ENERGY FOR EVERYONE
propane

Heat Applications of Propane in Agriculture

LESSON 12
UNIT: PROPANE
PROBLEM AREA: PROPANE USE IN AGRICULTURE

Propane Education & Research Council

STUDENT LEARNING OBJECTIVES

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

1. Identify the use of propane for heating applications in agriculture.
2. Evaluate propane as a heat source in agriculture applications.
3. Identify the equipment needed for propane heating applications.
4. Estimate heat loss and energy needs for agricultural applications..

NATIONAL SCIENCE STANDARDS ADDRESSED IN THIS LESSON

All students should develop an understanding of:

Physical Science: Content Standard B

- Interactions of energy and matter

NATIONAL MATHEMATICS STANDARDS (NCTM) ADDRESSED IN THIS LESSON

Compute fluently and make reasonable estimates:

- Develop fluency in operations with real numbers, vectors, and matrices, using mental computation or paper-and-pencil calculations for simple cases and technology for more-complicated cases

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. BTU
2. convection heaters
3. greenhouse emissions
4. heat capacity
5. propane forced-air heaters
6. radiant heaters
7. space conditioning
8. storage water heaters
9. tankless water heaters
10. vented propane heaters
11. water heaters

TELL STUDENTS...

"Today's lesson will look at the use of propane for heating applications in agriculture. You will be expected to identify equipment used for heating, to evaluate propane as a heat source, and to estimate heat loss and energy needs for agricultural applications."

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.

1. Before class, write the following terms on the board: wood heater, propane heater with generator, natural gas heater, and electric heater.
2. Tell the students it is necessary for them to decide on a heat source for a new commercial broiler house. Refer to the terms on the board and ask, "Which of these would be best?"
3. Allow students to give positive and negative responses for each heater, and write their answers on the board.
4. Review their answers, and explain that the propane heater/generator would probably be best. Explain that natural gas would be a good choice, but gas lines are rarely found in areas of agricultural production.
5. In addition, share the following: Wood is usually not practical or economical and is labor intensive. If the power was to go out, the electric heater would be useless. Electricity is also expensive in many areas of the country compared to the other choices. The propane heater/generator would provide clean-burning heat, and the house would be heated efficiently. For these reasons and others, propane is a practical and economical choice for many agricultural applications.

Summary of Content and Teaching Strategies

OBJECTIVE 1

Identify the use of propane for heating applications in agriculture.

ANTICIPATED PROBLEM

How is propane used for heating applications in agriculture?

Propane can be used to provide heat in many agricultural applications. Propane heaters offer precise temperature control at a reasonable cost and without compromising environmental quality. Propane can be used as a heat source in a variety of ways (e.g., space conditioning, heating water, livestock facilities, and greenhouses).

A. ***Space conditioning*** is the use of a propane space heater that is mounted on the wall or suspended overhead to maintain a comfortable temperature in farm buildings. Propane space heaters have many advantages and are available in a wide range of heating capacities. The measure of heat energy required to raise the temperature of a specific substance by one degree or one temperature interval is ***heat capacity***.

B. Farm operations and related facilities often need hot water for cleaning and other tasks. Propane water heaters can meet the hot water needs of agricultural operations efficiently and economically. The traditional ***water heaters*** are tanks with devices that heat water and store the hot water until it is used. Tankless water heaters are used to heat water on demand. As a result, they operate more efficiently than traditional types.

C. Another important use of propane is to heat livestock facilities. Propane is used extensively to fuel heating systems for incubation and brooding. Propane infrared poultry brooders are one of the most efficient methods of keeping chicks warm and healthy. They provide more even heat and a larger circle of warmth, so it takes fewer infrared brooders to properly warm a poultry house. This is a significant cost savings to the farmer. Additionally, propane-powered space heaters, generators, and poultry brooders are reliable even during electric power outages.

D. Propane is clean burning, so it is ideal for heating a greenhouse. Heating a greenhouse is one of the largest expenses in greenhouse crop production, so saving money and fuel is important. Propane heaters can be used individually or in combination with multiple units. The geographical location of the greenhouse determines the number and sizes of heaters needed. For example, northern region greenhouses may require more heaters than most southern region greenhouses because of more extreme fluctuations in temperature. Vented heaters, in particular, are recommended for greenhouses.

