

Using Soap Foam to Alter the Density of Plaster of Paris

Developers:

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Discipline:

Physical Science, General Science

Grade Levels:

Grades 6 through 8

Objectives:

To determine the density of Plaster of Paris that has been prepared with a foam generated from dishwashing liquids and shampoo.

Background:

Calcium Sulfate products are generally thought to be heavy, with a high density and sink in water. This experiment will provide a way to decrease the density of calcium sulfate by adding a solution of foam to a prepared slurry of Plaster of Paris. Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is not a satisfactory product because the 2 moles of water of hydration reduce the setting time or working time considerably. The only product to use for this experiment is Plaster of Paris.

This product and experiment must be carried out under adult supervision. It is not to be used for casting of fingers, hands or other body parts because heat is generated while setting and it may cause burns. Also, avoid eye contact and wear safety goggles at all times.

Materials:

Student laboratory groups of 5 students.

Safety goggles or glasses - 1 pair for each student

25-50 lbs. of Plaster of Paris - Can be found in a hardware store, building supply store or craft shop.

Dishwashing liquids - Dawn® or Ivory® are preferred

Shampoo - Head and Shoulders® preferred

150-200 waxed paper cups - 4 oz. sample cup

25-50 waxed paper cups - 32 oz. mixing cup

100 tongue depressors 6" x ¾" - Fisher® brand

½-gallon or 1-gallon plastic jugs

10-, 25-, or 50-ml. graduated cylinder

100-ml beaker

Small fish tank

Procedure:

1. Prepare a 5% solution by volume of foaming agent using either a dishwashing liquid or a shampoo. Add 5 mL of soap to 95 mL of water in a ½-gallon jug. Swirl gently to dispense the soap in the water. Then shake vigorously for about 3 minutes just before adding the soap to the Plaster of Paris in Step 5. I noted my preferences above and found the best results with Dawn® and Head and Shoulders®.
2. Weigh the 4-oz. waxed cup to obtain the tare of the cup.
3. Weigh the cup filled with water to get the volume of the cup. The weight of water in grams is equal to the volume in mLs.
4. Prepare a control sample of Plaster of Paris (8-oz. by volume) and 1 4-oz. cup of water. Mix thoroughly and fill several sample cups and label control. Allow the sample to set at least 24 hours.
5. Prepare a second mixture of Plaster of Paris (2 4-oz. cups by volume, 1 cup of water). Mix thoroughly and stir in 3 4-oz. cups of foam from step 1. Make sure the mixture from one is shaken well and measure out the foam exactly.
6. Make at least 3 samples of the mixture and set aside for 24-48 hours to allow the samples to dry.
7. Samples in step 6 should be weighed on a triple beam balance to see if they lose weight over a period of time.
8. After waiting at least 24 hours, weigh and record each sample less the tare weight of the waxed cup.
9. We are now ready to compare the density of each sample and the control. Density is a term used to compare the heaviness of the same volume of different substances.

A solid that has a higher density than water will sink to the bottom of the beaker.

$$D = \frac{M}{V} = \frac{130 \text{ g of sample}}{117 \text{ mL of H}_2\text{O}} = 1.11 \text{ g/mL}$$

A solid that has a lower density than water will float to the top of the beaker.

$$D = \frac{M}{V} = \frac{64 \text{ g of sample}}{117 \text{ mL of H}_2\text{O}} = 0.55 \text{ g/mL}$$

10. Calculate the density of the control. Is it more than one? Will it float?
11. Calculate the density of Samples 1, 2 and 3. Will they float? Why does it act the way it does?
12. Place all four samples in the container of water and observe the reaction of each sample. From your calculations, did you get the right answers?