

Storing Propane Fuel

LESSON 9

UNIT: PROPANE

PROBLEM AREA: PROPANE USE IN AGRICULTURE



STUDENT LEARNING OBJECTIVES

Instruction in this lesson should result in students achieving the following objectives:

1. Explain the concepts of pressurized gas storage.
2. Classify storage cylinders and systems for propane applications.
3. Explain how to store small propane cylinders for home and farm use.
4. Describe propane tank installations.
5. Describe overfill protection devices and other propane safety features.

NATIONAL SCIENCE STANDARDS ADDRESSED IN THIS LESSON

All students should develop an understanding of:

Physical Science: Content Standard B

- Structure and properties of matter
- Interactions of energy and matter

LIST OF RESOURCES

The following resources may be useful in teaching this lesson:

- Propane.com/Agriculture
- Energy.gov
- PropaneSafety.com

LIST OF EQUIPMENT, TOOLS, SUPPLIES, AND FACILITIES

- Copies of sample test
- Visuals from accompanying masters copies of student lab sheet

TERMS

The following terms are presented in this lesson (*shown in bold italics throughout the lesson*):

1. bulk tanks
2. distillation
3. elastomeric seals
4. fixed containers
5. gas
6. liquid
7. overfill prevention device (OPD)
8. portable tanks
9. regulator
10. safety relief valve (pressure relief valve)
11. shut-off valve
12. tank gauge

TELL STUDENTS...

"Today you will be learning about how gas is stored under pressure. You will also learn some of the safety features used with propane cylinders. In addition, you will learn about how cylinders are classified and how they should be installed and stored in the home or on the farm."

INTEREST APPROACH

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible interest approach is included here.

WORD SEARCH

1. Hand each student a word search puzzle that is face down (**VM-A**). Give students five minutes to find as many words as they can that relate to propane gas. Tell the students they may turn over their papers and begin when you say, "Go."
2. After five minutes, ask the students to stop. Ask each of the students to count the total number of words they found. You may choose to reward the student who found the most words.
3. Have students call out the words they found, and write them on the board. Ask the students to explain how each of the words may relate to propane storage and safety. You may want to give students additional time to find all of the words.

Summary of Content and Teaching Strategies

OBJECTIVE 1

Explain the concepts of pressurized gas storage.

ANTICIPATED PROBLEM

How and why is propane pressurized?

Propane is a highly useful and safe product that can be found in two physical states: liquid and gas. The product purchased is a **liquid** – a form of matter that has no definite shape but has a definite volume. However, propane exists as a **gas** – a form of matter that has no definite shape or definite volume – in nature.

- A. Natural gas mixtures are found under the earth's surface; the mixtures contain several hydrocarbon compounds that are useful as energy sources. Natural gas is primarily methane gas, but it also contains ethane, butane, and propane. The individual gases are separated out through the process of **distillation**, which involves applying heat to a pressurized tank. When the gas mixture reaches the boiling point of one of the individual gases (e.g., propane boils at -44°F), that gas will evaporate and leave the mixture. It is then captured through a cooling process (condensation). The process continues until other gases in the mixture are separated.
- B. Applying pressure to propane causes the gas to convert to its liquid state so it can be placed in pressurized propane tanks and transported.
- C. As a liquid, propane is 270 times more compact than in its gaseous state, making it much more economical to store and transport in this physical state.

SUGGESTED TECHNIQUE TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Display **VM-B** to help explain the economy of pressurized propane. Tell the students to take notes during the discussion.

OBJECTIVE 2

Classify storage cylinders and systems for propane applications.

ANTICIPATED PROBLEM

What are the types of propane cylinders, and what are their applications?

Propane cylinders and tanks are designed to keep propane pressurized, allowing it to stay in its liquid form until it is used. Special paint that reflects heat helps keep the propane below its boiling point. For safety purposes, every propane cylinder has certain standards that need to be met prior to being filled.

