Water Purification

Objectives

1. Understand and apply water purification methods.

2. Evaluate efficiency of methods via observation.

Introduction

As a result of the natural erosion of rock and soil, all bodies of water contain undissolved particles, termed sediments. Fine particles like sand, and silt, settle out quite rapidly. Bulldozing for housing developments, clear-cutting of timber, strip mining for minerals, overgrazing by livestock, and plowing of farmland are all practices that remove natural ground cover and accelerate erosion of the land. Surface runoff and soil loss are greatest when the ground slopes steeply.

Increased loads of sediments in streams, rivers, and lakes can cause many problems. Suspended particles make water turbid, which reduces light penetration and thus the rate of photosynthesis. As sediments settle out, they can bury bottom-dwelling organisms and fish spawning grounds, and generally disrupt aquatic habitats. Sediments also cause problems by filling irrigation ditches and clogging harbors and lakes.

Another concern is that if toxic substances such as metals and pesticides are released into water, the toxins adhere to suspended particles and become concentrated in sediments. A later disturbance in the water, such as an increase in acidity, may then release the toxins. In clear water, toxic substances are more likely to remain in solution and become diluted to insignificant concentrations by the flow of water.

In the oceans, accidental oil spills and leaks from supertankers are a major cause of environmental damage. Waste oil generated by industries, cities, gas stations, and individuals are other significant sources of oil pollution. As little as one quart of oil can contaminate two million gallons of water; one gallon can form an oil slick measuring eight acres.

Of even greater concern than the pollution of surface water is the pollution of groundwater, which is the primary source of water for 50% of the people in the United States. Ground water is usually pumped directly from the ground into homes. It is normally of such high quality that it meets safe drinking water standards without the need for purification or treatment. However, in a number or locations in recent years, formerly pure groundwater has become contaminated with hazardous substances.

The main sources of hazardous materials that threaten groundwater are dump sites where chemicals are leaking from corroded metal drums. Leaking materials seep down through the soil; the larger particles are filtered out and travel only short distances, but soluble substances can percolate down to groundwater. Other sources of groundwater pollution include pesticides and fertilizers from farmland, sewage from septic tanks and leaking sewer pipes, and gasoline leaking from service station storage tanks.

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In this experiment you, you will be given a sample of water that is polluted with oil, suspended solids, and dissolved contaminants. You will purify the water using techniques that are similar to those used for primary treatment of sewage. You will judge the efficiency of the technique by the appearance of the purified sample.

Materials Needed

Chemicals	Equipment
• Polluted Water Sample • 0.5 g Aluminum Sulfate, $Al_2(SO_4)_3$ • 0.5 g Calcium Hydroxide, $Ca(OH)_2$	• 2 Medium-size Test Tubes • Ruler • Glass wool • Short stem plastic funnel • Sand • Ring Stand • 150 mL beaker • Charcoal • Filter paper • Glass filter funnel • Tweezers • Parafilm

Procedure

1. Obtain a sample of polluted water in a medium test tube from your instructor.

2. On your report sheet, record the color and odor of the sample, and the presence of solids or oil.

3. Obtain a measure of the volume of the sample as follows: Place the test tube in a test tube rack and then place a ruler along side it. Read the height of the sample in the test tube to the nearest millimeter, and record on your report sheet. Be sure to read to the top of the sample.

4. If oil is present in the sample, it will float on the surface of the water. Read the height to the top of the water and record on your report sheet.

5. a. With your spatula take a pea-sized amount (approximately 0.5 grams) of aluminum sulfate, $Al_2(SO_4)_3$, and add it to the test tube. Cover the test tube with parafilm. With your index finger on top of the plastic film, invert the tube to mix the contents.
   b. With your spatula, take a pea-sized amount (approximately 0.5 grams) of calcium hydroxide, $Ca(OH)_2$, and add it slowly to the test tube. Shake the tube gently, and then allow the mixture to stand for 5 minutes. The $Al_2(SO_4)_3$ and $Ca(OH)_2$ react to form a precipitate of aluminum hydroxide ($Al(OH)_3$) that settles out and carries suspended particles with it (Equation 1)

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$$Al_2(SO_4) + 3\ Ca(OH)_2 \rightarrow 2\ Al(OH)_3 + 3\ CaSO_4 \qquad (1)$$

6. Place a glass wool plug in the bottom of a wide short-stem plastic funnel, and add one-half inch of sand.

7. Support the plastic funnel in a ring stand. Place a 150-mL beaker under the tip of the funnel. Carefully pour the water sample into the funnel. The liquid will filter through the sand into the beaker. Be patient, the solution might take a while to filter.

8. On your report sheet, record the color and odor of the filtered sample, and note the presence of any solids or oil.

9. Add approximately half a teaspoon of charcoal to the sample in the beaker, and swirl the beaker gently for several minutes.

10. Fold a filter paper and place it in a glass filter funnel. Support the funnel in a ring stand, and place the end of the funnel into a test tube. The test tube must be identical to the one in which you received your original sample.

11. Carefully pour the contents of the beaker into the filter funnel. The water will filter through the filter paper and collect in the test tube.

12. Measure the height of the purifed water in the test tube with a ruler, as described in step 3. Record the height on your report sheet.

13. On your report sheet record the color and odor of the purified water, and the presence of solids or oil.

Waste Disposal

Discard the purified water in the sink and flush it down the drain with tap water.

Discard the contents of the plastic funnel in the trash can. Use tweezers to remove the glass wool plug and rinse out funnel in the sink.

Adapted from *Chemistry Fundamentals: An Environmental Perspective*, James E. Girard and Phyllis E. Buell

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Name: _____ _____

Date: _____

Property	Polluted	Purified by passing through sand	Purified by adding charcoal
Color			
Odor			
Solids			
Oil			

1. Height of polluted water sample. _____
2. Height of water in polluted water sample. _____
3. Percent oil in sample $\left(\frac{\text{line 1} - \text{line 2}}{\text{line 1}} \times 100\right)$ = _____
4. Height of purified water sample. _____
5. How much of the original sample did you lose during purification?

6. Do you consider the purified water suitable for drinking? Explain your answer.