

Mineral Trapping of CO₂ Demonstration

Purpose

To demonstrate that CO₂ can be injected into a deep saline aquifer and trapped as a solid mineral.

Supplies, sources, and costs

- 100g of play sand
- A container with a lid that can hold the sand
- 5g of 50% sodium silicate solution
- A source of CO₂
 - Quart sized glass canning jar with lid and rim
 - Clear vinyl tubing
 - Plastic pipettes
 - Distilled White Vinegar
 - Baking soda
 - 2 oz plastic measuring cup
 - Plastic test tubes with lid
 - Centrifuge tub rack

Set the mason jar on a flat surface. Measure 3 grams baking soda and pour into the mason jar.

Fill the centrifuge tubes with 12 ml of distilled white vinegar, place lid back onto the tube and place in the centrifuge tube rack. We need 3 tubes per jar.

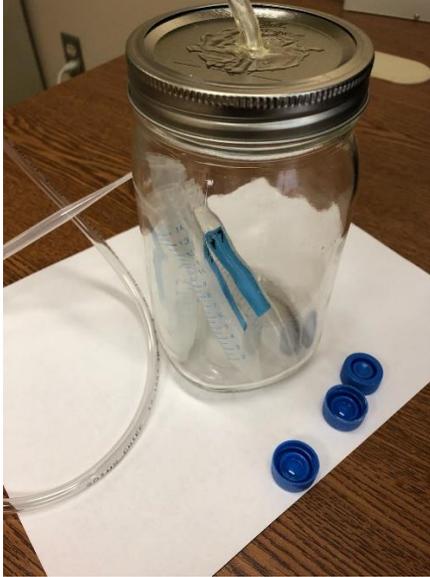
Fill plastic vials with 100 grams of play sand. Close the lid and set aside.

Dilute the Sodium Silicate with water. 1 part sodium silicate to 1 part water.

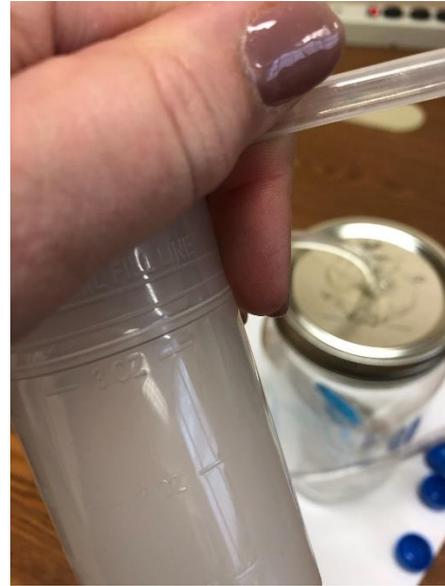
Measure 5g of the 50% sodium silicate solution.

Procedure

1. Pour sodium silicate solution into the sand vial, close and shake.
2. Remove the lid of the centrifuge tube and carefully set upright in the mason jar. Be careful not to spill any of the vinegar. Do this for 3 tubes.
3. Place the lid onto the jar and screw closed.
4. To inject the CO₂ into the wet sand, open the sand container and place the pipette end of the tub from the mason jar into the sand container without sinking it into the sand/sodium silicate solution. Close the lid as much as able and seal the rest of the top with the palm of your hand. Continue holding the sand in one hand and with the other hand, shake the mason jar to release the vinegar from the tubes into the baking soda, producing CO₂.
5. Wait about 5 minutes – sand should now be cemented into a solid “rock”.



Tubes in jar with liquid still
CO₂
in the tubes



Sealing sand container with hand so
doesn't escape

Script

After CO₂ is captured it can be permanently stored deep underground. This is called Geologic Sequestration.

This can happen by dissolving CO₂ in underground water (called an aquifer).

Aquifer water is a solution of many different elements in the form of ions.

If the CO₂ reacts it can make a stable mineral precipitate, in other words, the CO₂ becomes part of the rock.

Pretend this liquid and sand are an aquifer deep underground (dump sodium silicate solution into sand and shake).

Now pretend we captured CO₂ from somewhere else to pump it underground (show them the CO₂ generator).

