Heavy Metal Concentration of Exhausted Dye Bath Effluents

by A. NETZER, H. K. MIYAMOTO, and P. WILKINSON
Water and Wastewater Treatment Research
Canada Centre for Inland Waters
P.O. Box 5050
Burlington, Ontario L7R 4A6, Canada

Effluents from textile mill dyehouses can create serious environmental hazards. These wastes inevitably contain a substantial concentration of soluble organics, suspended solids, dissolved salts, and are characterized by aesthetically objectionable colours. Many commercial dyes and auxiliary textile chemicals are proven carcinogens (PORTER 1972).

However, it is not widely realized that these effluents also contain significant amounts of various heavy metals. Zinc, chromium, lead, copper, mercury and nickel are the most prevalent. These metals originate from several sources. Zinc, copper and chromium may be present as an integral part of numerous dyes. Furthermore, during the manufacture of dyes, several heavy metals are retained in the final product in the form of impurities originating from intermediate compounds or catalysts employed in the synthesis. Process chemicals involved in the dyeing, and various compounds used for improving washfastness, lightfastness, and for imparting flame retardancy and permanent press to the fabric may also contribute significantly toward the total heavy metal pollution load originating from textile mills (ADMI 1972).

Presently, research is being conducted at the Canada Centre for Inland Waters to study the treatability of dye effluents by biological and physical/chemical means.

EXPERIMENTAL

Effluents for the experiments were collected from three different types of dyeing establishments: hat; carpet; and yarn dyeing. The hat maker is engaged exclusively in dyeing rabbit fur while the other operations dyed mainly acrylic and nylon fibres.

Bulletin of Environmental Contamination & Toxicology,
Vol. 14, No. 3 © 1975 by Springer-Verlag New York Inc.

Table 1

CONCENTRATION OF HEAVY METALS IN DYE EFFLUENTS

SAMPLE NO.	METAL mg/l						DESCRIPTION OF DYEING OPERATION
	Cr	Ni	Cu	Pb	Zn	Mg	
1	—	0.20	1.8	0.27	3.20	0.80	HAT (rabbit fur)
2	—	0.60	1.9	0.90	1.60	1.20	
3	—	0.96	—	—	3.50	---	
4	—	0.10	1.2	0.25	1.80	1.00	
5	—	0.16	2.2	0.60	4.40	1.70	
6	—	0.14	1.8	1.90	2.90	1.90	
7	170.00	—	—	1.20	0.69	1.10	
8	0.83	—	2.5	1.40	3.90	1.20	
9	—	—	—	—	4.40	---	CARPET
10	—	—	0.75	0.25	0.59	---	
11	—	—	—	—	54.00	---	
12	—	—	0.12	0.10	0.33	---	
13	—	—	4.20	0.10	0.10	---	
14	—	—	—	—	0.14	---	
15	—	—	3.40	0.25	0.42	---	
16	—	—	—	1.00	0.30	---	
17	0.35	—	—	1.50	0.71	---	YARN
18	—	—	—	4.00	58.00	---	
19	—	—	—	—	0.20	---	
20	—	—	—	—	0.40	---	
21	—	—	—	—	0.26	---	
22	—	—	0.15	—	1.80	0.50	
23	—	—	0.20	—	0.50	---	
24	—	—	—	1.10	0.50	---	
25	—	0.50	0.60	0.45	0.95	10.00	
26	—	0.10	—	—	1.20	1.30	
Frequency of Detection	3/26	8/26	13/26	15/26	26/26	11/26	EPA effluent limitations schedule A (after 1977)
	0.05(+6) 0.25(+3)	1.0	0.2	0.05	0.05	NA	
Detection Limit	0.1	0.1	0.1	0.1	0.1	0.5	

After collecting the effluents, portions were filtered through a 0.45 micron Millipore filter and acidified with concentrated nitric acid. The samples were then analyzed for heavy metals by a Perkin Elmer Model 403 atomic adsorption spectrophotometer. Table 1 shows the concentration of the various metals found in these effluents, the detection limits for these procedures and the proposed Environmental Protection Agency limitations for heavy metal discharges from textile mills for 1977.

RESULTS AND DISCUSSION

At least one heavy metal was present in each dye effluent at a significantly high concentration. Zinc in excess of the proposed E.P.A. limitations was found in all the effluents. Lead and copper were detected in about fifty percent of the effluents at concentrations exceeding 0.1 ppm. Nickel was found in about one-third of the samples at levels in excess of 0.1 ppm. Fifty percent of the samples revealed the presence of mercury in excess of 0.5 ppm. Surprisingly, chromium was found in only three of the samples although many of the dye formulations encountered contained several pre-metallized chrome dyes. It appears, however, that such dyes are easily adsorbed onto the fabric fibre leaving only trace amounts of chromium in the spent effluent if the dyebath is properly exhausted.

Because heavy metals are a known public health hazard, some form of treatment (e.g. lime precipitation, ion-exchange, carbon adsorption, etc.) should be provided for such effluents prior to their discharge into a municipal sewer system or open watercourses.

REFERENCES

1. AMERICAN DYE MANUFACTURER'S INSTITUTE, Textile Chem. Colorist. 4:275(1972).
2. LESLIE, M.E.: Amer. Dyestuff Reporter, 58: 15(1974).
3. PORTER, J.J.: Water Wastes Engrg., 9(1): A8(1972).
4. SOCIETY OF CHEMICAL INDUSTRY IN BASLE: The dyestuffs of the society of chemical industry in Basle and their application, vol. IIb, hat dyeing, 3rd ed., Basle (1938).