UNIT A - MIX AND FLOW OF MATTER

TOPIC 4: FLOW RATE AND VISCOSITY

VISCOSITY

Viscosity is *a property of a fluid that describes its thickness or thinness*. A thicker liquid is more *viscous* and has a higher viscosity. Viscosity is a *property* of all fluids, including liquids and gases, whether they are *pure substances* or *mixtures*.

Examples: high – molasses, syrup, glue

low – water, juice

VISCOSITY OF A GAS VS. LIQUID

It is more difficult to imagine the viscosity of a gas because most gases are invisible and difficult to feel for "thickness". Viscosity in gases increases and decreases in a different way than it does for liquids.

FLOW RATE

Flow rate is the *time it takes for a fluid to flow from one point to another.* It is the *volume of fluid that passes a point in a pipe or tube in a certain amount of time.*

Formula:

$$\text{Flow rate} = \frac{\text{Distance}}{\text{Time}}$$

OR → Flow rate = distance ÷ time

FLOW RATE

When comparing 2 or more fluids:

If something has a high flow rate → less viscous!

If something has a low flow rate → more viscous!

Example: Ms. B poured coffee down her binder. The coffee traveled 20 cm in 10 seconds. She then spilt her yogurt which travelled the same distance but took 60 seconds.

$$\text{Flow rate of coffee} = \frac{20\text{cm}}{10\text{sec}} = 2\text{cm/sec}$$

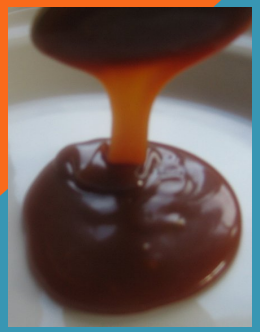
$$\text{Flow rate of yogurt} = \frac{20\text{cm}}{60\text{sec}} = 0.333\text{cm/sec}$$

VISCOSITY IN THE WORKPLACE:

It is important for some industries to know how viscous a fluid is because they *need to understand viscosity of liquids and how to adjust it to suit specific industry applications.*

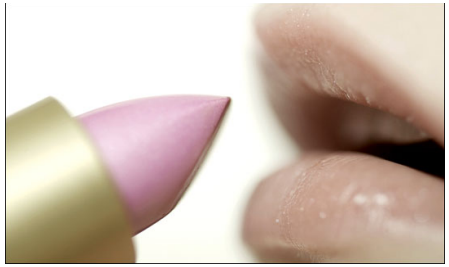
A few examples of industries and products in which the viscosity of a fluid is important are:

