing industries from Lahore metropolitan area

S.No	Area	Approx. discharge Gallons/day	pH WHO. Des. Range 7-8.5 WHO. Max. limit 6.5-9.2	Electrical Conductivity (mS/cm) WHO. Des. Range 250-2000 WHO max. limits 2000	TDS (ppm) WHO. Des. Range 1500 WHO max. limit<500
1	Zone-1	100-500	10.44	10.10	6464.00
2	Zone-1	-do-	10.37	10.70	6848.00
3	Zone-1	-do-	10.51	9.80	6272.00
4	Zone-1	-do-	10.68	13.00	8320.00
5	Zone-1	-do-	9.98	12.90	8258.00
6	Zone-1	-do-	10.17	12.95	8288.00
7	Zone-1	200-600	0.98	91.00	58240.00
8	Zone-1	-do-	0.91	88.70	56768.00
9	Zone-1	-do-	0.92	89.55	57312.00
10	Zone-1	300	7.16	5.14	3290.00
11	Zone-1	-do-	7.60	5.31	3398.00
12	Zone-1	-do-	7.66	5.90	3776.00
13	Zone-1	400	6.98	7.60	4864.00
14	Zone-1	-do-	6.91	7.50	4800.00
15	Zone-1	-do-	6.92	7.55	4832.00
16	Zone-1	500	10.55	11.10	7104.00
17	Zone-1	-do-	10.37	11.00	7040.00
18	Zone-1	-do-	10.27	10.70	6848.00
19	Zone-1	450	0.85	103.80	66432.00
20	Zone-1	-do-	0.87	104.20	66688.00
21	Zone-1	-do-	0.81	101.61	65030.00
22	Zone-1	500	0.85	181.00	115840.00
23	Zone-1	-do-	0.57	175.70	112448.00
24	Zone-1	-do-	0.58	176.00	112460.00
25	Zone-2	600	7.68	993.00 uS/cm	636.00
26	Zone-2	-do-	7.58	979.00 uS/cm	627.00
27	Zone-2	-do-	7.48	965.00 uS/cm	618.00
28	Zone-2	-do-	8.35	395.00 uS/cm	253.00
29	Zone-2	-do-	8.14	385.00 uS/cm	246.00
30	Zone-2	-do-	8.10	375.00 uS/cm	240.00
31	Zone-3	-do-	6.95	9.26	5926.00
32	Zone-3	-do-	6.88	9.21	5894.00
33	Zone-3	-do-	6.86	9.18	5875.00
34	Zone-3	-do-	6.24	878.00 uS/cm	562.00
35	Zone-3	-do-	6.17	866.40 uS/cm	554.00
36	Zone-3	-do-	6.10	857.50 uS/cm	549.00
37	Zone-3	-do-	2.10	2.58	1638.00
38	Zone-3	-do-	2.00	2.33	1491.00
39	Zone-3	-do-	1.98	2.10	1344.00
40	Zone-3	-do-	7.16	5.98	38274.00
41	Zone-3	-do-	7.14	5.85	3744.00
42	Zone-3	-do-	7.31	5.99	3834.00
43	Zone-4	-do-	6.51	3.80	2434.00
44	Zone-4	-do-	6.47	3.70	2368.00
45	Zone-4	-do-	6.41	3.65	2336.00
46	Zone-4	-do-	2.20	5.54	3546.00

(Cont'd.....)

(Table 1 Cont'd.....)

S.No	Area	Approx. discharge Gallons/day	pH WHO. Des. Range 7-8.5 WHO. Max. limit 6.5-9.2	Electrical Conductivity (mS/cm) WHO. Des. Range 250-2000 WHO max. limits 2000	TDS (ppm) WHO. Des. Range 1500 WHO max. limit<500
47	Zone-4	-do-	2.19	5.45	3488.00
48	Zone-4	-do-	2.17	5.40	3456.00
49	Zone-4	-do-	7.87	830.00 uS/cm	531.00
50	Zone-4	-do-	7.70	820.00	525.00
51	Zone-4	-do-	7.78	840.80	538.00
52	Zone-5	-do-	8.25	1343.00 uS/cm	860.00
53	Zone-5	-do-	8.13	1320.00 uS/cm	845.00
54	Zone-5	-do-	8.10	1305.00 uS/cm	835.00
55	Zone-5	-do-	7.62	2.22	1421.00
56	Zone-5	-do-	7.70	2.32	1485.00
57	Zone-5	-do-	7.87	2.55	1632.00
58	Zone-4	-do-	6.15	745.00 uS/cm	477.00
59	Zone-4	-do-	6.12	735.00 uS/cm	470.00
60	Zone-4	-do-	6.10	735.00 uS/cm	461.00
61	Zone-4	-do-	6.05	4.24	2716.00
62	Zone-4	-do-	6.00	4.20	2688.00
63	Zone-4	-do-	6.10	4.80	3072.00
64	Zone-4	-do-	3.19	47.50	30400.00
65	Zone-4	-do-	3.15	45.00	28800.00
66	Zone-4	-do-	3.70	44.00	28160.00
67	Zone-4	-do-	0.70	142.30	91072.00
68	Zone-4	-do-	0.79	148.00	94720.00
69	Zone-4	-do-	0.80	154.00	98560.00
70	Zone-4	-do-	6.04	844.00 uS/cm	540.00
71	Zone-4	-do-	6.03	834.00 uS/cm	534.00
72	Zone-4	-do-	6.01	844.00 uS/cm	5283.00
73	Zone-4	-do-	5.60	834.00	25600.00
74	Zone-5	-do-	5.58	30.00	24320.00
75	Zone-5	-do-	5.57	37.00	23680.00
76	Zone-5	-do-	3.24	955.00 uS/cm	611.00
77	Zone-5	-do-	3.25	945.00 uS/cm	605.00
78	Zone-5	-do-	3.21	930.00 uS/cm	595.00
79	Zone-5	-do-	7.46	1600.00 uS/cm	1024.00
80	Zone-5	-do-	7.49	1610.00 uS/cm	1030.00
81	Zone-5	-do-	7.46	1620.00	1037.00
82	Zone-4	-do-	7.50	2.80	1792.00
83	Zone-4	-do-	7.50	2.90	1856.00
84	Zone-4	-do-	7.30	2.65	1696.00
85	Zone-4	-do-	8.33	1.60	1024.00
86	Zone-4	-do-	8.29	1.58	1011.00
87	Zone-4	-do-	8.25	1.44	922.00
88	Zone-4	-do-	6.35	4.94	3162.00
89	Zone-4	-do-	6.40	4.98	3187.00
90	Zone-4	-do-	6.45	5.25	3360.00
91	Zone-4	-do-	1.83	13.20	8448.00
92	Zone-4	-do-	1.79	12.90	8256.00
93	Zone-4	-do-	1.88	12.98	8307.00

