Intro to Fluids: Density and Viscosity

Pipe Trades

Grades
- Grades 3, 5, 8

Learning objective
Describe the properties of fluids, including density, and viscosity

Concepts
- Density
- Fluids
- Viscosity
- Temperature

Description and Trades Connection

In this lesson, students will explore the fundamental properties of fluids, such as density, and viscosity. Through engaging activities and hands-on experiments, they will gain a deeper understanding of how these properties affect the behavior of different liquids.

Understanding fluid properties such as density, and viscosity is important in the pipe trades. Plumbers prevent pipes from freezing by adding antifreeze, which changes the fluid's density. By understanding the density of the fluid, pipe tradespeople can calculate the pressure required to move fluids through pipes. Viscosity knowledge helps plumbers select appropriate pumps and pipes for different fluids, ensuring efficient flow and preventing blockages.

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Scan to access video demonstrations, activities, classroom resources and more at learninginnovation.ca/k-12STEM

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Curriculum Connections

Grade 3: Matter

Students investigate and analyze how materials have the potential to be changed.

- Knowledge:
  - A liquid is a state of matter that has a definite volume but no definite shape.
  - A liquid flows and takes the shape of the container it is in.
- Understanding:
  - Solids, liquids, and gases have distinct properties.
- Skills & Procedures:
  - Describe solid, liquid, and gas states of matter in terms of the properties of shape and volume. Conduct an investigation to demonstrate the properties of the state of matter.

Grade 5: Classroom Chemistry

Students investigate the particle model of matter in relation to the physical properties of solids, liquids, and gas

- Knowledge:
  - Volume is the amount of space a solid, liquid, or gas takes up.
  - Density is a comparison of the mass of a solid, liquid, or gas to its volume.
  - Density can be described comparatively using the phrases denser and less dense.
- Understanding:
  - The movement and arrangement of particles affect the physical properties of matter
- Skills & Procedures:
  - Directly compare the density of liquids

Grade 8: Mix and Flow of Matter

- Investigate and describe the composition of fluids, and interpret the behaviour of materials in solution
- Investigate and compare the properties of gases and liquids; and relate variations in their viscosity, density, buoyancy and compressibility to the particle model of matter.
- Identify, interpret and apply technologies based on properties of fluids

Preparation:

Gather all necessary materials, including the Fluid Properties STEM kit and various liquids, and set up the classroom with materials. Review key concepts related to density, and viscosity.

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Procedure

Introduction (5 minutes):

- Introduce students to the Fluid Properties STEM kit and key concepts.
- Start by showing the Fluid Properties STEM kit and explaining that it will help students learn how water and other liquids behave. Show kit overview video OR give a similar overview yourself:
  - Fluid properties kit: Overview video (Lethbridge Polytechnic, 2024)
- Ask students what comes to mind when they hear the words “fluids”, “density” and “viscosity.”
- Explain that today, we will learn what these three terms mean and why they are important in the pipe trades.
- NOTE: Some grades do not have these concepts in their curriculum. The depth of your conversation depends on the grade level of your students.

Key Terms and Concepts:

- **Fluid:** Fluids have a definite volume but no definite shape. Fluids take the shape of their container and flow. Show different liquids in their original container and note the shape. Optionally, pour some of these liquids into a fluid properties pipe and see how the liquid now takes on the shape of the pipe.
- **Density**: Density is the mass per unit volume of a substance. It tells us how much matter is packed into a given space.
  - Example: Show a clear pipe with water and oil. Explain that oil floats on water because it is less dense.
  - Application in Pipe Trades: Plumbers need to know the density of fluids to understand how they will move through pipes. For example, antifreeze is added to water in pipes to prevent freezing, which changes the density of the fluid. As density increases, it becomes harder to move the fluid through pipes. This is important for all fluids, not just water.

Time

30-45 minutes

Materials

- Whiteboard and markers
- Various liquids (water, oil, detergents, soap etc.)
- Drain buckets (10) *(included in kit)*
- Measuring cups (10) *(included in kit)*
- Scales (10) *(included in kit)*
- Pipe stands (10) *(included in kit)*
- 1” & 3” pipe assembly (10) *(included in kit)*

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Procedure

    - Additional Notes: Temperature can also affect density; for example, in a hot water heating tank, hot water rises to the top because it is less dense. Ice is less dense than water and rises to the top if it is in water.
- **Viscosity:** Viscosity is a measure of a fluid's resistance to flow. It describes how "thick" or "sticky" a fluid is.
    - Example: Compare room temperature syrup to heated syrup. Heated syrup flows more easily because it is less viscous.
    - Application in Pipe Trades: Plumbers need to know the viscosity of fluids to choose the right pumps and pipes. More viscous fluids require more pressure to move.
    - Additional Notes: Viscosity affects how fluids adhere to pipes and how hard they are to move. Temperature can change viscosity; for example, heating syrup makes it flow faster.

Hands-On Activity:

- With the stations set up and students divided into groups, students can begin to explore liquids, density and viscosity. This can also be done as a whole class demonstration.
- Students can take the volume and weight of each liquid before putting it into the pipe.
    - To take the weight of the liquid, first take the weight of the measuring cup. Next, pour the liquid into the measuring cup to the desired volume. Weigh the liquid in the measuring cup for a total weight. Subtract the weight of the measuring cup from the total weight to get the weight of the liquid. Record the volume and weight of the liquid on a piece or paper or on the board if this is being done as a whole group demonstration.
    - With the volume and mass of the liquid, students can observe the density of each liquid and if desired, density can be calculate with the formula Density= Mass/Volume
- Show how different liquids (water, oil, detergents) behave in the pipes by pouring each liquid into a separate pipe, highlighting the shape of the liquid and viscosity.
- Have students predict which liquid will flow fastest through the pipe and then test their predictions. Have them measure the flow rate of each liquid through the pipes by timing how long it takes each liquid to drain from the pipe. Students can record their observations on a piece of paper or it can be recorded on the board if done as a whole class. Encourage them to discuss how the properties of each liquid affect its flow.
- NOTE: Use the same size of pipe for each liquid.

Conclusion:

- Recap the key points of the lesson, emphasizing the importance of understanding fluid properties in plumbing.
- Ask students to share their observations from the hands-on activity.

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Assessment and Online Resources

Assessment suggestions

- Have students rate their understanding of density and viscosity.
- Discuss the lesson as a class:
  - How does temperature affect the viscosity of a liquid?
  - Why is it important for plumbers to understand the density of different fluids?

Online resources

- Fluid Properties Kit Home Page (Lethbridge Polytechnic, 2024)
- Fluid properties kit: Overview video (Lethbridge Polytechnic, 2024)

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