- A. Propane cylinders have several safety features that must be free of damage.
 1. Propane cylinders are qualified (safety-tested and marked with a date) when they are made and must be requalified every 12 years. The requalification date confirms that the cylinder has been inspected and is free from damage. The cylinder cannot be refilled if it is not inspected before the due date. Several safety labels and markings are made on the cylinders to promote safety and proper use.
 2. The cylinders need to be inspected for cracks or leaks, bulging, major denting or gouging, defective valves, leaking pressure relief devices, damage to the cylinder valves or foot rings, and evidence of abuse.
- B. Propane tanks are available in a variety of sizes. The tank size typically reflects the recommended use for the propane. Consumers who use propane for recreational purposes (e.g., camping or grilling) generally require a smaller tank than those who use propane for agricultural or home use.
 1. **Portable tanks** (tanks that can be moved) include cylinders and bottles. Portable containers are generally small or medium. To be considered a portable tank, the gas capacity has to be 1,001 pounds or less. Portable tanks are used for grilling, camping, hand torching, agricultural weed burners, recreational vehicles, plumbers' melting pots, etc. Many tanks used in homes are considered portable.
 2. **Fixed containers** (storage containers) are large, stationary propane storage tanks. These tanks are found at industrial facilities and are sometimes considered bulk tanks. They can hold 1,001 pounds or more.
 3. **Bulk tanks** can hold more than 2,000 gallons and are often used for emergency purposes (e.g., back-up tanks).

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Have students create checklists pertaining to requalification for propane cylinders.
2. Ask the students to share their answers or collect their checklists.
3. Lead a class discussion regarding where fixed containers, bulk tanks, and portable tanks may be located in your area.

OBJECTIVE 3

Explain how to store small propane cylinders for home and farm use.

ANTICIPATED PROBLEM

How should cylinders be stored for farm and home use?

Propane cylinders are built to store pressurized propane gas, but they must be used properly and should only be filled to 80 percent of the tank's capacity. Filling to less than 100 percent capacity allows for liquid propane expansion, which might occur on hot days.

- A. Small propane cylinders should be stored properly.
1. They should be stored outside, not in the garage or in any other indoor area – even during the winter.
 2. The cylinders should be kept out of excessive heat because heat can cause a buildup of pressure within the cylinder. The buildup of pressure can, in turn, cause the pressure release valve to release propane. It may seem convenient to store cylinders beside a grill or fireplace, but it is not safe.

SUGGESTED TECHNIQUE TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Fill a hat, small box, or bowl with role-play scenarios about propane tank safety. Divide the class into small groups, and have each group do a role play using the information in this objective.

POSSIBLE SCENARIOS

1. Mr. Larson, a farmer, forgets to take a propane cylinder off the back of a truck. As a result, it sits in the 95° heat all day.
2. Brad's dad decides to put the grill and the gas cylinder in the storage shed because it is a very hot day.
3. While distracted by a phone call, the technician at the processing plant fills a propane cylinder to 99 percent capacity.

OBJECTIVE 4

Describe propane tank installations.

ANTICIPATED PROBLEM

What is required for the proper installation of propane tanks?

Any type of propane tank should be installed by a professional, licensed propane dealer. If filling a fixed cylinder or bulk tank, certain preparations should be made prior to installation, including the completion of a sample planning worksheet to determine the proper location and an appropriate tank choice.

- A. **Step 1:** Gather the cylinder(s), tools, and equipment required for the installation. Solid masonry blocks are probably the best long-term foundations. For proper drainage, the blocks should raise the cylinder above the ground sufficiently to avoid water damage to the foot ring. Concrete foundations are sometimes used in flood plains. In some areas, state and local codes may require that propane containers be installed in and secured to a concrete foundation. When a tank is being installed, it should be delivered empty and filled on-site.
 - B. **Step 2:** Verify the proper location for the cylinder. The Department of Transportation (DOT) has safety requirements that must be followed. For example, the relief valve must be at least 5 feet in any direction from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. The cylinder should also be filled on-site from a bulk truck. The filling connection and vent valve must be at least 10 feet from any exterior source of ignition, openings into direct-vent appliances, or mechanical ventilation air intakes. The propane installer will determine the best location.
1. The installer will explain his or her rationale for selecting the cylinder location.
 2. The customer's general preference for the cylinder location (e.g., side of house or rear of house) will be considered. The installer is required to place the tank in an approved and safe location.
 3. The distance to important buildings and property lines as well as access for fuel delivery and fire-fighting personnel must be considered.
 4. If the cylinder is to be filled on-site (stationary service), there should be access for fuel delivery from a bulk truck. Therefore, the site for the cylinders should be no farther than 50 or 60 feet from the parking location.
 5. A sketch of the property and cylinder location will need to be drawn to indicate the total number and types of cylinders to be used.
- C. **Step 3:** Prepare the foundation. The location should be rechecked to ensure that the cylinder will be located the required distance from combustibles and sources of ventilation, exhaust, etc. Also, the site and blocks should be level.
 - D. **Step 4:** Properly unload and install the cylinder. If only one cylinder is being installed, the cylinder should be placed upright in the center of the foundation. If two cylinders are being installed on the same foundation, both cylinders should be placed on the foundation with at least 2 or 3 inches separating them for service access and maintenance purposes.