Table 2
The concentration of Zn, Cd and Ni in the waste water samples

S.No.	Area	(ug/ml)
Zn WHO Max. Conc. 5.0 ug/ml		
1	Zone-1	0.19
2	Zone-1	11.36
3	Zone-1	11.58
4	Zone-1	13.49
5	Zone-1	0.70
6	Zone-1	0.00
7	Zone-1	14.41
8	Zone-1	6.18
9	Zone-1	10.48
10	Zone-1	0.36
11	Zone-1	15.00
12	Zone-1	7.39
13	Zone-1	0.42
14	Zone-1	0.18
15	Zone-1	0.00
16	Zone-1	14.22
17	Zone-1	2.16
18	Zone-1	9.48
19	Zone-1	0.02
20	Zone-1	0.01
21	Zone-1	0.01
22	Zone-1	2.01
23	Zone-1	2.61
24	Zone-1	0.90
25	Zone-2	0.17
26	Zone-2	0.05
27	Zone-2	6.47
28	Zone-2	15.48
29	Zone-2	1.08
30	Zone-2	0.50
31	Zone-3	11.07
32	Zone-3	13.85
33	Zone-3	0.69
34	Zone-3	0.19
35	Zone-3	0.08
36	Zone-3	0.11
37	Zone-3	9.37
38	Zone-3	0.38
39	Zone-3	9.28
40	Zone-3	0.00
41	Zone-3	0.01
42	Zone-3	2.76
43	Zone-4	0.03
44	Zone-4	0.06
45	Zone-4	1.22

(Cont'd.....)

(Table 2 Cont'd.....)

S.No.	Area	(ug/ml)
Cd WHO Max. Conc. 0.01 ug/ml		
46	Zone-4	0.14
47	Zone-4	0.06
48	Zone-4	0.10
49	Zone-4	0.10
50	Zone-4	0.20
51	Zone-4	0.10
52	Zone-5	0.20
53	Zone-5	0.25
54	Zone-5	0.30
55	Zone-5	0.20
56	Zone-5	0.10
57	Zone-5	0.40
58	Zone-4	0.50
59	Zone-4	3.00
60	Zone-4	0.10
61	Zone-4	1.00
62	Zone-4	0.40
63	Zone-4	0.10
64	Zone-4	0.10
65	Zone-4	7.00
66	Zone-4	2.50
67	Zone-4	0.10
68	Zone-4	4.50
69	Zone-4	1.00
70	Zone-4	0.10
71	Zone-4	10.00
72	Zone-4	6.50
73	Zone-4	24.20
Ni WHO Max. Conc.		
74	Zone-5	14.70
75	Zone-5	26.30
76	Zone-5	6.50
77	Zone-5	1.00
78	Zone-5	9.40
79	Zone-5	1.60
80	Zone-5	1.80
81	Zone-5	4.20
82	Zone-4	20.60
83	Zone-4	3.00
84	Zone-4	7.30
85	Zone-4	2.60
86	Zone-4	0.50
87	Zone-4	24.90
88	Zone-4	24.70
89	Zone-4	13.00
90	Zone-4	0.06
91	Zone-4	0.30
92	Zone-4	7.80
93	Zone-4	21.50

The data for electrical conductivity (E.C.) reveals that the higher values of TDS come from Zone-1 and Zone-4, which have a direct effect on the discharge. The data for cadmium in the wastewaters reveals that the wastewaters samples of Zone-4 and Zone-5 show higher degree of cadmium discharge. Zinc in wastewaters show higher degree of zinc discharge in the environment through wastewaters of metal finishing industries. Nickel in the wastewaters of metal finishing industries around Lahore metropolitan area reveals that the higher degree of nickel discharge in the environment.

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