Bull. Environm. Contam. Toxicol. 23,227-230 (1979)

Adsorption of Mercury and Copper by Ground Rubber in Packed Columns

G. R. Lightsey[1] and Richard W. Henderson[2]

[1]Department of Chemical Engineering, Mississippi State University, Mississippi State, Miss. 39762, and [2]Department of Chemistry and Physics, Francis Marion College, Florence, S.C. 29501

The combining of industrial and municipal waste offers many advantages and is gaining in popularity. However, certain metal ions present in industrial wastes can be a long term hazard (ANONYMOUS 1973, BERROW and WEBBER 1972, DAVIES 1972, WEBBER 1972).

Metal ions can be removed from water by several methods, including ion-exchange, activated carbon, and reverse osmosis (SMITH 1973). Previous work has shown that peanut hulls, raw southern pine bark, and composted bark will remove significant amounts of various heavy metal ions from solution (HENDERSON et al. 1977a). The present investigation concerns the removal of Hg and Cu ions from solution by ground scrap rubber.

MATERIALS AND METHODS

Material

The rubber used was finely ground rubber scrap from tire retreading operations (average particle size of 909 microns). Approximately 70,000 tons/yr of this type rubber is produced in the U.S. and costs about $5 per ton.

Reagents

A solution of Hg and Cu at the concentrations expected in municipal wastewater (ABBOTT 1971) was made by dissolving the reagent grade metal salts $HgCl_2$ and $CuCl_2$ in distilled water.

Method

The Hg and Cu solution was contacted with the ground scrap rubber using a 6 ft, 1.5 inch ID plexiglass column packed with 1100 g of the rubber. Four sampling ports were located at 1.5, 3.0, 4.5, and 6.0 ft from the entrance to the column. The feed rate, which was delivered in an up-flow mode at a constant 20 ft of head, was varied from 150 to 500 cc/min (8.6 to 28.6 bed volumes/h). Samples were collected periodically from the sampling ports and the Hg and Cu concentrations were measured.

Atomic Absorption was used to analyze the heavy metal concentrations. The conditions used for each element studied were those specified in the Perkin-Elmer manual, "Analytical Methods for Atomic Absorption Spectrophotometry".

0007-4861/79/0023-0227 $01.00

All solutions were stored in polyethylene bottles to guard against container adsorption (KING et al. 1974).

DISCUSSION OF RESULTS

The results of the experiment are shown in Figure 1. The Hg concentration of the filtrate at a 1.5 ft bed depth tended to decrease with lower flow rates. This was expected since lower flow rates increases the contact time between the solution and the rubber. Unexpected was the tendency of the concentration of Hg in the filtrate to decrease with time rather than increase as the adsorption capacity of the rubber was exhausted. Apparently the poor wetting of the rubber prevented the solution from contacting the entire rubber surface during the initial stages of the experiment.

As seen in the concentration versus bed depth curve, rubber will remove essentially all the Hg from solution if given sufficient contact time. It was interesting to note that approximately the same amount of Hg was removed in each section of the column (e.g. 0-1.5, 1.5-3.0 ft. etc.). Apparently the contact time and not the concentration of Hg is the controlling factor in determining the rate of adsorption.

The adsorption capacity of the rubber for Hg is in excess of 0.16 mg/g. This compares to previous batch equilibrium tests which showed ground rubber scrap to have an adsorption capacity of 0.8 mg Hg/g rubber (HENDERSON et al. 1977b).

The concentration of Cu in the filtrate at the 1.5 ft depth also decreased as the flow rate was reduced. However, after approximately 4 bed volumes of through put, the rubber removed only a small amount of the Cu from solution regardless of flow rate. Based on a flow of 4 bed volumes, the breakthrough adsorption capacity of the rubber is approximately 0.126 mg/g. This compares to an adsorption capacity of 0.22 mg Cu/g for rubber found in equilibrium batch test (HENDERSON et al. 1977b).

Almost 80% of the Cu is removed by passing the solution through six ft of ground rubber even at flow rates as high as 500 cc/min. At lower flow rates less bed depth is required for the same percentage removal of Cu.

ACKNOWLEDGEMENT

This work was supported by a Faculty Research Grant from Francis Marion College.

