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SHORT COMMUNICATION (II)

A Study of Wastewater Discharge from Electroplating Factories

RINGKASAN

Air buangan dari dua kilang sador-elektrik telah dianalisa. Paras logam-logam berat dan sianida dalam air buangan dari kilang tanpa kemudahan bagi tindakan ke atas air buangannya melebihi had-had yang dibenarkan. Kehadiran pencemar-pencemar ini merbahaya kepada kesihatan alam sekitar.

Kualiti air buangan dari kilang dengan kemudahan bagi tindakan ke atas air buangannya bersesuaian dengan piawai air.

INTRODUCTION

There are some fifteen electroplating factories in Kuala Lumpur and Klang area, specializing in various forms of plating, namely chromium, zinc, silver and occasionally, cadmium. Almost all of these electroplating factories do not have any facilities for wastewater treatment. Wastewater containing cyanide and metallic ions like copper, nickel, chromium, lead, zinc, silver and others is discharged directly into drains. The presence of these pollutants can pose a health hazard to the environment if their levels exceed certain allowable limits. The present study is an attempt to determine the extent of cyanide and metal pollution in the wastewater of a typical electroplating factory without wastewater treatment and to compare the quality of its wastewater with another with treatment facilities.

Description of Factory, Process and Sampling Points.

Wastewater discharge was collected from factories X and Y. Factory X is involved in chrome, zinc and silver plating and does not provide any facilities for wastewater treatment. Factory Y has a complete wastewater treatment plant and specializes only in chrome plating. In both factories the material to be chrome-plated is first dipped into a copper bath, followed by a nickel bath to provide a suitable base before the final coating of chrome.

In factory X, the rinse water after each metal plating bath is discharged down the drain without any form of treatment at the end of each day.

In factory Y, overflow of rinsewater is collected in an acid waste tank and alkaline waste tank according to its pH. From the acid waste tank AC(I), the wastewater is pumped into acid waste treatment tank AC(II) where pH is adjusted to about 2 before addition of sodium metabisulphite. This reduces hexavalent chromium to trivalent chromium. The pH is then readjusted to between 10–11 and pumped into the combination tank AC/AL. Wastewater from the alkaline waste tank AL(I) is pumped into the alkaline waste treatment tank AL(II) where pH is raised to 14 before addition of sodium hypochlorite to destroy the cyanides. After this the pH is readjusted to about 10 before the solution is pumped into AC/AL. Wastewater in AC/AL is then pumped back into AL(II) for a second cycle of treatment. It is then pumped into the sedimentation tank SII where the metal hydroxides settle down as a sludge. The second sedimentation tank F.D. ensures that settlement of sludge is complete. The pH of the water is then adjusted to about 7 before it is finally discharged.

METHODS

Metallic ions were analysed using an atomic absorption spectrophotometer IL 651. Hexavalent chromium was determined colorimetrically using diphenyl carbazide as given in 'Standard Methods for The Examination of Water and Wastewater (1971)'.

Free cyanide level was determined by colorimetric method using a pyridine-pyrazolone mixture as reported by Epstein (1947). Total cyanide was determined in similar way after EDTA treatment to free the complexed cyanide.

Duplicates were carried out in all the colorimetric analyses.

TABLE 1

Concentration of ions in wastewater from electroplating factory X ($\mu g\ cm^{-3}$)

Samples*	pH	Cu	Ni	Cr hexavalent	Cr trivalent	Zn	Ag	Pb	CN–(free)	CN–(total)
E_1	3.0	1.91	36.50	1.34	77.41	–	–	–	–	–
E_2	10.3	–	–	–	–	–	16.85	–	77.75	–
E_3	11.9	–	–	–	–	92.00	–	–	268.75	–
E_4	2.6	5.48	37.30	1.25	184.25	239.00	–	1.11	–	–
E_5	8.6	62.00	–	–	–	–	–	–	1.50	61.50
E_6	5.6	0.50	105.00	–	–	–	–	–	–	–

*E_1 rinse water from chromic acid bath
E_2 rinse water from silver bath
E_3 rinse water from zinc bath
E_4 washings from the floor
E_5 rinse water from copper bath prior to chromium bath
E_6 rinse water from nickel bath prior to chromium bath
The values listed for all the heavy metals except Cr(VI) were the means of four readings; Cr(VI) and cyanide samples were run in duplicates.

