FLOTATION AND SEPARATION

INTRODUCTION

Many minerals and industrial rocks are processed through a separation process called flotation. This processing is required in order to separate the desired mineral or minerals from other minerals in the ore rock. For coal, water washing is used to clean the coal; however, when pyrite is present in the coal, a flotation method to separate pyrite from the coal is used because water alone doesn't remove the pyrite. The coal is sprayed with a chemical that makes the pyrite repel water. Then the coal is dumped into long boxes with water, and air bubbles are injected from the bottom. The sprayed coal attaches to the air bubbles and is floated to the surface to be skimmed off. The pyrite and other impurities are left in the bottom of the box where they can be transferred to a slurry pond.
Of the chemicals sprayed onto the coal, fuel oil or kerosene is the cheapest. Other chemicals in combinations can also be used.
For materials other than coal, the surfactant chemicals lower the surface tension of water, make smaller bubbles, and build froth. The froth has to be strong enough to support the mineral but weak enough to break down in launderers. The two most common types of frothers are alcohols and glycols. Alcohol froth starts fast but does not last long. Glycols, short polymers of propylene glycol, are strong, persistent frothers. For many applications mixtures of about 25% alcohol and 75% glycol give a fast start and last much longer.

OBJECTIVE

Students investigate a model that illustrates the separation of minerals based on alteration of properties through flotation.

MATERIALS NEEDED:

- Dry roasted peanuts
- Raisins
- Clear Soda Water
- Drinking Water
- 2 clear drinking glasses for each student or group
- Balance (or scale) to weigh peanuts and raisins
- Graduated cylinders to measure the volume of the raisins or peanuts, not including the air of the simple volume measurement of, for example, ½ cup.

PROCEDURE (student directions):

1) Mix ½ cup dry roasted peanuts with ½ cup raisins.
2) Add ½ of the mixture to each drinking glass.
3) Fill the first glass 2/3 full of plain water.
4) Fill the second glass 2/3 full of the clear soda water.
5) Record which of the materials float and which sink in each cup.

EVALUATION:

- Measure the densities of the raisins and of the peanuts in g/mL by weighing a raisin to the nearest milligram (or several raisins if the balance you use doesn't have enough significant figures, then divide by the number of raisins) and measuring the volume by displacement of water in a graduated cylinder. Repeat for the peanuts.
- Measure the densities of water and of the soda water by weighing a specific number of milliliters of each and dividing the mass in grams by the volume in milliliters.
- How do the bubbles affect the densities of the raisins and peanuts?

TEACHER TIPS

- In the plain water both peanuts and raisins will sink but in the soda water, the peanuts will float.
- Why does this work? The densities of both raisins and peanuts are greater than water, so they sink. In soda water, the bubbles attach to both the peanuts and raisins. For the peanuts, the overall density of this combination is less than water, so the peanuts float. Even with bubbles, the overall density of the raisins is greater than the water, so they still sink.
- Why is this application important to the minerals industry? Flotation is one of the methods used in the industry for extraction of minerals. Frothers are added to the solution to lower the surface tension of the water. The froth must be strong enough to support the mineral but weak enough to break down in launderers. Common frothers are alcohols and glycols.

OPTIONS:

- Students can experiment with other items such as beans or shell macaroni.
- Students can research and experiment with other types of frothers for flotation.
- Are the results the same?
- What other items could be used? What properties do the materials have that allow them to be separated by these methods?
- Students can record the time that the peanuts continue to float in the soda water. If fresh soda water is added after the peanuts sink, do the peanuts float again?

- Can the density of the water be changed to separate peanuts and raisins without the use of bubbles?