

# FATE AND EFFECT OF COPPER ON THE PERFORMANCE OF A ROTATING BIOLOGICAL CONTACTOR

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## INTRODUCTION

The rotating biological contactor (RBC) is a fixed-film biological treatment system which is gaining increased acceptance for purification of sewage from small and medium size communities. It is also being used at certain industrial installations. Recently, Olem and Unz (1980) reported that continuous oxidation of ferrous iron was accomplished biologically by an RBC unit. The hold that the RBC has gained is due to: predictable performance, short process detention time, excellent shock and toxic load capabilities; high efficiency in carbon and nitrogen removal, good sludge settleability and filterability and low capital, operating and maintenance costs (Antonie and Welch, 1969; Antonie et al ., 1974; Antonie, 1976 and Clark et al., 1978)

Since practically many sewage treatment plants receive combined wastewater containing heavy metals, it is of significance to study their fate and impact on biological treatment facilities. Whereas it is possible to trace down in literature several studies for the removal of a wide range of metals by the two conventional treatments (Stoveland and Lester, 1980 and El-Gohary et al., 1982), there is still a need to assess their interaction and behaviours within the RBC system. Copper was chosen for this study.

## OBJECTIVES

The specific objectives of this study include: (1) Performance evaluation of RBC as a function of rotational speed and organic load. (2) The toxic effect and distribution pattern of copper in the RBC system.

## MATERIALS AND METHODS

A laboratory-scale RBC unit was constructed. The reactor, 14 cm diameter and 40 cm length, provides a specific surface area of 56.55 cm<sup>2</sup> per cm of reactor length available for biological film growth. To assure uniform waste characteristics and avoid great fluctuations in sewage composition, the system was fed with synthetic sewage. The hydraulic load was maintained constant at 11 cm<sup>3</sup>cm<sup>-2</sup>d<sup>-1</sup>.

Copper was dosed as copper sulphate solution via constant speed pump and mixed with the feed prior to entry into the system.

All parameters were analyzed in accordance with procedures described in "Standard Methods" (APHA, 1980). Copper ion concentrations were determined using atomic absorption spectrophotometry.

## RESULTS

### Effect of Rotational Speed

As control, the system was operated without copper addition. The organic load was kept constant at  $1.23 \text{ mg BOD}_5 \text{ cm}^{-2} \text{ d}^{-1}$ . Rotational speeds of 4.0, 8.0, and 12.0 rpm were tested.

After reaching a steady state, the continuous flow RBC unit was subjected to increasing doses of copper, namely 0.5, 1.0, and  $2 \text{ mg l}^{-1}$ . The effect of each copper dose was investigated for a period of four weeks after reaching the steady state.

From the results obtained one would conclude that rotational speed has no significant effect on RBC performance at the investigated organic load. Also, continuous feeding of up to  $2.0 \text{ mg Cu l}^{-1}$  exerted no reduction in the efficiency of the system. Analysis of total and soluble copper in the effluents indicated that the rotational speed has no effect on the capacity of the system for removing copper. However, increasing copper concentration in the feed from 0.5 up to  $2.0 \text{ mg Cu l}^{-1}$  raised total and soluble copper in the effluent from 0.12 and 0.08 to 0.91 and  $0.51 \text{ mg l}^{-1}$ , respectively. Measurements of copper concentration in the sludge produced indicated the high capacity of the biofloc for copper accumulation.

### Effect of the Organic Load

To assess the impact of increasing the organic load applied to the system on the efficiency of the RBC for copper removal, a control run, without copper addition was carried out. The hydraulic load was kept constant and the organic load was raised to  $2.46 \text{ mg BOD}_5 \text{ cm}^{-2} \text{ d}^{-1}$  by increasing influent concentration.

The results obtained showed that the efficiency of the system is not affected by increasing the organic load or varying the rotational speed. Therefore, a constant rotational speed of 4 rpm was chosen to examine the effects of continuous feeding of increasing copper doses. The results obtained revealed that the organic removal efficiency is unaffected by copper addition.

However, residual copper in the effluent decreased by increasing the organic load and was accompanied by higher copper accumulation in the produced sludge, compared to the lower load.

### Sludge Production

Sludge production and the specific growth rate of the biomass ( $\mu$ ) were determined during the different operating conditions.

A proportional relationship between copper concentration in the feed

and its concentration in the sludge at a constant rotational speed of 4 rpm and different organic loads was recorded.

#### DISCUSSION

Available data indicates that increasing the organic load applied to the system, led to an increase in the capacity of the RBC unit for removing copper. This is due to the fact that more than 76 percent of copper removed from the system is associated with the biomass. Therefore, copper removal and toxicity depends on the ratio between biomass production and copper ion concentration, rather than copper concentration alone. These findings are in agreement with those given by Buch (1971) and Adams et al. (1975). Moreover, high organic and inorganic substrate concentration in the wastewater may also enhance the formation of copper complexes (that is, organo-copper complexes, copper-amine complexes) and can reduce the toxicity of copper significantly.

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