AP CHEMISTRY LAB
PLASTIC DETERMINATION BY TITRATION[1]

Discussion:

The concept of distinguishing between low-density and high density polyethylene presented by Kolb (1) led to the development of a density lab involving volumetric analysis. Often called the flotation method, this procedure may be used to determine the density of a solid that is insoluble in two miscible liquids of different densities (2).

The plastic barrel of a Bic Round Stic2 pen serves as the solid. It is composed of a polypropylene and contains the pigment titanium dioxide, TiO_2. The density of the plastic, as reported by the Bic Corporation, is 0.903 g/mL and must fall between the densities of the two liquids. Thus, ethanol and water serve as suitable liquids.

Using titration, the end point is reached when a solution of the two liquids has a density equivalent to the plastic of the barrel. At this point, the plastic just becomes buoyant. The solution's mass and density can be calculated since the solution volume and volumes of both liquids at the end point of titration are known. The following procedure is used to determine density of the two liquids. Density of the plastic barrel is then determined utilizing titration and ethanol displacement. Sample data and calculated results are provided in the table.

Materials:

Bic Round Stic pen barrels ethanol d˙H_2O *Glass buret

Procedure A: *Density of Ethanol and Water*

1.) Fill two 50-mL burets, one with distilled water and one with ethanol.
2.) Label two 100-mL beakers, #1 and #2.
3.) Mass beaker #1 and run 15.00 mL of ethanol into it from the buret.
4.) Mass the beaker and ethanol. Save this for procedure B.
5.) Repeat the above procedure using water and beaker #2. Save this for procedure B.

Procedure B: *Density of Plastic by Titration*

1.) Remove and discard from the barrel the inside ink cartridge and the end caps of a Bic Round Stic pen.
2.) Use scissors to cut off two 3-4 mm pieces of the barrel. Save the remainder of the barrel for Procedure C.
3.) Drop one piece into each of the two beakers containing liquids from Procedure A.
4.) Observe evidence that the plastic's density is greater than ethanol but less than water.
5.) Place beaker #1, containing ethanol and plastic, under the buret with water. While stirring vigorously, titrate with water until the plastic just becomes buoyant.
6.) Record the volume of water required to reach the end point.
7.) Remove the plastic very carefully from the solution and use a graduated cylinder to determine the solution's volume.

Procedure C*: Density of Plastic by Displacement*

1.) Determine the mass of the remaining Bic Round Stic pen barrel saved from Procedure B.
2.) Record the volume of ethanol remaining in the buret.
3.) Drop the barrel into the ethanol buret and record the new volume.

Calculations

1.) Calculate the density of the two liquids from the Procedure A data.
2.) Calculate the mass of both liquids in the titration using the densities obtained in Procedure A. Add the masses of water and ethanol to determine the solution's mass at the end point.
3.) Calculate the density of the plastic by using the solution's mass and volume. At the end point, the solution's density is equivalent to that of the plastic.
4.) Calculate the percentage of volume reduction of the titrated solution.
5.) Calculate the plastic density again, this time using the barrel mass and volume displacement of ethanol obtained in Procedure C.
6.) Calculate percentage of error for the densities of water and ethanol. Calculate the percentage of error for the density of plastic determined by both titration and ethanol displacement.

*Buret must be glass. Ethanol will dissolve and destroy a plastic buret.

1. From the Journal of Chemical Education: Vol 70, Number 5.