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Conduct a discussion on how to properly prepare for, place, and install a propane tank.
2. Ask the students to pretend they are propane dealers and to map out what they would do first. Explain that many propane dealers use a worksheet to identify proper placement and installation.
3. Use **VM-C** to assist students with comprehension of this objective.

OBJECTIVE 5

Describe overfill protection devices and other propane safety features.

ANTICIPATED PROBLEM

What devices and safety features can be found on propane cylinders and what are their functions?

Propane tanks have several features to ensure consumer safety: the overfill prevention device (OPD), shut-off valve, regulator, safety relief valve (pressure relief valve), and tank gauge.

A. An **overfill prevention device (OPD)** is a safety feature that helps prevent small propane cylinders from being overfilled because overfilled cylinders do not have enough space if the liquid expands when exposed to warmer temperatures. This can cause an increase in cylinder pressure and may create hazardous conditions. Most cylinders with OPDs have special triangular hand wheels with the letters “OPD” on them. In many states, cylinders without OPDs cannot be refilled.

- B. The **shut-off valve** is located at the top of the propane cylinder and is responsible for closing off the flow of gas from the cylinder. This can be used in times of emergency or in case of a leak.
- C. A **regulator** controls the flow of propane gas.
- D. The **safety relief valve (pressure relief valve)** is used to protect 20-pound and other propane cylinders from over-pressurization. Excessive pressure can occur as a result of an increase in temperature or due to overfilling. The valves are typically spring-loaded devices with **elastomeric seals** – items that prevent the internal cylinder pressure from rising above a predetermined level by venting the excess pressure and then resetting when the pressure is reduced to an acceptable level.

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Give the students five minutes to write the names of safety devices found on propane cylinders and their uses.
2. Collect their writings to assess their comprehension.
3. Review as needed.

REVIEW/SUMMARY

Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. The anticipated problems can be used as review questions.

APPLICATION

Use the included visual masters to apply the information presented in the lesson.

EVALUATION

Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

ANSWERS TO SAMPLE TEST

Use the included lab sheets to apply the information presented in the lesson.

PART ONE: MATCHING

- | | | |
|------|------|-------|
| 1. l | 5. f | 9. d |
| 2. g | 6. j | 10. k |
| 3. a | 7. e | 11. c |
| 4. b | 8. i | 12. h |

PART TWO: SHORT ANSWER

- Step 1:** Gather the cylinder(s), tools, and equipment required for the installation.
Step 2: Verify the proper location for the cylinder(s) on the site.
Step 3: Officially prepare the foundation of the cylinder after the location has been decided.
Step 4: Make sure the cylinder is properly unloaded and installed on the prepared location.
- Propane cylinders should be stored outside. Do not store any propane cylinders in the garage or in any other indoor areas, even during the winter. Keep cylinders out of excessive heat to prevent the buildup of pressure within the cylinder, which may cause the pressure release valve to release propane. It may seem convenient to store cylinders beside a grill or fireplace, but it is not safe.
- 30 percent.

PART THREE: COMPLETION

- liquid
- portable tanks or cylinders
- overflow prevention device
- tank gauge

Storing Propane Fuel

PART ONE: MATCHING

INSTRUCTIONS: Match the term with the correct definition.

- | | | |
|----------------------|---------------------|--|
| a. distillation | e. OPD | i. shut-off valve |
| b. portable tanks | f. fixed containers | j. bulk tanks |
| c. elastomeric seals | g. gas | k. safety relief valve (pressure relief) |
| d. regulator | h. tank gauge | l. liquid |

- _____ 1. A form of matter with definite volume but no definite shape
- _____ 2. A form of matter that has no definite shape or definite volume
- _____ 3. Propane that is pressurized to the correct temperature and turns into a liquid
- _____ 4. Propane tanks that can be moved
- _____ 5. Large, stationary propane tanks
- _____ 6. Tanks with the capacity to hold more than 2,000 gallons
- _____ 7. A safety feature that prevents small propane cylinders from being overfilled
- _____ 8. A safety feature that closes off the flow of gas that comes from the cylinder
- _____ 9. A safety feature that controls the flow of propane
- _____ 10. A safety feature that protects 20-pound and other propane cylinders from over pressurization
- _____ 11. A safety feature that prevents the internal cylinder pressure from rising above a predetermined level by venting the excess pressure and resetting when the pressure is reduced to an acceptable level
- _____ 12. A feature that indicates the remaining amount of propane in a tank

