

## Environmental Competition

### BACKGROUND

The removal of heavy metals from industrial wastewaters is an important unit process in environmental engineering. Acidic, metal-laden wastewaters are often produced in industrial processes (e.g., metal plating). These wastes must be “pretreated” (i.e., pH must be adjusted and most of the metals must be removed) before the wastewater can be discharged to a municipal wastewater treatment plant. Metal removal by chemical precipitation, typically of metal hydroxides, is the most common method of pretreatment of metal-containing wastewaters. Metal removal by chemical precipitation is sometimes complicated by the presence of complexing or chelating agents in the wastewater. These complexing agents can affect both the theoretical minimum metal concentration and the corresponding optimum pH value for treatment.

### PROCEDURE

Each team will treat the following wastewater via chemical precipitation using the available additives and equipment. After this, each team will decant their treated water (i.e., separate their treated water from the precipitates) and readjust the pH to an acceptable range for discharge to a municipal wastewater treatment plant (pH 6-8). Each team meeting the pH criteria will submit a sample for analysis of total copper by atomic absorption spectrophotometry. The goal of the competition is to produce pretreated water with the lowest concentration of copper possible while minimizing unnecessary chemical addition. Total copper concentration and conductivity (as a measure of chemical addition) will be used to rank the competitors. Teams will be given one hour and thirty minutes from the start time to the submittal time to complete all parts of this competition.

### WASTEWATER COMPOSITION (1 L per team)

$10^{-3}$  M  $\text{CuCl}_2$

$10^{-4}$  M nitrilotriacetate (NTA)

pH 3 (via nitric acid)

### AVAILABLE ADDITIVES

Caustic (NaOH) - 1 M solution

Calcium Chloride ( $\text{CaCl}_2$ ) - 100 g/L solution

Ferric Chloride ( $\text{FeCl}_3$ ) - 50 g/L solution

Alum ( $\text{Al}_2(\text{SO}_4)_3$ ) - 50 g/L solution

Sodium Carbonate ( $\text{Na}_2\text{CO}_3$ ) - 10 g/L solution

Nitric Acid ( $\text{HNO}_3$ ) - 0.1 M solution

### AVAILABLE EQUIPMENT

Litmus paper

Stirring Rod

Treatment Tank (1 L beaker)

50 mL graduated cylinders

Burets



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Adjustable Pipettes

## TEAM REQUIREMENTS

Each team must have safety glasses for all members. No more than 4 members are allowed for each team