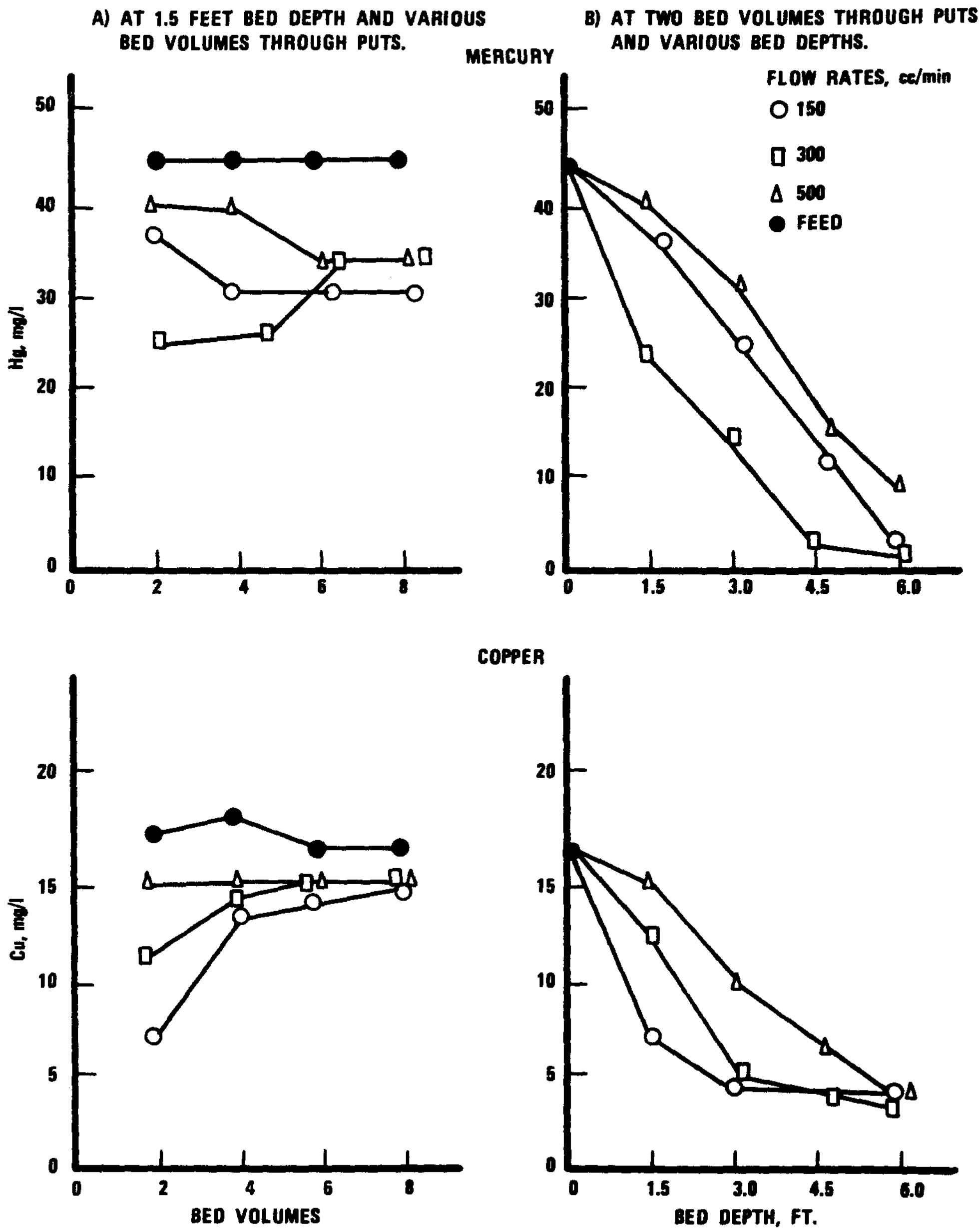

FIGURE 1

ADSORPTION OF Hg AND Cu FROM SOLUTION BY GROUND SCRAP RUBBER.

REFERENCES

ANONYMOUS: Water and Sewage Works, July 1973, p. 50.

BERROW, M. L., and J. W. WEBBER: J. Sci. Food Agric. 23, 93 (1972).

DAVIES, R.: Water and Poll. Contr. 109, 19 (1972).

HENDERSON, R. W., G. R. LIGHTSEY, and N. A. POONAWALA: Bull. Environ. Contam. Toxicol. 17, 355 (1977a).

HENDERSON, R. W., G. R. LIGHTSEY, and N. A. POONAWALA: Bull. Environ. Contam. Toxicol. 18, 340 (1977b).

KING. W. G., J. M. RODRIGUEZ, and C. M. WAI: Anal. Chem. 46, 771 (1974)

SMITH, S. B.: Traces of Heavy Metals in Water-Removal Processes and Monitoring. E.P.A. Report No. 902/0-74-001, Nov. 1973, p. 55.

WEBBER, J.: Water Poll. Contr., p. 405 (1972).