Observing Dissolved Air in Water

Overview

Oxygen dissolved in water is crucial for fish and many other marine animals to breathe, but how can we see it for ourselves? By heating water, students will observe air bubbles forming from dissolved gases including oxygen. They will also observe the water vapor bubbles that eventually form at the boiling point. The water will then be cooled to room temperature and reheated to show that the dissolved air came out of the water during the first heating.

Concepts

- Oxygen dissolved in water permits fish and other aquatic creatures to breathe and live underwater.
- Less gas can remain dissolved in heated water.
- Driving the air out of water by excessive heating can kill fish through oxygen depletion.

Materials

- Cooking pans or glass beakers
- Heating sources: Bunsen burners, or stove tops (gas or electric), or hot plates
- Thermometers (optional)

Preparation

Teachers may wish to observe this effect first at home by putting tap water, 2 - 4 cm (0.8 - 1.6 in) deep, in a cooking pan or large frying pan. Use a low heat so that the water temperature rises about 10°C (18°F) every minute. Very small dissolved air bubbles will begin to form on the bottom at about 35°C (95°F), usually around the edge of the pan. They will gradually expand and then rise to the surface and pop. At about 90°C (194°F) water vapor bubbles will form but collapse before reaching the surface. After the water starts to boil, turn off the heat and let the water cool to room temperature. Reheat the water and observe the lack of dissolved air.

Try again the next day with the same water: no air bubbles should appear. Cool the water and with the pan covered, vigorously shake the water for about ten seconds. Reheat the water to see if air has been dissolved. Different heat sources will produce different bubble patterns depending on where the thermal energy is transferred.

This activity can be done individually at home by the students, with reports afterward, or in the classroom in small groups.

Procedure

Engagement

Question students if any are SCUBA divers. How do they breathe underwater? How do fish breathe underwater? If there is an aquarium in the classroom does it have a bubbler (aerator)? How does air get into water in nature? How can we tell air really is dissolved in water? This activity will give one method to answer the last question.

Activity

1. Bring a cooking pan from home or use a school beaker.
2. Pour tap water into your container to a depth of two to four centimeters (0.8 - 1.6 in). (Alternative: Let two beakers of cold water sit overnight or a couple of days. Put an aquatic plant in one of the beakers. This plant's photosynthesis will add more oxygen to alter the initial condition of this beaker.)
3. Place your container over the heat source. (If using the alternative method, remove plant from beaker. Note which beaker had the plant in it. Heat both beakers side by side.)
4. Activate your heat source at a low setting.
5. Time the temperature change (if using a thermometer) to give about 10°C (18°F) increases each minute.
6. Observe the air bubbles formed on the container bottom, noting size and distribution.
7. Estimate the total number of bubbles formed (hundreds, thousands) and their approximate diameters in mm.
8. Just before boiling, about 90°C (194°F), notice the different bubbles being formed on the bottom. Do they rise to the surface as the air bubbles did?
9. Continue heating the water until boiling occurs, then turn off the heat source.
10. Cool the water to room temperature by placing the pan in a sink containing a few centimeters of water at room temperature or cooler.
11. Reheat the water and look for air bubbles. How are your observations similar to or different from your observations the first time you heated the water. (If using the alternate method with two beakers, put both side-by-side on a hot plate. Note any differences between the beaker with and the beaker without the plant.)
12. (Optional) If time permits, cool the water again to room temperature. After it is cool, place a cover over the pan and vigorously shake the water for about ten seconds. Reheat the water and again look for air bubbles.

Explanation

Dissolved air in the water will expand on heating, forming bubbles at the bottom surface. When the *buoyant* force on a bubble overcomes surface tension, it will rise to the surface and pop. With time, *convection* currents in the water will cause all of the dissolved air to coalesce and form bubbles near the warm bottom and side surfaces.

The second set of bubbles that form near the boiling point are water vapor bubbles. These rise to the surface once their internal pressure exceeds atmospheric pressure. At higher elevations where atmospheric pressure is lower, boiling occurs at lower temperatures.

After the dissolved gas has been driven off through heating and when the same water is reheated a short time later, you will not observe bubbles until the water starts to boil. Shaking the cool water, or using a bubbler such as those used in aquariums, helps put oxygen and other gases back into the water.

The amount of dissolved oxygen in fresh water and seawater is important for life. Aquatic animals such as fish require oxygen to live. They obtain it by processing dissolved oxygen in the water.

Extension

Investigate whether there is a connection between adding large amounts of heat to rivers and the loss of fish due to oxygen depletion. What type of natural or human-caused processes could add significant amount of heat to rivers or seas? Are there rules and regulations that limit the input of heat into rivers, streams, and oceans? Why or why not? Should there be such limitations?

Links to Related CD Activities, Images, and Movies

Activity *Properties of Fresh Water and Sea Water*

Vocabulary

buoyant *convection*

Source

San Juan Institute Activity Series, 1997.