CE 326 Principles of Environmental Engineering

JAR TEST

BACKGROUND

Coagulation and flocculation are important unit processes in water and wastewater treatment plants. The purpose of coagulation/flocculation is to remove suspended matter, turbidity, color, microorganisms, and odor producing substances. Coagulation involves the addition of chemicals to destabilize [allow them to agglomerate] the suspended particles, colloidal materials, and macromolecules. Some common coagulants used are aluminum sulfate (alum) and ferric sulfate. Flocculation is usually defined as the aggregation of destabilized particles into larger flocs under slow mixing conditions. The flocs formed are subsequently removed by sedimentation and/or filtration (see pages 172 - 178, Davis and Cornwell).

A useful laboratory experiment for the evaluation of coagulation/flocculation of an untreated water is the jar test. This test provides information on the effects of the concentrations of the coagulants, mixing of the raw water, and the water quality parameters such as pH and alkalinity on the coagulation process. The jar test is often used for the design of treatment facilities and in the routine operation of treatment plants.

OBJECTIVES

The objectives of the jar test experiment are to estimate the optimum concentration of aluminum sulfate for the removal of suspended matter and to investigate the change in alkalinity as a result of aluminum sulfate addition.

MATERIALS

Phipps & Bird Six-Place Stirrer	1 or 2-liter beakers
Aluminum sulfate (alum) solution	Hach turbidimeter
Pipettes/syringes	Burettes
Erlenmeyer Flasks	0.02 N H_2SO_4
Water sample (Des Moines River water)	Volumetric flasks
Methyl orange (MO) indicator	

PROCEDURE

1. Determine the turbidity and pH of the raw water sample.
   Also determine the alkalinity of raw water sample using the procedure below.
2. Place 1 or 2 liters of raw water in each of the six beakers of the laboratory stirrer. Immerse blades and stir the raw water samples at about 100 rpm.
3. Add alum solution into each of the beaker to obtain the desired concentrations in the raw water samples.
4. Let the samples mix at approx. 100 rpm for 1minute, then decrease the speed to approx. 30 rpm. Allow the sample to mix for a period of 10 minutes. Observe any changes in the suspended matter in the sample.

5. At the end of the mixing period, turn off the stirrer, let the flocs settle (at least 20 minutes) and carefully remove the supernatant from each beaker and determine the turbidity in each of the samples. Determine the pH of each treated water sample.
6. Measure the alkalinity of the sample with the largest alum concentration.

Alkalinity Measurement

1. Add 50 mL of water sample (V_s) to an erlenmeyer flask
2. Add 2 to 3 drops of methyl orange indicator
3. Read the starting volume of standard 0.02 N H_2SO_4 on the burette. Titrate water sample with standard 0.02 N H_2SO_4 until color changes from yellow-orange to red.
4. Read the final volume of the acid in the burette. Record volume used (V_a).
5. Compute alkalinity as follows:

Alkalinity (in mg/L $CaCO_3$) = [mL acid (V_a) x Normality of acid x 50,000] / [mL sample (V_s)]

RESULTS

Beaker #	1	2	3	4	5	6
Dosage						
Turbidity						
pH						
Alkalinity						

REPORT FORMAT

Introduction

Describe the purpose of jar testing and summarize the theoretical background. Expound on the information that is presented in this handout.

Procedure

Describe the experimental procedure.

Results

Report all results in a Table format.
Plot turbidity and pH as a function of coagulant dose.

Discussion

What is the best coagulant dose?
Why did the pH change?
Why did the alkalinity change with dose?
Compare the measured alkalinity change with that of the theoretical alkalinity change requirements? See page 173 in the textbook.

Conclusions