THE EXISTANCE OF CONTAMINATING HEAVY METALS IN WASTEWATER AT A NUMBER OF ELECTROPLATING PLANTS

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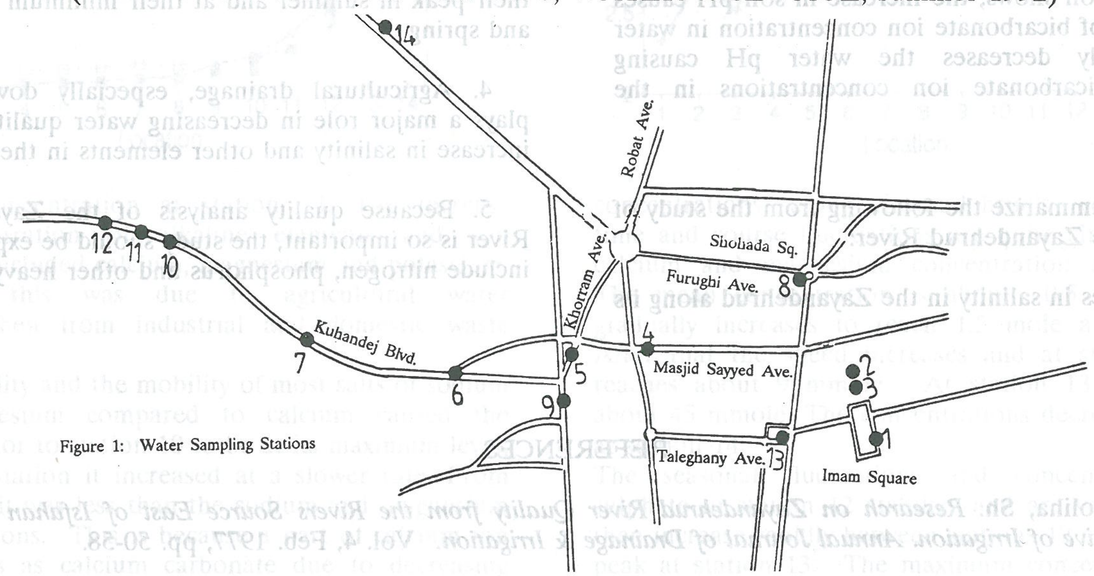

Figure 1: Water Sampling Stations

In this article the main chemical pollutants in electroplating processes were studied. The location, the methods of effluent disposal, and the concentration of five heavy toxic ions were measured for fifteen electroplating workshop effluents in the city of Isfahan, Iran. The analytical results show the range of concentrations as follows:

Cr^{3} Cr^{6+}	0.05	to	598 ppm
Ni^{2+}	30.0	to	960 ppm
Zn^{2+}	7.8	to	249 ppm
Cd^{2+}	0.01	to	0.75 ppm
Cu^{2+}	11.0	to	813 ppm

The minimum and maximum flow rates of these workshops were about 150 to 1000 liters per shift. The effluents were directed to dug wells, municipal sewage systems or surface waters. By comparing the heavy metals, concentrations in effluent with the threshold values, it is clear all workshops are working far beyond accepted standards. Disposal of these effluents into the environment may cause heavy metal ions to diffuse into ground water and damage agricultural crops as well. The practical and economical way to handle the problem is to settle all workshops in one location and treat the effluent in a common waste treatment plant.

INTRODUCTION

Pollution from heavy metal ions occuring in electroplating plants is most significant and dangerous to the environment, causing seepage to groundwater to form toxic compounds and potentially create danger for humans and their ecosystem.

The importance of protecting water resources and the increasing price of chemicals necessitates the study of contamination of surface and ground water simultaneously with the changes in the electroplating process in order to decrease waste water amounts. The electroplating industry is affected by several perameters. The main factors include: increasing cost of materials, i.e. materials for the electroplating process and the cost of water. Additionally, the environmental impact considerations include controling waste water and the disposal of hazerdous waste.

