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BOT-810

Gas Solubility Demonstration
(The Baby Bottle Experiment)

By Ron Perkins

When a bottle with liquid is shaken, the rubber top expands.

Materials: 2 hard plastic 8 oz baby bottles, and
4 rubber nipples w/o holes.

Procedure:
Fill a baby bottle with soda (pour soda slowly, so as not to produce a "head") and securely attach the top using a rubber nipple without a hole. Shake and observe.

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Additional Investigations:

1. Repeat the procedure with two baby bottles at the same time, one containing cold soda and one containing the same volume of soda at room temperature.
2. Observe what happens when the baby bottle with an expanded nipple is placed in an ice water bath and shaken.
3. Does it matter if the bottle is completely filled with soda to start or only partially filled? At what point do you see a difference?
4. Do different types of soda give different results?
5. Can you design and make an apparatus to quantitatively measure the expansion of the rubber nipple?
6. What happens when a Mentos tablet is attached to the inside of the nipple, the top secured, and the Mentos tablet allowed to fall into the soda? Are there other materials that will cause this change?

Explanation:

An unopened can or plastic bottle of soda feels solid because of the more than 3 volumes of dissolved carbon dioxide gas creating a pressure as much as 55 PSI above the liquid. This is about 4 times atmospheric pressure.

When soda is opened, we hear the noise of the escaping compressed gas. In an open container, most of the dissolved gas in the soda is released into the atmosphere and the soda eventually tastes "flat." However, if the container is immediately resealed after opening, as is the case with the baby bottle, the pressure above the soda builds up until a new equilibrium pressure is established. The equilibrium pressure is enough to expand the rubber nipple significantly. It is amazing to see!

The demonstration can be used to teach that the solubility of a gas decreases with increasing temperature. In fact, a gas has zero solubility at the boiling point of a liquid. At normal atmospheric pressure this is 100ºC for water. This explains why chlorinated water is often boiled and allowed to cool before adding to a fish tank. The process removes the dissolved chlorine gas, Cl_2.

The solubility of a gas decreasing with increasing temperature is of great concern because it is directly related to global warming. The higher the temperature; the less dissolved oxygen in the earth's water supply! This greatly affects aquatic life. Of equal concern is the vast amounts of carbon dioxide being released into the atmosphere from the ocean, causing even higher temperatures due to the Greenhouse Effect. Already we are observing a loss of coral reefs, which are largely made up of carbonates. The result is more carbon dioxide into the atmosphere. In 1972, Professor George Whitesides, Professor of Chemistry at Harvard University, predicted "we are rapidly bringing the temperature of the earth to the melting point of lead." Thirty-five years later global warming has become of great concern! Much of global warming can be related to the decreasing solubility of gas as the temperature increases.

Note: This demonstration was first observed at one the early CHEM ED Conferences in Canada in the 1970's.