TABLE 2

Concentration of ions in wastewater from electroplating factory Y ($\mu g\ cm^{-3}$)

Locations*	pH	Cu	Ni	Cr hexavalent	Cr trivalent	Pb	CN–(free)	CN–(total)
Al (I)	9.00	31.65	0.43	<0. 01	1.30	–	1.60	87.86
Al (II)	11.00	27.60	1.73	<0. 01	47.10	0.34	<0.02	–
AC (I)	2.2	39.30	0.36	<0. 01	56.60	0.95	–	–
AC (II)	3.0	25.35	7.60	<0. 01	178.50	0.78	–	–
AL/AC	13.8	0.98	0.36	<0. 01	5.28	0.25	<0.02	<0.02
S II	10.0	14.64	2.08	<0. 01	45.60	0.22	<0.02	<0.02
FD	12.0	0.95	0.36	<0. 01	4.71	0.34	<0.02	<0.02

* AL(I) alkaline discharge
AL(II) treatment tank of AL(I)
AC(I) acid discharge
AC(II) treatment tank of AC(I)
AL/AC Combination tank of AC(II)/AL(II)
S II 1st sedimentation tank
FD 2nd sedimentation tank

The values listed for all the heavy metals except Cr(VI) were the means of four readings; Cr(VI) and cyanide samples were run in duplicates.

RESULTS AND DISCUSSION

The levels of metals and cyanide in the wastewater of factory X and those in AL(I) and AC(I) of factory Y are in the same order of magnitude. In the wastewater of factory Y that is ready to be discharged, the levels of metals have been reduced to below 1 $\mu g\ cm^{-3}$ except trivalent chromium. The levels of free cyanide in factory X have values of 1.50, 77.75 and 268.75 $\mu g\ cm^{-3}$ in the rinse water of copper, zinc and silver baths respectively. These high levels of free cyanide can probably be accounted for by the fact that they are all cyanide baths. The level of free cyanide in factory Y after treatment is below 0.02 $\mu g\ cm^{-3}$. This suggests that the treatment is effective.

Wastewater discharge from factory X does not comply with the standards for industrial effluents in Malaysia (1979). This is to be expected since there is no treatment at all. For factory Y, all the metal concentrations except trivalent chromium comply with standard B. The cyanide level being below 0.02 $\mu g\ cm^{-3}$ complies with both standard A and B which are 0.05 and 0.10 $\mu g\ cm^{-3}$ respectively. Standard A is applicable to discharge of effluents into inland waters within the water supply catchment areas whereas standard B is applicable to discharge of effluents into any other waters.

Copper and zinc are both toxic metals. According to Neri *et al.* (1974) excess copper induces zinc deficiency and increased zinc: copper ratio produces an increase in serum cholesterol in human bodies. Copper is also known to be especially toxic for algae, aquatic plants and molluses (Hartung, 1973). The level of copper ranges from 0.50 to 62.00 $\mu g\ cm^{-3}$ while that of zinc ranges from 92.00 to 239.00 $\mu g\ cm^{-3}$ in the wastewater of factory X. These levels far exceed the allowable limit of 1.0 $\mu g\ cm^{-3}$ for both copper and zinc.

Both nickel and chromium are known to be carcinogenic (Hueper, 1974). Chromium is also known to be toxic for algae (Hartung, 1973). In view of this, the presence of 105 $\mu g\ cm^{-3}$ of nickel in the rinsewater of nickel bath in factory X cannot be taken lightly. The level of hexavalent chromium (1.34 $\mu g\ cm^{-3}$) more than doubles the allowable limit (0.05 $\mu g\ cm^{-3}$). It, therefore, poses a potential hazard to both human health and aquatic life.

The toxicity of lead is well documented (Smith and Waldron, 1974; Chisolm, 1971). Lead in the wastewater of electroplating industry comes from the lead anode used in the chromic acid bath. The detected level (1.11 $\mu g\ cm^{-3}$) is high enough to warrant a better control of the lead used.

Cyanide is lethal to human beings if taken orally. A single excessive dose may produce acute poisoning and rapid death (Durham, 1974). Its presence in water also has a significant effect on the biologic activity of the system. Dodge and Reames (1949) reported that the threshold limit of toxicity at infinite time for fish appears to be 0.1 $\mu g\ cm^{-3}$. In the wastewater of factory X, the level ranges from 1.50 to 268.75 $\mu g\ cm^{-3}$. Its implication therefore needs no elaboration.

CONCLUSION

The extent of metal and cyanide pollution in the untreated wastewater of an electroplating factory is a potential threat to human health as well as aquatic life. A closer look at electroplating factories is required to estimate the severity of the problem. In a factory with treatment facilities, the quality of water is acceptable.

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