When the CO₂ gas touches the water in between the sand grains, it dissolves into the water and makes carbonic acid.

When that carbonic acid touches the sodium silicate in the water it turns into sodium carbonate and silicon dioxide (which are both solids) and fill up the pore space between the sand grains.

Explanation

Sodium Silicate is used in this demonstration because it reacts quickly with CO₂ at these pressures and temperatures.

When CO₂ (gas) reacts with the sodium silicate solution (liquid: Na₂SiO_{3(l)}) it forms two precipitates: sodium carbonate (solid: Na₂CO_{3(s)}) and silicon dioxide (solid: SiO_{2(s)}). This acts like cement and “glues” the sand grains together without plugging the pores.

In an actual aquifer, the process occurs over years rather than minutes. The pressure and temperature are much higher, which means that the CO₂ will naturally be a dense-phase fluid (supercritical phase¹). The chemistry of the water can be different depending on where the aquifer is located.

Example Supplies, Cost, and Acquisition Sources

1. 100g of play sand

[QUIKRETE 50-lbs Play Sand](#)

Item # 10392

Cost: \$4.98

Vendor: Lowe's



¹ Supercritical phase occurs when the temperature and pressure exceed the critical point of a substance, resulting in supercritical fluid. *Super*= above, *critical*=end of the boundary between gases and liquids. In practice, this is the minimum pressure and temperature required to squeeze the atoms/molecules of a substance as close together as physical possible, which means maximum storage in minimal space. The critical point for CO₂ is

2. Sample bottle with lid

[100 MI. Natural Polypropylene Hinge Top Plastic Vial](#) (72 vials)

Item # B06XCCJTL6

Cost: \$82.00

Vendor: Amazon



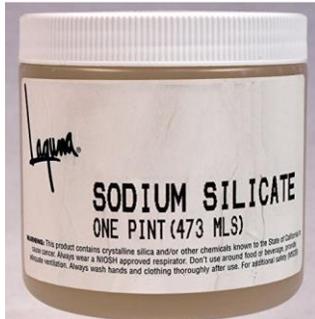
3. Sodium Silicate

[Laguna Clay Sodium Silicate pint](#)

Item# B0019LVJ00

\$14.98

Vendor: Amazon



4. Quart glass Mason Jars

[Ball Mason 32 oz Wide Mouth Jars with Lids and Bands](#)

Item: B07HGG3DD1

\$18.38

Vendor: Amazon



5. Clear Vinyl Tubing

[Sioux Chief 1/4" OD x 10' Clear Vinyl Tubing](#)

Item: 6840138

\$1.46

Vendor: Menards



6. Plastic pipettes

[100pcs 3ML Plastic Disposable Transfer Pipettes](#)

Item: B07MSNQYTV

\$5.39

Vendor: Amazon



7. Distilled White Vinegar

[White Vinegar - 32 oz](#)

Item: 5733613

\$1.27

Vendor: Menards



8. Baking Soda

[Baking Soda](#)

Item: 5732800

\$0.58

Vendor: Menards



9. 2 oz. plastic measuring cup

[Plastic Measuring Cup Transparent Graduated Beakers Jug Pour](#)

Item: B07F3Q7DHV

\$1.69

Vendor: Amazon



10. Plastic test tubes

[15ml Plastic Centrifuge Tubes](#) pack of 50

Item: B07FDN4XHB

\$13.99

Vendor: Amazon



11. Centrifuge tube rack

28 Well Centrifuge Tube Rack

Item: B07DK49ZZR

\$7.59

Vendor: Amazon



Procedure to Make the CO₂ Source Container

Allow 24 hours for preparation and drying time

Using the CO₂ source supplies, start by drilling a ¼" hole in the center of the jar lid.

Cut a strip of the clear vinyl tubing 24" – 30" long.

Remove the suction part of the plastic pipette.

On one end of the tubing, thread it through the 14" hole on the jar lid. Glue or epoxy around the edges of the hole on both sides to make it airtight.

On the other end of the vinyl tubing, attach the cut off end of the plastic pipette. Seal around the edges with glue or epoxy so it is airtight.

Let this dry overnight.



String the band back onto the lid.