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Begin the lesson by asking the students to list ways in which propane is superior to other fuels. Ask them to share their ideas.
2. Use ***VM-A*** to assist students in comprehending this objective.

OBJECTIVE 2

Evaluate propane as a heat source in agricultural applications.

ANTICIPATED PROBLEM

Is propane an efficient and clean heat source in agricultural applications?

Propane has long been recognized as a "green" energy. As a result, many farmers (eight out of ten) have turned to propane as an energy source.

A. ***Greenhouse emissions*** are gases (e.g., carbon dioxide – CO_2) that trap heat in the atmosphere and raise the earth's natural temperature. Carbon dioxide is produced when fossil fuels (e.g., gas and coal) are burned; incomplete combustion also produces carbon monoxide (CO), which is deadly. Propane emits less greenhouse gas emissions than gasoline, diesel, and the production of electricity with coal. Propane provides farm buildings with reliable, convenient energy for heat and hot water, especially in locations beyond the reach of a natural gas infrastructure.

B. The amount of energy produced when propane is burned is measured in British thermal units (***BTU***). Heat sources can be compared based on BTU. Propane normally outputs 91,000 BTU per gallon, compared to 124,000 BTU for one gallon of gasoline and 139,000 BTU for one gallon of diesel. The environmental benefits and convenience of using propane, however, make it a desirable fuel. Another major factor in evaluating fuel costs is to determine the cost per BTU. The cost of propane per BTU is one third the cost of using electricity, and it can heat air up to 25 degrees warmer.

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Before you explain the information above, ask the students to spend one minute writing what they think of when they hear the words "green energy." Collect their responses for review.
2. Discuss the benefits of propane as a green energy. Explain that propane efficiency is calculated by BTU cost, and complete some calculations on the board.

OBJECTIVE 3

Identify the equipment needed for propane heating applications.

ANTICIPATED PROBLEM

What equipment is needed for propane heating applications?

Agricultural heating equipment is somewhat different from that used in the home.

A. Space heaters come in a variety of sizes and types. There are convection heaters, forced-air heaters, and infrared or radiant heaters.
   1. ***Convection heaters*** produce warm air that is circulated to cooler areas by means of natural air convection or with assistance from a fan. Portable units are useful for heating large, open spaces (e.g., outbuildings and barns).
   2. ***Propane forced-air heaters*** are equipped with fans that blow warm air from a burner over a heat exchanger into the space to be warmed. These heaters are ideal for small- to medium-sized work areas (e.g., equipment repair work shops).
   3. ***Radiant heaters*** provide quiet, energy-efficient heating through radiant heat transfer. Such heaters are generally mounted overhead with the infrared energy directed at floor level. Although some convection heat is lost to the ceiling, these heaters are extremely energy efficient. Humans and animals absorb energy directly from the heater, so the desired level of comfort can be achieved without warming the surrounding air excessively.

B. Many different models of propane gas water heaters are available for farm use. The two basic designs are storage water heaters and instantaneous water heaters. Both designs, on average, cost 42 percent less to operate than comparable electric heaters. A propane gas water heater can save farmers nearly $2,000, compared to an electric model over an average unit's life span. In addition, propane units heat more than twice as much water in an hour as electric water heaters.
   1. ***Storage water heaters*** are designed with a gas bottom-burner. Heated water is held in temperature-controlled storage tanks. Compared to electric models, propane storage heaters can produce up to four times as much hot water as electric heaters in the same amount of time.
   2. Instantaneous or ***tankless water heaters*** do not heat water continuously. A gas burner automatically ignites to heat water when the faucet is turned on. The unit shuts off when the faucet is turned off. Initial costs are higher for a tankless water heater than for storage models; however, these units are more economical over time. Smaller instantaneous heaters are becoming common on farms.

C. Brooding lamps are heated with propane to provide high heat to newborn chicks. There are two types of brooders, but the radiant brooders are more effective at heating the floor and the animals. Propane heating is used to a lesser extent for other types of livestock heating needs (e.g., stables).

