Glass Solubility Demonstration

Introduction

Is glass really soluble in water? In this demonstration, the difference between the solubility of soft-glass and borosilicate glass is observed.

Concepts

- Hydrolysis
- Solubility

Materials

Phenolphthalein solution, 1%, 2 mL
Glass test tube, borosilicate, Pyrex®
Large test tubes, 2, (20 × 150 mm preferred)
Rubber mallet or hammer
Test tube rack
Water, distilled or deionized
Non-borosilicate glass (soft-glass)
Zipper-lock plastic bag
Mortar and pestle

Safety Precautions

Use extreme caution when breaking glass. Make sure the glass is in a protective bag and that there is proper protection from glass shards. The phenolphthalein solution is an alcohol solution and is a flammable liquid, a fire risk, and is moderately toxic. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Fill the two large test tubes about three-quarters full with distilled or deionized water.
2. Place nine or ten drops of the phenolphthalein solution into each of the large test tubes and swirl to mix.
3. Place a clean piece of soft-glass into one of the zipper-lock bags. Make sure the bag is closed and that safety glasses are worn. Set the bag on a hard surface and smash the glass into small pieces with a rubber mallet, hammer or other solid object.
4. Carefully transfer the pieces of glass to a clean mortar and pestle and grind the small pieces of soft glass into a fine powder.
5. Place a spatula full (about 1 g) of the soft-glass powder into one of the large test tubes. Notice the pink coloration of the resulting solution.
6. Repeat steps 3, 4, and 5 with a clean piece of borosilicate glass. Observe that the resulting mixture does not undergo a color change.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Dispose of the solution according to Flinn Suggested Disposal Method #26b. Dispose of the remaining glass powder as solid waste according to Flinn Suggested Disposal Method #26a.

Tips

- Make sure that all glassware and mortar and pestles are very clean.
- This activity may be used as a teacher demonstration or as a student activity.
- Teachers may want to break the glass into smaller pieces and allow the students to grind the glass into powder.

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- Some examples of soft-glass that may be used in this demonstration are: clear spaghetti jars, mayonnaise jars, and brown or clear beer bottles. You may want to experiment and try other types of glass.
- It is advised that you double bag the glass before you break it into pieces.
- Pose the following question to students—If glass is indeed soluble, why don't window panes dissolve when it rains or why doesn't a drinking glass dissolve when it is filled with water?

Discussion

Although glass has the appearance of a solid, it is really a highly viscous liquid. It is a supercooled liquid that has amorphous and isomorphic qualities. Glass is amorphous because it lacks a crystalline form and it is isomorphic because it refracts light at the same angle in all directions.

In this demonstration, the solubility of two types of glass (soft-glass and borosilicate glass) is compared. Soft glass (also known as soda-lime or non-borosilicate glass) is composed of 75% silica (SiO_2), 20% soda ash (Na_2CO_3), and 5% lime (CaO). When the powdered soft glass is placed into the distilled water and phenolphthalein solution, hydrolysis of the glass occurs. Hydrolysis of glass produces sodium hydroxide (NaOH) and calcium hydroxide $Ca(OH)_2$.

$$Na_2CO_3(s) + 2H_2O(l) \rightarrow H_2CO_3(aq) + 2NaOH(aq)$$

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$$

The change in color of the solution is caused by the presence of the hydroxide ions (OH^-). In a pH range of 8 to 10, the phenolphthalein indicator turns a red or pinkish color. Water alone does not contain enough hydroxide ions to give a pH between 8–10. Therefore, the glass must be adding hydroxide ions to the solution, since after the addition of the glass, the pH was great enough to turn the phenolphthalein solution pink. This demonstrates the solubility of some of the components of the glass.

Borosilicate glass (also known as the tradename Pyrex®) is composed of soda-lime glass and 5–10% boric oxide (B_2O_3). The boric oxide present in borosilicate glass causes the glass to be acidic. Also, borosilicate glass is not very soluble in water. Therefore, there will be a slight or no color change of the phenolphthalein in the solution.

References

Nicholson, L. *J. Chem. Educ.* **1989,** *66*, 725.

Pauling, L. *General Chemistry;* Dover: New York, 1970; p 644.

Sax, N. E.; Lewis, R. J. *Hawleys Condensed Chemical Dictionary;* Van Nostrand Reinhold: New York, 1987; pp 562, 619.

SourceBook Version 1.0 Volume 2; Orna, M. V.; Schreck, J. O.; Heikkinen, H., Eds.; ChemSource: New York, 1994; Activity 1: Preparation of Colored Glass, p 5.

Materials for *Glass Solubility Demonstration* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0019	Phenolphthalein Indicator Solution, 1%, 100 mL
GP6060	Tube, Culture, Without Lip, Borosilicate Glass

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.