

# VISCOSITY IS A VIRTUE

## PRE-LAB DISCUSSION

The machines upon which our technology depends will not operate without lubricants. Engines are made of metal parts, which move against each other, creating friction and wear. Lubricants function to keep the metal parts from actually touching each other. A thin layer of oil, grease, or other lubricant must be placed between the moving parts to prevent them from actually touching. The lubricant must be placed between the parts before they are forced together, and must have enough **viscosity** so as not to be squeezed out from between the parts before the pressure between the metal parts is relieved. The higher the viscosity, the slower the lubricant will move and the better it will adhere to the metal parts. Therefore, once a lubricant is placed between moving parts, the higher the viscosity, the more it will protect moving parts.

But the problem is more complicated. Machines move at speeds that allow only milliseconds to place the lubricate between the moving parts. The lubricant must be thin enough to get an adequate amount of lubricant between the parts when they are not being forced together. Understanding viscosity is further complicated by the fact that the viscosity of most fluids decreases as temperature increases. Machines operate over a wide range of temperatures, so a lubricant which protects moving parts at room temperature will not do the job at 200° F.

The Society of American Engineers determines the viscosity of motor oils by measuring the time it takes a weight to drop through a standard distance of oil. A weight will fall more slowly through a high viscosity oil than it will through an oil of low viscosity. All lubricating oils have a viscosity rating on the container. Most automobile engines require an oil that has 30 weight S.A.E rating.

In very cold climates, a thinner oil may be used in the wintertime and in very hot areas, a thicker oil may be used in summer. Oil chemistry has advanced from just refining oils to specific viscosities, to adding chemical agents, which control viscosity over a range of temperatures. Now motor oils have viscosity ratings such as 10w- 30w. This means that the oil acts like a thin oil at cold temperatures but at higher temperature gives the protection of a 30-wt. oil.

Heat will cause the long molecules of an oil to break into small molecules. This will change a thick oil to a thin oil. Oxygen will react with oil to create heavier particles which become "sludge" that may clog oil lines or narrow channels that oil must move through to provide lubrication.

In this investigation, you will compare the viscosity of three different grades of motor oils. You will compare their viscosity at three different temperatures and then you will test a multigrade oil at the same three temperatures. Finally you will test a sample of used motor oil. You will need to find the oil change sticker [usually inside of a car door]. From this you will determine the brand and grade of the oil. By comparing the mileage on the car's odometer and the mileage on the oil service sticker, you will be able to determine the number of miles driven using this oil.

#### OBJECTIVES:

To compare the viscosity of motor oil at different temperatures; compare the viscosity's of several grades of motor oil; and to compare the viscosity of new and used motor oil.

#### EQUIPMENT/CHEMICALS

Glass beads, large test tubes, test tube clamp, ring stand, 250 or larger beakers, hot plate/Bunsen burner, ice, at least 3 grades of motor oil, one sample of multi-grade motor oil, sample[s] of used motor oil, watch or timer with second hand. [optional-microscope]

#### PROCEDURE

##### PART I

##### *COMPARING MOTOR OILS AT ROOM TEMPERATURE*

1. Complete at least 3 trials on each oil sample and record all results in the data table.

Clamp a large test to a ring stand. Fill it almost to the top with a sample of motor oil.

2. Mark the level of oil in the test tube. Each time the test is repeated, the test tube must be filled to this line with oil.
3. Use a timer with a second hand. Drop a glass bead in the test tube and record the seconds it takes to drop to the bottom.
4. When the test of this oil is completed, pour the oil through a wire screen and into a beaker. Remove the glass beads from the screen and set them aside on a paper towel.
5. Repeat steps 1-4 for all of the motor oil provided for this investigation.

## PART II

### *COMPARING MOTOR OILS AT NEAR FREEZING TEMPERATURES*

1. Place the test tube of oil in a beaker of ice and water. Stir the oil *very carefully* with a thermometer until the oil is about 3° C. Record the lowest temperature of the oil.
- 1a. [***Alternative method***] refrigerate the oil samples overnight. Record The temperature of the oil at the beginning of each test.
2. Repeat Part I steps 1 through 5 and record the results of the trials in the data table.

## PART III

### *COMPARING MOTOR OILS AT NEAR BOILING TEMPERATURES*

1. Place the test tube with the oil sample to be tested in a beaker of boiling water. ***Caution. Use a hot plate or turn off the Bunsen burner before placing the oil sample in the boiling water. Never allow an oil sample to come even close to a flame.***
2. Repeat Part I steps 1 through 5 and record the results of the trials in the data table.

Type of oil	Seconds at 3°C	Seconds at room temperature	Seconds at near 100°C
	Ave Trial 3 Trial 2 Trial 1	Ave Trial 3 Trial 2 Trial 1	Ave Trial 3 Trial 2 Trial 1

Questions

1. Describe the appearance and odor of the used motor oil. If possible, examine a thin film of used oil under a microscope.
2. How does the viscosity of the used oil compare to the same grade of virgin oil?
3. What factors may have caused the changes in appearance, odor, and viscosity of the used motor oil?
4. Does the used oil protect the moving metal parts in as well as fresh oil? Why or why not?

THINKING SCIENTIFICALLY

1. Why is it important for the life of a machine to change the oil regularly?
2. Why do some experts recommend that an engine is allowed to warm up a few minutes before driving a car in very cold weather?
3. It has been said that most of engine wear occurs in starting the engine. Explain how this may be true based on your knowledge of motor oil and its functions.
4. You are buying a used car and find two similar cars with about the same mileage on the odometer. A salesman who traveled over a large area drove one. An office worker who drove in the city to

work and did other local driving drove the other. Which car would you buy based on your knowledge of oil and engine wear? Explain your choice.