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Measuring Carbon Dioxide with BTB

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Earth Central: Measuring Carbon Dioxide

The BTB CO_2 Test

BTB (bromo-thymol blue or $C_{27}H_{27}Br_2O_5SNa$) is a pH indicator that changes from blue to yellow as acidity increases (pH 7.6 to 6.0). By bubbling CO_2 through a solution of BTB in water, carbonic acid is formed, and the indicator changes color. Air containing higher levels of CO_2 will change the color closer to yellow.

Preparing BTB Solution

(This can be done several days in advance.) BTB is usually purchased in concentrated liquid or powder form. Fill a clean 2-liter bottle about 9/10ths full of water and add concentrate or powder to make a deep blue solution.

While BTB is not particularly dangerous, when working with children it is they should use goggles. The main cautions for sensible use are to bubble air samples slowly to avoid splashing, and when you take breath samples, *don't put anything that has been in contact with BTB into your mouth!!*

Comparing Air Samples

We will bubble a fixed volume (50 ml) of various air samples through the BTB solution and compare the color changes.

Collect a beaker of BTB solution and keep it covered to reduce changes due to atmospheric CO_2. Measure out 15 ml of the solution into 5 or 6 small cups, and set the cups on white paper. Leave one cup unused as a control.

In some cases air samples can simply be drawn into the syringe and then bubbled through the solution in one of your cups by putting the tip of the syringe in the bottom of the cup and depressing the plunger slowly.

Air samples can also be collected with balloons. The neck of the balloon should be twisted, but not tied, and held firmly pinched to keep the sample from leaking out. With the help of a lab partner the sample can be transferred to the syringe by wrapping the end of the balloon over the tip of the syringe, pinching it in place, and then untwisting the neck of the balloon. Draw in air from the balloon into the syringe, and then retwist the neck in case another sample is wanted.

Suggestions for Various Air Samples

Plain air: Is it the same by a bus stop? in a copier room? at the end of a stuffy lecture?

Your Breath: What if you hold your breath for awhile first? or run up and down the stairs? Does it vary between smokers and non-smokers?
$\longrightarrow$ To collect breath samples safely, inflate a paper bag with your breath, then put the whole cylinder of the syringe into the paper bag and draw air into the syringe while sealing the bag around the syringe with your fingers. If you use a balloon, BTB will get on the neck of the balloon, so you shouldn't re-use it.

Pure CO_2: Put about 2–3 teaspoons of baking soda in a wine bottle, then add about a half cup of vinegar. Wait a second while the CO_2 displaces the air already in the bottle, then put a balloon over the neck. "Swishing around" the mixture may help generate more CO_2. Note: CO_2 is denser than air, so it will tend to stay in the bottle once filled. You can even pour it out over a candle and put it out.

Auto Exhaust: Make a long narrow funnel out of a file folder and duct tape. One end should be big enough to fit over a tail pipe, the other small enough to get the mouth of a balloon over. With a parked, idling car (this experiment is more of a challenge to do on a moving car) put the funnel over the tail pipe and hold the balloon over the small end. The balloon will inflate quite quickly when you get a good seal.

Questions to Think About

1. Would (unpolluted) raindrops falling from different heights have the same pH?

2. How could you make this test more quantitative?

Sources

LHS GEMS book, "Global Warming & the Greenhouse Effect" 1990 *Contains many activities related to CO_2 and understanding how the greenhouse effect occurs.*