Science Lab

SEED

Viscosity and Temperature

Different liquids have different properties. One of these properties is *viscosity*, the liquid's resistance to flowing. Water, milk, and fruit juice are comparatively thin and flow more easily than thicker, more viscous liquids such as honey, corn syrup, shampoo, or liquid soap.

Viscosity is an important property of drilling fluids. A more viscous fluid is better able to suspend rock cuttings and transport them to the surface. However, more pressure is needed to pump very viscous fluids, resulting in additional wear and tear on the drilling equipment. Viscous fluids are also more difficult to separate from the cuttings.

Temperature affects the viscosity of most liquids. This experiment focuses on the viscosity of shampoo in a bottle as it is heated and cooled.

Equipment and Materials

To conduct this experiment you will need:

Clear or light colored shampoo (at room temperature)
Clear plastic bottle about 444 mL (15 oz) capacity or slightly larger, with tightly fitting cap [Note: Perhaps use two plastic bottles of inexpensive shampoo. See step #2.]
Stopwatch that measures to 0.1 or 0.01 seconds
Glass marble small enough to fit through the mouth of the bottle
Permanent marking pen
Ruler
Hot water (hot water from a faucet is OK)
Basin large enough for bottle lying on its side to fit
Cold water
Ice cubes
Paper towels
Safety goggles
Thermometer (optional)
Chart like the one below to record your results

The Experiment

Here's what to do:

1. On the side of the bottle about 3 cm (1 in) from each end, draw two lines all the way around with a permanent marking pen. Measure and record the distance between the lines.

2. Uncap the bottle, insert a marble, fill to the top with shampoo at room temperature, and close the cap tightly. [Note: If you have two bottles of shampoo, you could insert the marble in one, and then pour in shampoo from the other to fill to the top.]

3. Turn the bottle upside down and observe the marble as it sinks downward. The marble should come to rest in the cap. This ensures that the marble will drop down the middle of the bottle when it is inverted once more.

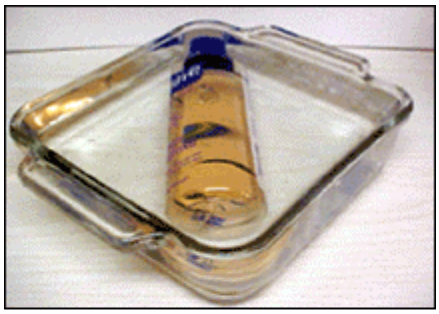
4. Invert the bottle once more and use the stopwatch to measure the time it takes for the marble to sink down the middle of the bottle from the top line to the bottom line. Record the time in the Room Temperature column of the data table opposite Trial 1.

5. Repeat steps #3 and #4 four more times, for a total of five time measurements. Then calculate the average time of the marble sinking in shampoo at room temperature.

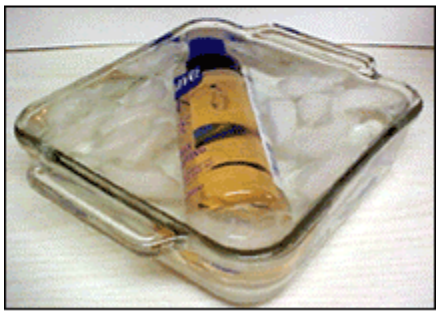
6. Next, investigate the viscosity of shampoo at a temperature higher than room temperature. Fill the basin with hot water from a faucet or other source. Tighten the cap on the bottle and place it in the basin so that the hot water bath can heat up the shampoo. Leave the bottle in the hot water for about 15 minutes. Carefully turn the bottle every five minutes or so to heat the shampoo evenly.

Note: Follow good safety procedures with hot water. Do not splash hot water around or put your fingers into it. Please have an adult assist you with this.

7. Repeat steps #3 and #4 five times and record the data in the Warm Shampoo column of the table. Then calculate the average time of the marble sinking in warm shampoo.



8. What do you think will happen if you cool the shampoo? Let's find out. Fill the basin with cold water and place the bottle of shampoo in it. Add a dozen or more ice cubes, and stir the water gently. Leave the bottle in the cold water for about 15 minutes. Carefully turn the bottle every five minutes or so to cool the shampoo evenly.



9. Repeat steps #3 and #4 five times and record the data in the Cold Shampoo column of the table. Then calculate the average time of the marble sinking in cold shampoo.

Time in seconds for a marble to sink _____ cm in shampoo at different temperatures

Trial	Shampoo at Room Temperature	Warm Shampoo	Cold Shampoo
1			
2			
3			
4			
5			
Average Time			

10. Optional: Measure and record the temperature of the shampoo with a thermometer during the three sets of measurements. Also compare the temperature of the shampoo to the temperature of the water baths.

Temperature and Viscosity

Our Results

We measured the time it took the marble to sink from the top line to the bottom line in the shampoo at three different temperatures.

Time in seconds for a marble to sink 11.5 cm in shampoo at different temperatures			
Trial	Shampoo at Room Temperature	Warm Shampoo	Cold Shampoo
1	23.2 s	10.8 s	46.7 s
2	22.9 s	10.6 s	46.9 s
3	22.8 s	10.8 s	44.9 s
4	23.1 s	9.8 s	43.4 s
5	23.2 s	11.4 s	44.2 s
Average Time	23.0 s	10.7 s	45.2 s

The time for the marble to sink in shampoo at room temperature was greater than the time to sink in warm shampoo, and less than the time to sink in cold shampoo. From the data, we see that cold shampoo has a higher viscosity than warm shampoo and shampoo at room temperature. We can infer that the viscosity of shampoo increases as the temperature decreases.

Try These Ideas

Here are some additional variations to try. Repeat the experiment using:

- a marble of a different size.

- a different liquid, such as corn syrup.

- a taller bottle or a different sinking distance.