

CE 326 Principles of Environmental Engineering

Chemical Concepts Demonstration

Introduction

Some of the common uses of water that are dependent on quality are domestic and industrial water supplies, water based recreation, propagation of aquatic life, and aesthetic enjoyment. Drinking water requires the highest quality for obvious reasons and must be free of health hazards such as pathogens, toxic compounds, and carcinogens. Aesthetic factors such as clarity, taste and odor, and chemical stability are also important. The water quality standards for drinking water are found in the Safe Drinking Water Act (SDWA). See pages 159-168 in your text.

In this demonstration several common measures of water quality will be determined using simple chemical and biological techniques. The purpose of the demonstration is to provide a general introduction to water quality as it relates to various sources of water. The water quality parameters to be demonstrated include pH, alkalinity, hardness, turbidity, color, and microbial quality.

pH is a measure of the hydrogen ions in solution and gives an indication of the acid or alkaline conditions of a sample. For practical purposes, it is the negative logarithm of the hydrogen ion concentration. pH is important in every phase of water treatment including chemical coagulation, disinfection, corrosion control, and biological processes.

Alkalinity is a measure of the capacity of a water to neutralize an acid. The alkalinity of natural water is primarily due to anions associated with weak acids, and the most important of these is the bicarbonate ion (HCO_3^-).

Hardness is associated with polyvalent cations. Calcium and magnesium are usually the most abundant ions contributing to hardness. Hardness cations are removed in precipitation reactions and can form scale in hot water pipes and water heaters.

Color in water is an undesirable condition that may be caused by either organic or inorganic materials such as clay particles or humic substances (high molecular weight, slowly biodegradable organic compounds that result from natural decay processes). Prepared standards containing potassium chloroplatinate are frequently used in estimating color in water samples. Color units correspond to the concentration of chloroplatinate (K_2PtCl_6) in the standards.

Turbidity is a measure of the light scattering nature of a water sample. It correlates with the concentration of suspended matter in the sample. Turbidity is an indication of the performance of filtration in water treatment. Suspended matter is a concern because it is an indication of poor treatment performance and may interfere with the disinfection processes by harboring and shielding microorganisms.

Microbiological quality of a water source may be tested in a variety of ways. Due to the difficulty in measuring specific pathogens (disease causing organisms), surrogate measurements such as fecal coliforms and streptococci are often made.

Equipment and Materials

pH meter

glassware

samples: Des Moines River Water, Boone tap water, Coke, lemon juice

solutions: methyl orange, EBT, pH buffers, 0.02 N H₂SO₄, 0.01 M EDTA

membrane filters, agar plates

Procedures:

pH - measure the pH of all the samples

Alkalinity - measure the alkalinity of the two water samples

1. Add 50 mL of sample to 125 mL flask
2. Add 2 drops of methyl orange indicator solution
3. Titrate with standard acid until color changes from yellow-orange to red
4. Calculate the alkalinity:

$$alk = \frac{mL \text{ acid}}{sample \text{ volume}} \frac{1 \text{ mg alk as } CaCO_3}{mL}$$

Hardness - measure the hardness of the two water samples

1. Add 25 mL of sample to flask and dilute to 50 mL with deionized water
2. Add 1-2 drops of pH 10 buffer
3. Add 1-2 drops of EBT solution
4. Titrate with EDTA to a blue color
5. Calculate hardness:

$$hardness = \frac{mL \text{ EDTA}}{sample \text{ volume}} \frac{1 \text{ mg hardness as } CaCO_3}{mL}$$

Color - measure the color of the river water sample

1. Pour sample into Nessler tube to the 50 mL mark - dilute sample if necessary
2. Compare to prepared standards
3. Calculate color: Color = estimated color units • dilution ratio

Turbidity - measure the turbidity of the river water sample

1. Place sample in turbidimeter tube
2. Place tube in turbidimeter and measure NTUs

Microbiological Quality - prepare plates by filtering 30 mL, 10 mL, and 1 mL of river water each through a 0.45 μ filter. Place filter, grid side up, on prepared agar and mark the dish with the sample size and group identification. Place prepared plates upside down in 35°C incubator.

Report (see page 52 - 54 of the CCE Communication guide:<http://www.cce.iastate.edu/students/>)

studentguide/CCEGuide.pdf for report format)

Title (Author, Class, Section, Date).

Introduction.

Methods.

Describe the tests performed in the demonstration.

Results.

Tabulate the measured results (use conventional units, e.g., mg/L). Provide sample calculations as necessary.

Discussion.

Provide a discussion of the results, and indicate the significance of your findings. Include in your discussion the following:

- what are the likely sources of acidity in the Coke and lemon juice?
- assuming that the tap water is processed from the Des Moines River water sample, what percentage of the hardness, alkalinity, and turbidity is removed during treatment?
- why is it important to remove hardness, alkalinity, and turbidity?
- what is the purpose of an indicator organism in water treatment?