Oceanic Absorption – Oceanic Sequestration

Science

Goal: Explore the potential for the ocean to hold CO_2.

Objectives: Students will …

- Understand different techniques being considered to reduce carbon dioxide in the atmosphere
- Use chemistry to simulate oceanic sequestration

Materials (per lab group, 3 students per group):

- 100ml of vinegar
- 2 – #6, two-hole rubber stopper with plastic tubes
- 2 – 250ml flask
- 1 length rubber tubing, 45 cm long
- 3 Safety glasses
- 1 – 250ml beaker
- 1 – 30ml syringe (no needle)
- Supply of water
- 5g of sea salt
- Box of baking soda
- 300ml Phenol Red
- Straws or rigid plastic tubing
- 3 Oceanic Absorption – Lab Procedure sheets
- 3 Oceanic Absorption – Student Sheets

Time Required: 45-60 minute period

Standards Met: M1, M12, M13, S1, S2, S3, S7

Procedure:

PREP

- Prepare 10 lab stations each with the materials listed above.
- Photocopy Oceanic Absorption – Lab Procedure and Oceanic Absorption – Student Sheet.
- Review the teacher sheet and familiarize yourself with oceanic absorption as a means of carbon sequestration.

IN CLASS

- Explain that students will conduct an experiment to learn about the method of oceanic absorption for carbon sequestration.
- Divide students into groups of 3. They should then move to a lab station with the appropriate materials needed to complete the lab.
- Hand out Oceanic Absorption-Lab Procedure. Review.
- Allow students to conduct the lab while you roam the room and help.
- When students have completed the lab, ask them to clean their lab materials and station so that the next class can use the materials.

- Hand out Oceanic Absorption – Student Sheet.
- Discuss experiment results using the student sheet as a guide.

Oceanic Absorption – Teacher Sheet

Introduction and Teacher Background: (Refer to "Where CO_2 Goes to Die" in resource section of your notebook). CO_2 is soluble in ocean water, and through natural processes the ocean both absorbs and emits huge amounts of CO_2 into the atmosphere.

It is widely believed that the ocean will eventually absorb most of the CO_2 in the atmosphere. However, the kinetics of ocean uptake is slow, causing a peak atmospheric CO_2 concentration of several hundred years.

One approach to enhancing the rate of CO_2 absorption in the ocean involves adding combinations of micronutrients and macronutrients to those ocean surface waters deficient in such nutrients. The objective is to stimulate the growth of phytoplankton, which are expected to consume greater amounts of carbon dioxide. When carbon is thus removed from the ocean surface waters, it is ultimately replaced by CO_2 drawn from the atmosphere. The extent to which the carbon from this increased biological activity is sequestered is unknown at this point, and would require additional research. Any R&D on natural enhancement would also require complete examination of potential environmental issues.

Direct Injection of CO_2

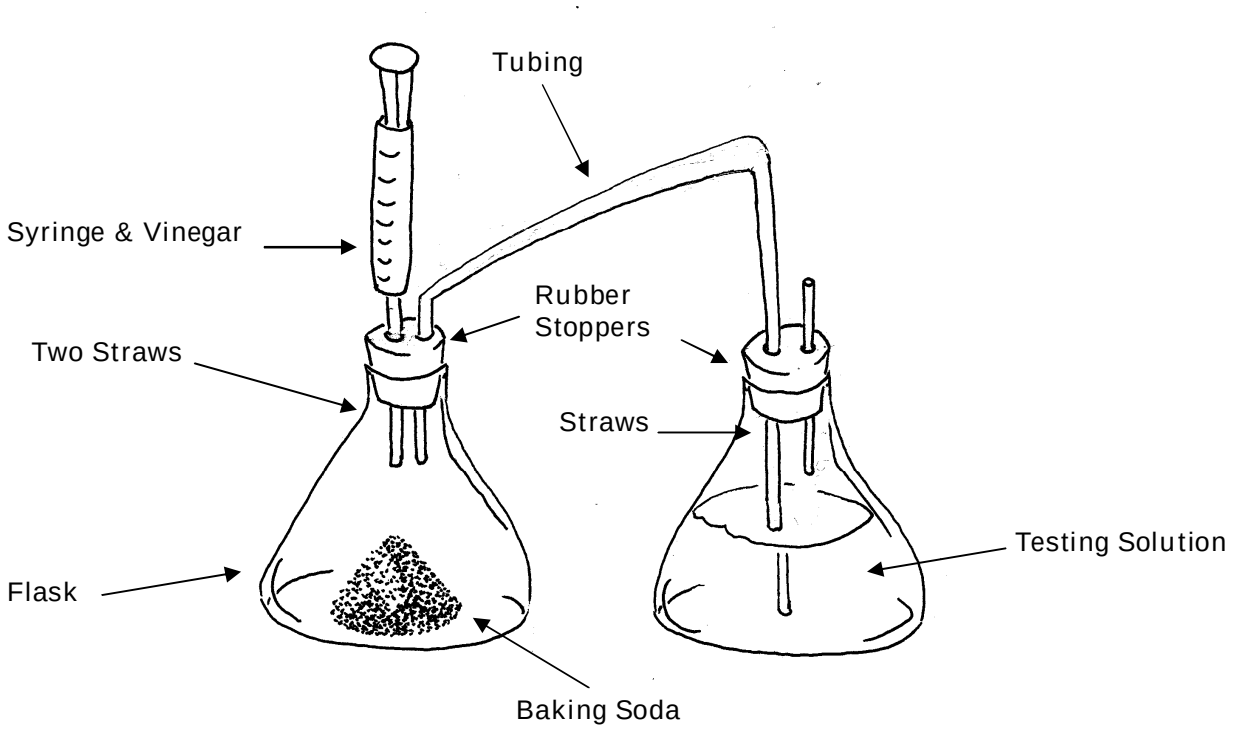
Technology exists for the direct injection of CO_2 into deep areas of the ocean; however, the knowledge base is not adequate to optimize the costs, determine the effectiveness of the sequestration, and understand the resulting changes in the biogeochemical cycles of the ocean.