Food industry - sauces, syrups, frostings, gravies, etc



VISCOSITY IN THE WORKPLACE

Cosmetics – lipstick, foundation, nail polish, mascara, etc,

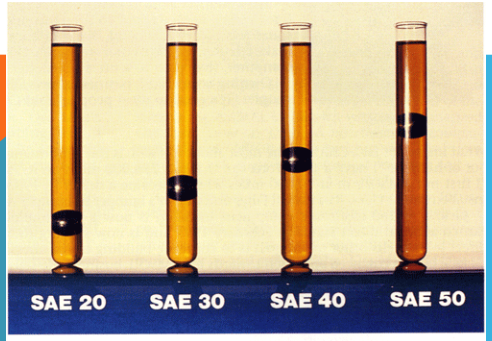


Candy Makers – melting chocolate, caramel

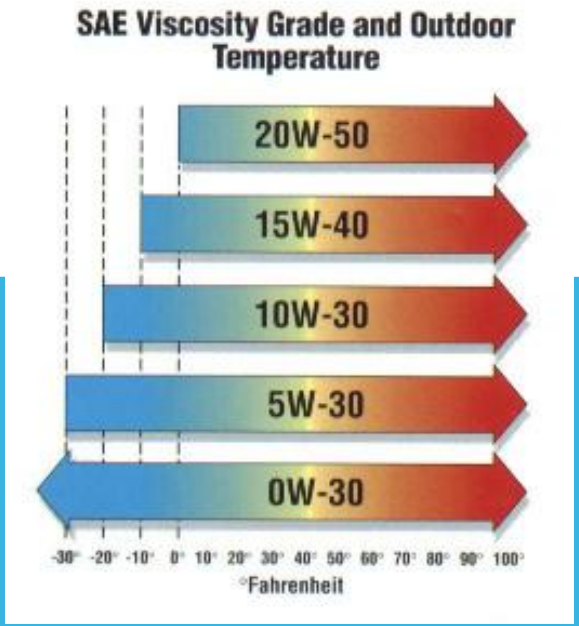
VISCOSITY IN THE WORKPLACE

Paint – easily applied with brush, roller or sprayer; good coverage

Automotive – use the correct engine oil for the season and needs

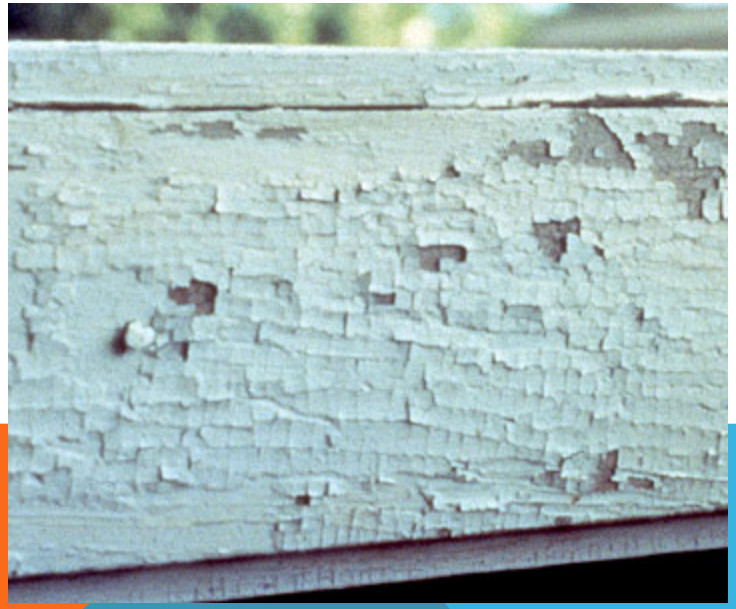


Steel balls of equal weight dropped into test tubes filled with motor oils fall at different rates. Their rate of fall depends on the viscosity of the oil. The ball travelling through the light SAE 20 oil has travelled farthest, while the ball in the heavy SAE 50 has travelled least.



VISCOSITY

A situation where a fluid would not perform well if it were too thin is with paint: if it were too thin, it would not stick properly to the wall. Thin paint checks and cracks easily.



VISCOSITY

A situation where a fluid would not perform well if it were too thick is makeup or with syrup:

VISCOSITY

The viscosity of nail polish and mascara is controlled by the amount of *solvent* that is added. Any less, and both products would be too *difficult* to apply; any more and they would take too *long* to dry.

HOW DOES THE VISCOSITY OF LIQUIDS VARY?

Another way to define viscosity is *resistance to flow*. The attractive forces between the particles allows them to move around, but they may experience difficulty passing each other. This resistance to flow creates *internal friction*. Friction is caused when two surfaces *are rubbed together*. It is easier for some fluid particles to *move* past each other, compared to other fluids.

HOW DOES THE VISCOSITY OF LIQUIDS VARY?

The Particle Model of Matter helps explain why oil has a higher viscosity than water: *The attractive forces between particles in some fluids are stronger than the attractive forces in other fluids. As oil particles flow past each other they are so attracted to one another that they slow down as they pass by. Water particles slip past each other easily with little attraction between the particles.*

HOW DOES THE VISCOSITY OF LIQUIDS VARY?

The Particle Model of Matter shows us that as the temperature of a material increases, the attractive forces (bonds) between the particles of the material *decrease* due to the extra energy from the heat. *Warmer* liquids flow more quickly and *cooler* liquids flow more slowly. In summary, the viscosity of a liquid *decreases* as it is heated, and *increases* as it is cooled.

HOT OR COLD?

HOW DOES THE VISCOSITY OF GASES VARY?

Gases flow *differently* than liquids particles. Gas particles are so far apart, and the attractive forces are so low, that the type of gas particle is *less* important than in a liquid. Particles of gas are more likely to *collide* with each other rather than rub against each other.

HOW DOES THE VISCOSITY OF GASES VARY?

As gas particles gain energy, their motion *increases* in all directions, increasing the number of *collisions*. Under this condition, internal friction is *high*, and the gas will not flow easily or quickly out of the opening.

The viscosity of a gas *increases* as it is heated, and *decreases* as it is cooled.

QUICK REVIEW:

Viscosity is *a property of a fluid that describes its thickness or thinness*.

Two materials that have a low viscosity and two materials that have a high viscosity are:

Low viscosity –

High viscosity –

QUICK REVIEW:

How is viscosity, the size & shape of particles, temperature and internal friction related?

In a liquid:

QUICK REVIEW:

Flow rate is the time it takes for a fluid to flow from one point to another.

$$\text{Flow rate} = \frac{\text{distance}}{\text{time}}$$

If a material has a high viscosity, then that material has a *slow* flow rate.

LAB: VISCOSITY LAB

Please see handout!