Table #1: The Mean Values of Analysis from 22 Electroplating Plants (EPA Report)

Effluent Concentration (mg/l)			
Pollutant	Minimum	Maximum	Average
Cyanide,total	<0.1	95.9	14.4
Copper	0.1	47.2	4.7
Nickel	<0.1	52.2	5.7
Chromium, total	0.1	178.0	20.2
Zinc	0.4	101.4	19.3
Lead	<0.1	3.0	0.4
Cadmium	<0.1	24.3	4.3

During electroplating, the main process is immersion of the parts in solution and then cleansing the layers of chemical materials on the surface--or drag out. If this process does not occur satisfactorily, what transpires is the waste of a few valuable chemicals, thousands of gallons of water, and money spent for pollution cleanup.

A report published by the EPA, titled "Control and Treatment Technology for Metal Finishing Industry in Plant Changes", gives information about reducing electroplating treatment methods and cleaning systems (Tbls. 1 & 2).In this regard, the study of electroplating processes and recent adjustments in processing can help us prevent wasting chemicals and conserving water by creating less waste water.

Changes in the process usually consist of techniques to decrease the amount of dragout in the solution and water consumption. The end result affects the cost of chemicals, water consumption, and the expenditure needed to treat waste water.

Sources of wastewater in the elctroplating centers usually differ. The most predominent sources are drag out, and cleaning baths in different steps of the electroplating process. The amount of pollution from this source depends on factors such as design, size and shape of parts, the concentration of electroplating solution, etc... The wastewater generated by the cleaning process consists of huge amounts of water containing cyanide and metal ions usually in concentrations between 15 to 100 mg. per liter from metals used in electroplating. Most electroplating plants use zinc, copper, chromium, nickel, cadmium, ect. cleaning bath methods.

The mixture of cleaning water causes the decrease in concentration of metals. Generally the amount of pollutants in electroplating waste water vary in different plants.

In some of these plants the trickling of electroplating solutions off the parts is the main source of pollution. The cleaning tanks are usually placed a few meters from each other. The carrying rods are placed between the tanks and cause the electroplating solution to trickle off the parts to the ground or enter the wastewater discharge system.

Table 2: Analysis of solution used in electroplating process discharge period (from G.P.A. Report)

Pollutant or Parameter	Sample solution: Alkaline Cleaner 1	Alkaline Cleaner 2	Alkaline Cleaner 3	Electrocleaner	Acid dip 1	Acid dip 2	Acid dip 3
Volume (gal)	325.0	340.0	338.0	390.0	65.0	50.0	165.0
Cyanide total (mg/L)	2.5	85.5	2.8	1.3	(a)	(a)	(a)
Cadmium (mg/L)	0.2	2.6	0.4	0.8	6.4	0.1	1.99
Chromium, total (mg/L)	40.0	(a)	0.1	36.5	39.2	10.8	(a)
Copper (mg/L)	58.1	19.4	10.9	1.9	121	0.1	(a)
Nickel (mg/L)	6.9	0.9	0.3	5.2	128.0	0.6	(a)
Lead (mg/L)	4.4	(a)	0.7	1.9	11.6	0.1	(a)
Zinc (mg/L)	1.2	74.0	162.0	10.5	365.0	5.2400	(a)

a: Solution was not analyzed for particular pollutant.

MATERIALS & METHODS

Amounts of pollution from heavy metal ions in electroplating wastewater from fifteen plants in Isfahan: The concentrations of some heavy metal ions consisting of Cu^{2}, Cd^{2+}, Ni^{2+}, Cr^{3+}, Cr^{6+}, and Zn^{2+} in waste water samples were measured.

Sampling from the Waste Water

The most important task in this study was sampling waste water from these plants. Some of the difficulties were as follows:

1. Unstable volume of daily waste water.
2. Direct discharge of waste water into the municipal waste water system.
3. Changes in the processes due to differng work orders from the plants.
4. Lack of concise information given by plant owners.
5. Different schedules for waste water discharge.