To assure environmental acceptability, developing a better understanding of the ecological impacts of both ocean fertilization and direct injection of CO_2 into the deep ocean is a primary focus. It is known that small changes in biogeochemical cycles may have large consequences, many of which are secondary and difficult to predict. Of particular concern is the effect of CO_2 on the acidity of ocean water.

Using the CO_2 generator from Activity 1, students will determine if ocean (salt) water can hold more dissolved CO_2 than fresh water before it turns acidic.

FOR THIS LAB

Review the diagram below. This is the set-up students should have to ensure a successful lab.



Oceanic Absorption – Teacher Answer Key

Name: _____

1. What test solution turned yellow first?

   The fresh water turned yellow first.

2. What does turning yellow indicate in this experiment?

   Turning yellow indicates that the solution is saturated with carbon dioxide.

3. What was the concentration of the salt water (percent)? What is the average concentration of seawater?

   5 grams of salt in 150ml of phenol red gives a concentration of 3.3% (5/150). The average concentration of salt water (ocean water) is 35 parts per thousand or 3.5%.

4. If there were living organisms in our salt water test solution, how do you think they would be affected?

   Answer will vary. It is not known exactly what effects pumping CO_2 into seawater will have on living organisms. The average pH of salt water (ocean water) is approximately 8.2.

5. Do you think that deep-sea water injection is a feasible carbon sequestration method? Explain your answer.

   Seawater (salt water) does seem to hold more carbon dioxide than fresh water. However, little is known about what the effects of increasing the amounts of CO_2 in seawater will have on marine organisms. Answers may vary at this point. One possible answer is – until further research is done to study these effects, it may be advisable to limit using deep-sea water as a potential disposal or storage site for CO_2.