PART TWO: SHORT ANSWER

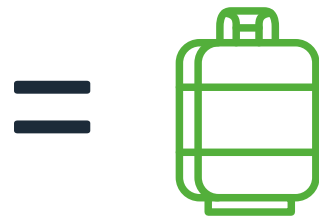
INSTRUCTIONS: Provide a short written answer to the following questions:

1. What are the four main steps in properly installing a propane tank?

Word Search – Propane

F S K G N H G C H C T Z T F A T K A B N W Y X E P
 H R E W A T O C V X U P A D U Z V H E G Y K M Z I
 K A I E C H X Y S L A Q V N P T R H C B S S H T S
 G F I X E D Z D U R C D L O O X K T C T K L H P P
 D T C D W T U K Z Y U H E S D I M P I S N Z B Y L
 I J V N R U C S D Y Z O O X A I T M F P A Z X M L
 I I E Y O J D L V M A W O P I G L C O Y T L D J M
 Y W Z Y U T N P I W Q B A I U Z I L E A W L R J J
 E J R E Q U A L I F I E D W W G F A N T U I R G M
 M S G N C S B Q V Y Z F T H Y Q D K R F O F E S D
 M I E A Y W O L Z I V M O Q Z Y Q P O P D R P R V
 S R S P H Q Z W I S H Q Q I M S C U T X C E P W X
 R L Y O J O L E A D E P V I F N L H A W D V S K H
 O A G R U U K A R I R Q X K V Z S E L R T O J M U
 E H D P R B X A O S M S R V E D L T U B V H W J M
 F N E Y J R S R P T H N O M D B F F G H L R A E L
 W V Q X S X N T F I N P U I A U L X E V X U I B K
 N V S A F E T Y H L E H T T G H R C R D C O H L P
 V B W X J M P V A L V E R V A A J K Z E N E U Z J
 D Q H M W A M P N A Q O G G U W Y F D L W K G B P
 V H I O S T X S O T P V Z K G X I M S I K R M U A
 S L W I P H F N L I X X Q J E M D T Y I U E A L R
 C J I U X J R S I O J N F T K E W X D B W Q O K H
 W D K M K Q J X W N E H K I V Q S L A E S A I X K
 B O M P J Z V Y S I D J T Q K S P Z W I X Q K L R

Propane Gas to Propane Liquid Ratio



Cylinder Installation Worksheet

CUSTOMER INFORMATION

1. Name: _____
2. Address: _____
3. City: _____
4. Type of installation: _____

CYLINDER INFORMATION

1. Type of cylinder: _____
2. Water capacity: _____
3. Number of cylinders: _____
4. Serial number(s): _____

5. Regulator type, mfr, model: _____

LOCATION

1. Distance from important building: _____
2. Distance from property line: _____
3. Distance from sources of ignition: _____
4. Distance from stored combustibles: _____
5. Distance from other flammable liquids: _____

INSTALLATION INFORMATION

- 1. Date scheduled: _____
- 2. Time scheduled: _____ am/pm
- 3. Installer: _____
- 4. Assisted by: _____

SPECIAL NOTES

SKETCH OF CUSTOMER SITE

Installer Signature: _____

Customer Signature: _____

SPECIAL CONSIDERATIONS

- 1. Septic tank: _____
- 2. Underground utilities: _____
- 3. Drainage: _____
- 4. Security fence: _____

TESTS (NEW REGULATOR OR PIPING ONLY)

- 1. Piping pres. test: _____ psig _____ min.
- 2. System leak check: _____ min.
- 3. Regulator lock-up: _____ inches

Overfilling a Container with Gas

PURPOSE

The purpose of this activity is to demonstrate the purposes of safety features, especially the overfill protection device (OPD) on propane tanks. This activity will demonstrate, using nonflammable materials, a reaction to illustrate the characteristics of gases under pressure.

OBJECTIVE

Demonstrate the reaction of gases to pressure.

MATERIALS

- Safety goggles
- Two-liter of diet soda
- Mentos® candies
- Paper
- Writing utensil
- Computer (if teacher says report must be typed)

PROCEDURE

1. Find a suitable outdoor area because this activity is very messy, so observers must stand back at least 15 feet.
2. Place the 2-liter of diet soda on a flat surface.
3. Roll the piece of paper just large enough to hold the Mentos candies. This will help in dropping the Mentos into the drink bottle all at one time.
4. Remove the drink cap, and position the tube of Mentos® candies over the top of the bottle.
5. Drop all of the Mentos into the drink at once, and move quickly to avoid the spray. Expect a quick spraying of soda from the bottle as the reaction takes place.
6. Write a report explaining the reaction. Be sure to relate the rapid expansion of gas materials in this activity to what could happen in propane cylinders without safety devices.