Anti-Bubbles

Intermolecular Forces

Introduction

Some soapy water is squirted out gently into a cup of soapy water and strange anti-bubbles are produced.

Concepts

- Density
- Intermolecular forces
- Surface tension

Materials

Corn syrup, 10–15 mL
Dish detergent, 1–2 mL
Food coloring
Water, 300 mL
Beaker, 400-mL
Beakers, 100-mL, 2
Beral-type pipet or eye-dropper
Spoon

Safety Precautions

The materials in this demonstration are considered safe. All food-grade items that have been brought into the lab are considered laboratory chemicals and are for lab use only. Do not taste or ingest any material in the lab and do not remove any remaining food items after they have been used in the lab. Food coloring will stain skin and clothing. Wear chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Fill a 400-mL beaker with 300 mL of water.
2. Add approximately 1 mL of dish detergent (Dawn® or Joy® work well). Stir gently with a spoon to dissolve. If any suds should form, use the spoon to skim as many as possible from the surface.
3. Draw up some of the soapy water into the pipet or eyedropper.
4. Holding the tip of the dropper 5–10 mm above the surface, aim four or five gentle squirts downward. Given enough patience and practice, you should be able to observe anti-bubbles forming below the surface (See Figure 1). *Hint:* Avoid drawing air back up into the dropper between squirts, and keep the surface as free of suds as possible.
5. Once you have perfected the technique for "blowing" anti-bubbles, some of the following activities may prove both fun and enlightening.

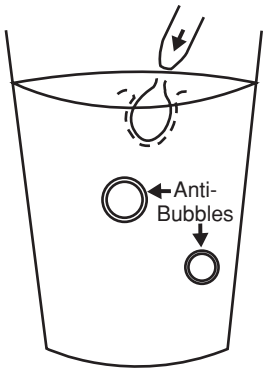

Figure 1

Procedure

Colored Anti-bubbles

1. Pour off 50–60 mL of the soapy water into a 100-mL beaker.
2. Add two or three drops of food coloring to the smaller beaker.
3. Stir, and then draw up some of this colored soapy water and use it to blow anti-bubbles in the original beaker of plain soapy water. The anti-bubbles will now be colored.

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Sinking Anti-bubbles

1. Add a few drops of dish detergent and more water to the original larger beaker to bring the solution back up to the 300-mL mark.
2. Pour off 50–60 mL of the soapy water into a clean 100-mL beaker.
3. Add 4–5 mL of sugar or corn syrup to the smaller beaker and stir to dissolve thoroughly (food coloring is optional).
4. Draw up some of this sugary/soapy water and use it to blow anti-bubbles in the original beaker of plain soapy water. One should be able to observe the anti-bubbles sinking and bursting on the bottom of the cup.

Suspended Anti-bubbles

1. Into a nearly full beaker of soapy water, pour some corn syrup to form a 1–2 cm layer on the bottom.
2. Stir this gently with a spoon, just enough to create a gradual transition from corn syrup on bottom to soapy water on top with no sharp interface visible in-between. Do not over-stir.
3. Blow some more anti-bubbles, drawing up the liquid from various levels in the gradient. If the gradient is relatively continuous, one should be able to suspend anti-bubbles throughout the entire beaker. These suspended anti-bubbles can last anywhere from a few seconds to well over an hour!

Disposal

All soap solutions may be poured down the drain according to Flinn Suggested Disposal Method #26b.

Tips

- The delivery of the squirt is critical—too soft and the anti-bubble will not form, too hard and it will burst. One suggestion is to let the first few drops just fall from the dropper. You should be able to observe little spheres of soapy water gliding across the surface. Gently squirting downward causes these spheres to make a visible depression into the liquid surface. And if the squirt is delivered with just the right force, it will drive the sphere and its surrounding mem brane of air below the surface, thus forming an anti-bubble. These anti-bubbles will appear at first like ordinary air bubbles under water. However, because anti-bubbles are comprised mostly of water with only a very thin membrane of air, they have a density only slightly less than that of the water that surrounds them. They therefore tend to rise much more slowly than air bubbles. For the same reason, anti-bubbles will come to rest just below the water's surface, not on top as air bubbles do.
- To keep a normal bubble aloft, one could blow jets of air up at it gently from beneath. To keep an anti-bubble down, one can blow jets of soapy water down at it gently from above. Try this.
- When a normal bubble bursts, it seems to disappear. When observing more closely, however, one can see a very small quantity of soapy water descend quickly to the floor—this representing, of course, the entire amount of soapy water that had been spread so thinly into the membrane of the original bubble. When an anti-bubble bursts, it too seems to disappear; yet upon closer inspection, one can observe a very small quantity of air rising quickly to the surface—this rep resenting the entire amount of air that had been spread so thinly into the membrane of the original anti-bubble. By intentionally poking a submerged anti-bubble with the tip of the eyedropper and causing it to burst, one can readily observe this effect.

Discussion

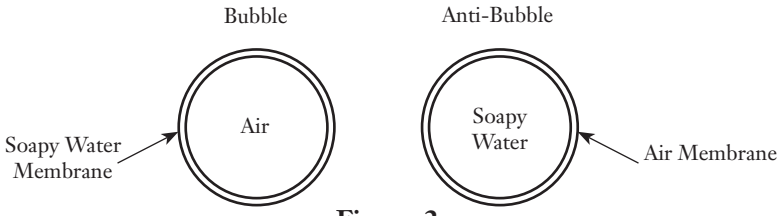

Figure 2

As the name implies, the anti-bubble is exactly the opposite of a normal bubble, the kind most children would blow in air with a bubble wand and some soapy water. Whereas a regular bubble consists of air on the outside, air on the inside, and a thin spherical membrane of soapy water, the anti-bubble consists of just the opposite—soapy water on the outside, soapy water on the inside, and a thin spherical membrane of air! See Figure 2. Exactly how they form is somewhat of a mystery, but numerous parallels can be drawn between anti-bubbles and normal bubbles. Several are listed below (See also the *Tips* section on page 2).

- To blow a normal bubble, one uses air to force a film of soapy water to protrude out into more air. To blow an anti-bubble, one uses soapy water to force a film of air to protrude out into more soapy water. In either case, when the membrane protrudes out far enough, it pinches itself off and forms a detached, autonomous sphere.
- The air inside a normal bubble has essentially the same density as the surrounding air, but the soapy water membrane, being considerably more dense, causes the bubble as a whole to be slightly more dense than the surrounding air, so the bubble slowly sinks. The soapy water inside an anti-bubble has essentially the same density as the surrounding soapy water, but the air membrane, being considerably less dense, causes the anti-bubble as a whole to be slightly less dense than its surroundings and so, as was mentioned above, the anti-bubble slowly floats.
- The membrane of a normal bubble is not of a uniform thickness, and as a result of this, the internal and external surfaces of the membrane reflect and refract light in such a way as to make rainbows of color. These same colors can be seen on the surface of an anti-bubble, implying that it, too, has a membrane of non-uniform thickness.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Form and function
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter, motions and forces
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, motions and forces

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Anti-Bubbles* activity, presented by Bob Becker, is available in *Intermolecular Forces*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Anti-Bubbles* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0241	Cleaner, Liquid Detergent
C0091	Corn Syrup, 16 oz
GP1025	Beaker, 400-mL
GP1010	Beaker, 100-mL
AP1718	Beral Pipets, Thin Stem, 20/Pkg
AP9285	Spoons, Plastic, 24/Pkg

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.