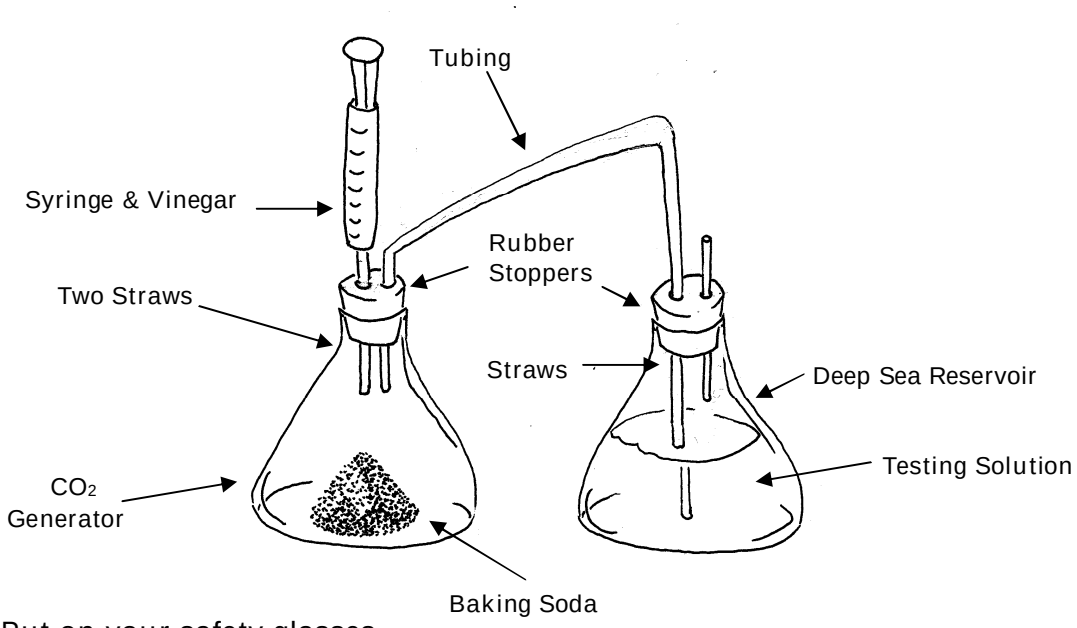
Oceanic Absorption – Lab Procedure

Name_____ Date_____

1. Be sure you have the materials listed below at your lab station.
   - 100ml of vinegar
   - 2 – #6, two-hole rubber stopper with plastic tubes
   - 2 – 250ml flask
   - 1 length rubber tubing, 45cm long
   - Safety glasses
   - 1 – 250ml beaker
   - 1 – 30ml syringe (no needle)
   - Supply of water
   - 5g of salt
   - Box of baking soda
   - 300ml Phenol Red
   - Straws or rigid plastic tubing

2. Assemble the CO_2 generator, and deep sea reservoir using Diagram 1 below. Make sure that all unions are airtight. Place enough baking soda in the flask to cover the bottom.

DIAGRAM 1



3. Put on your safety glasses.
4. Pour about 40ml of vinegar into a 250ml beaker. Put the tip of the 30ml syringe into the vinegar making sure that the plunger is all the way down. Keep the tip of the syringe below the surface as you pull back on the plunger to fill it to the 30ml mark. If you get air bubbles in the syringe, empty it and repeat the procedure again.

5. Put 150ml of phenol red in the testing container. Make sure that the straw that is delivering the carbon dioxide is submerged near the bottom of this flask. It is important that the CO_2 bubbles through the solution.
6. Place the syringe into the straw on the rubber stopper and slowly add 5ml of vinegar to the baking soda. Let the gas bubble through the testing solution. When the gas production has stopped, add another 5ml of vinegar.
7. Repeat this procedure until the phenol red turns yellow.
8. Rinse out your equipment and repeat the experiment except this time dissolve 5g of salt into the 150ml of phenol red.
9. When you have finished this activity, your instructor will tell you how to clean up your materials. Answer the questions on the Oceanic Absorption – Student Sheet.

Oceanic Absorption – Student Sheet

Name: _____Date _____

1. What test solution turned yellow first?

2. What does turning yellow indicate in this experiment?

3. What was the concentration of the salt water (percent)? What is the average concentration of sea water?

4. If there were living organisms in our salt water test solution, how do you think they would be affected?

5. Do you think that deep-sea water injection is a feasible carbon sequestration method? Explain your answer.

WORKSHOP COPY

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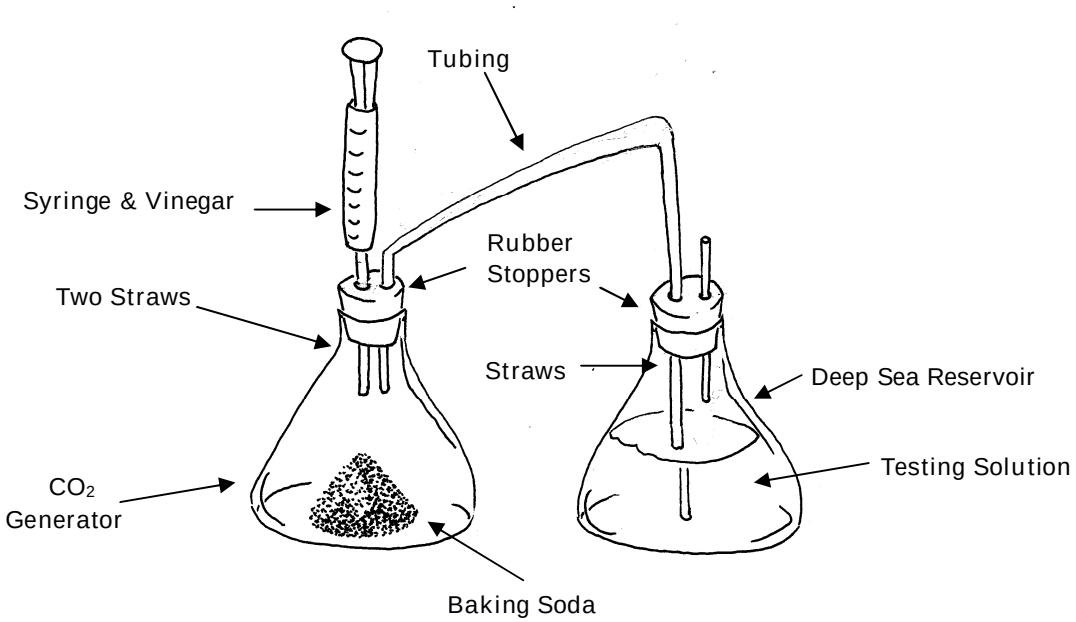

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Oceanic Absorption – Student Sheet

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2. What does turning yellow indicate in this experiment?

3. What was the concentration of the salt water (percent)? What is the average concentration of sea water?

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