Viscosity

Introduction

We deal with flowing liquids all the time. Getting sauce out of a bottle. The spread-ability of honey, jam and butter. Whether dressing stays on salad or drips off. The time taken for water to flow through the tap to fill the kettle. The flow-ability of shampoo is one of the factors that determine how shampoo spreads through our hair.

Flowing liquids are also commonly encountered in industry. The speed of filling a jar with peanut butter determines how many jars can be produced per day. Pouring liquid resin over carbon fibres to make carbon fibre composite. Currently, carbon fibre objects cannot be made fast enough to keep up with the rate of production of cars on a production line. Resin (glue) is applied to the carbon fibre cloth. The resin, which flows slowly, needs to penetrate the cloth, get into all the spaces between the fibres and stick to the fibres before it begins to harden. Both the speed of penetration into the cloth and the speed of hardening of the resin are affected by temperature.

Viscosity is the resistance to flow. Liquids with high viscosity do not flow easily; liquids with low viscosity flow easily.

In this activity, your task is to investigate temperature and the ability of a viscous material (honey) to penetrate a fibrous material (fly wire). We are not using industrial resin because it is toxic.

In carrying out a scientific investigation it is important to be very clear about the question you are trying to answer. With a clear question in mind you can identify the variables you will change (independent variable), keep constant (controlled variables) and measure (dependent variable) and design the steps necessary in conducting the investigation. In this activity, you will be given the steps to follow. You will be asked to make predictions and identify question can be answered using the procedure and later you will be asked to identify the question that the

method allows you to answer. You will also be asked to try to explain your observations using the particle model of matter.

Key ideas

Viscosity - The resistance to flow. More precisely, the resistance to change shape by when a force is applied.

Force - A force is a push or a pull. A force can cause movement in an object or cause compression, tension or torsion within the object.

Adhesive forces - The force of attraction of the particles (molecules) of one material for another. For a water drop on a window these would be the forces of attraction between water molecules and the glass molecules.

Cohesive forces - The force of attraction of the particles (molecules) of within a material. For a water drop on a window these would be the forces of attraction between water molecules and the glass molecules.

Flow - The movement of a fluid.

Flow rate - The amount of fluid that has moved in a given time.

Fluid - A fluid is a material than can flow. It can be either a liquid or gas. Fluids can flow to take the shape of their container. Technically, a fluid is a substance that continuously changes shape or flows when a force is applied.

Investigation - A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities

Variable - Something that can change.

Dependent variable - Variable that changes in response to changes in the independent variable and that is observed or measured.

Independent variable - Variable that is deliberately changed.

Controlled variables - Variables that are kept constant.

Fair test - When testing different materials all the variables except the one being tested need to be kept the same.

Equipment and materials

- Test tubes (5)
- Test tube holder (peg)
- Test tube rack
- Beakers (250mL or 500 mL)
- Measuring cylinder (10 mL)
- Thermometer (0–100°C)
- Fly wire (plastic insect screen).
- Rubber bands (5)
- White tile or cavity tile
- Honey
- Water baths set up at the following temperatures (10°C, 20°C, 40°C, 60°C and 80°C)

Hazards

In this activity, you will be handling **hot objects** and **hot liquids** that can burn your skin. Take special care near hot objects and when handling hot liquids. Use test tube holders for holding hot test tubes and for pouring hot liquids. Inform the teacher if you burn yourself so that first aid can be applied.

Broken glass is a hazard. Do not handle broken glass. Tell the teacher immediately if any glass is broken so that it may be cleaned up safely.

Spilt water (or any other liquid) on the floor can be a slipping hazard and must be cleaned immediately.

Investigation

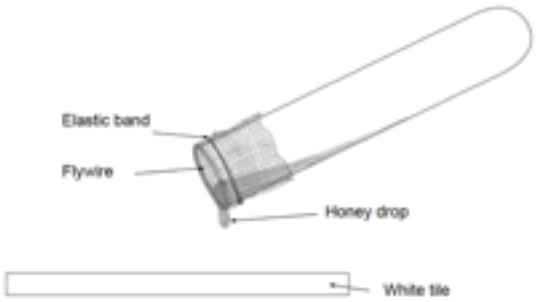
1. Set up 5 water baths at different temperatures. 10°C, 20°C, 40°C, 60°C and 80°C (This may have been done for you).

2. Put 2 mL of honey into each of five test tubes.

3. Cover the top of the test tube with two layers of fly wire and use a rubber band to hold the fly wire in place.

4. Place one test tube in each water bath and leave for 5 minutes.

5. Take the test tube out of the water bath and immediately (before the temperature changes) begin to pour the honey out of the test tube. Make sure you leave room for air to get into the test tube. Try to keep the angle of the tipped test tubes the same.



6. Depending on the available equipment, you might:

   - Tip the test tube up and pour the honey into a container. Measure the time it takes for two drops of honey to be poured out.

   - Pour the honey onto a tile with wells and time how long it takes to fill the well.

7. Record your results in the table.

Hypothesis and prediction

A hypothesis is a testable "educated-guess" answer to a scientific question. A hypothesis leads to one or more predictions that can be tested by an investigation.

What hypothesis is being tested in this experiment?

A prediction is a guess what might happen in a test, based on the hypothesis (testable "educated-guess") and previous observations.

What do you predict will happen in this experiment?

Remember to think about variables that will need to be controlled to ensure a "fair test". Decide which variables you will keep the same (controlled variables) which variable you will change (independent variable) and which variable you will measure (dependent variable).

Our **independent variable** is:

Our **dependent variable** is:

Our **controlled variables** are:

Results

What happened? Record your observations or measurements. Remember to include units for all numerical measurements. There is space in the table to include results from other groups in the class.

Temperature	**Time**					
	My results					
10°C						
20°C						
40°C						
60°C						
80°C						

Analysis

Do you need to summarize your results, draw graphs or do calculations such as work out averages? If so show your analysis here.
(Hint: put all the data on a single graph.)

Which liquid sample moved through the fibrous fly wire fastest?

Discussion and Conclusions

What question does the method allow you to answer?

What is the answer to this question?

Use a diagram to represent what happens to the particles in a liquid when it flows (is poured).

Use a diagram to explain what happens to the viscosity of honey when it is heated.

What was the advantage of using data from other groups in the class?

From your investigation, what advice would you give to the scientists working on the carbon fibre composite problem?

Copyright and Creative Commons

Excepting logos, trademarks or other third-party content as indicated, this resource is distributed under a Creative Commons 'Attribution-Non Commercial-Share Alike' 4.0 International License.
The moral rights of the authors, Ian Bentley, and Kieran Lim, have been asserted under the Australian *Copyright Act* 1968 (Cth).