SAMPLING METHOD

The sampling began in summer 1367 (1988) and lasted one year. Each day one liter was taken hourly from the wastewater and poured in a bucket. At the end of the day shift, all samples were poured into a larger bucket and mixed. Since the factory's pool was emptied every few days, a sample was taken from each bucket. Samples were taken according to the ratio of the duration of emptying the collection pool to the volume of the sample.

If the kind of material to be electroplated differed, a separate sample was taken. Then all samples were poured into one large bucket readied for a one liter sample analysis.

ANALYSIS METHOD FOR WASTE WATER

We used various methods for measuring metalic ions concentrations, including atomic absorbion.

RESULTS

The results of the analysis of samples from fifteen plants in this study included the location of electroplating, volume of water consumption in each shift, and the discharge location (table 3).

DISCUSSION & RESULTS

Discharge of waste water from electroplating plants mainly occurs into municipal sewage systems and holding wells. Each method has its own dangers and disadvantages for the environment. A study was conducted briefly as follows:

With respect to the importance of industrial waste-water entering ground water, geologic and topographical studies of the Isfahan plain show the most impermeable regions are located in the center and east; whereas the western part of the plain is most permeable. The depth of the wells required to reach the water table is more in the south than in the north and west. The minimum and maximum depth is about 2 to 15 meters. The chance of pollution to ground water is greatest at the locations of electroplating plants between Khorram St., Kohandej Blvd, and

Table 3 : The Results of Analysis of Wastewater from 15 Electroplating Plants in the City of Isfahan

plant number	location	type of electoroplating activities	amount of water used per shift in liters	discharge site for effuent	concentration of metalic ions mg/l: zn^{2+}	cu^{2+}	ca^{2+}	Ni^{2+}	cr^{6+}
1	Imam Sq.	copper handycrafts	75	holding well	104	112	0.2	587	.19
2	Imam Sq.	samovars & utensils	1000	holding well	12.4	47	0.6	288	120
3	Imam Sq.	samovars & utensils	500	holding well	7.8	12	0.06	259	55
4	Masjid Sayyid St.	automobile fenders	1000	holding well	114	273	0.19	292	193
5	Khorram Ave.	samovars & utensils	500	city sewer system	212	81	0.17	409	26
6	Kohandej Blvd.	samovars & utensils	150	holding well	23	37	0.06	50	0.96
7	Kohandej Blvd.	automobile fenders	150	holding well	12	14	0.07	121	204
8	Shohada Sq.	electroplating costume jewelry	1000	holding well	20	310	0.08	249	175
9	Khorram St.	brass lamps and mirror frames	700	sewer	8.6	65	0.06	960	48
10	Kohandej Blvd.	samovars & utensils automobile fenders	200	sewer	9	12	0.08	185	10
11	Kohandej Blvd.	metal frames & utensils	150	sewer	0.3	110	0.08	658	0.05
12	Kohandej Blvd.	utensils	150	holding well	250	14.5	0.75	48	12
13	Imam Sq.	samovars, utensils, fenders	1000	stream	15	220	0.15	155	205
14	Darvazdolat Sq.	trays and utensils	500	sewer system	21	250	0.08	210	140
15	Oshtorjan Indust. Dist.	hospital equipment & other industrial parts	n/a	conserving pond	10.5	51	0.01	30	598

Imam Square. The survey done on the waste water from those plants shows that, without exception, it causes environmental pollution.

Each plant produces more pollution in relation to specific ions. For example, cadmium in unit 12, which discharges its waste water in a dug well, can be cited as the most dangerous. Unit #15 for chromium ions, #11 for nickel ions and #5 for copper ions have the most pollution effects. Units 1,2,3, which discharge their waste water directly into holding wells, can cause ground water pollution. Units #4 and #5 discharge their waste water into the municipal sewer and can cause problems for the Isfahan waste water treatment plant.

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