D. Propane heaters are an excellent choice for greenhouses because ***vented propane heaters*** allow byproducts of combustibles to be expelled outside. The high heat and other greenhouse conditions require heaters to be specifically designed to work under these conditions.

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Discuss the different types of propane equipment needed to heat a variety of areas.
2. Ask the students to describe various situations where each type of equipment may work best before giving them all of the information.

OBJECTIVE 4

Estimate heat loss and energy needs for agricultural applications.

ANTICIPATED PROBLEM

What are the heat losses and energy needs for agricultural applications?

Heat loss depends on the materials and the construction of the agricultural application.

A. Heat loss information can be used to size a heater to the space, estimate annual fuel costs, etc. The amount of heat loss is calculated by multiplying the degree difference, the surface area of the building, and the BTU heat-loss factor.

   1. The following example calculates the BTU loss for a greenhouse, but the formula can be used for any structure. The degree difference is the lowest expected temperature in the area subtracted from the minimum desired greenhouse temperature (e.g., 60 °F).
   2. If the lowest temperature in the area is 33°F and the lowest desired greenhouse temperature is 60°F, the degree difference is 27.

B. The BTU heat-loss factor can be found for different building products. For example, the heat-loss factor for a particular type of greenhouse glass is 1.13, meaning that 1.13 BTU are lost each hour per square foot of exposed surface area. Many company websites provide product and BTU heat-loss factor information. Here are some BTU heat-loss factors for greenhouse coverings.

Greenhouse Covering	BTU Heat-Loss Factor
6 mil polyethylene	1.15
3 mm glass (single layer)	1.13
6 mm twin-wall polycarbonate	0.65
Polycarbonate/fiberglass	1.20

C. The surface area is equal to the total outside area of a building. To determine the surface area, the measurements of each surface are needed. The area of each surface will need to be determined; then the numbers should be added together.

   1. These basic formulas will be needed:
      - Area of a rectangle = length x width
      - Area of a triangle = ½ base x height

D. Consider this situation. The degree difference is 55; the surface area is 8,000 square feet; and the BTU heat-loss factor is 1.13. Therefore, 55 x 8,000 x 1.13 = 497,200, so 497,200 BTU are lost per hour. Propane contains 91,000 BTU per gallon, and it would require 5.46 gallons of propane per hour to heat this structure at the coldest times of the year (BTU lost/BTU produced per hour).

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Ask the students what material is best for building greenhouses to avoid large heat losses. Allow the students to be creative.
2. Explain that the answer depends on the materials used and the BTU heat loss factor of the materials.
3. Discuss how to determine the heat loss, and give examples.
4. Guide the students through example problems, and then assign **LS-A**.

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. e
2. f
3. c
4. j
5. i
6. a
7. h
8. b
9. d
10. g

PART TWO: SHORT ANSWER

1. a. storage water heater

   b. tankless water heater (instantaneous water heater)

2. Infrared brooders provide more even heat and a larger circle of warmth, so it takes fewer infrared brooders to properly warm a poultry house. This results in a significant cost savings for the farmer.

PART THREE: COMPLETION

1. green
2. British Thermal Unit
3. heat capacity
4. Tankless
5. greenhouse gas (or greenhouse emissions)

NAME: _____

Safety Considerations With Propane

PART ONE: MATCHING

INSTRUCTIONS: Match the term with the correct definition.

a. space conditioning	f. convection heaters
b. heat capacity	g. propane forced-air heaters
c. water heaters	h. radiant heaters
d. greenhouse emissions	i. tankless water heaters
e. BTU	j. vented heaters

_____ 1. A measurement of heat

_____ 2. Devices that produce warm air that is circulated to cooler areas by means of natural air convection or with assistance from a fan

_____ 3. Tanks with a heating device to provide hot water

_____ 4. Heaters that allow byproducts of combustion to be expelled outside

_____ 5. Hot water heaters that do not store hot water

_____ 6. Propane space heaters that are mounted on the wall or suspended overhead to keep farm buildings warm

_____ 7. Devices that provide quiet, energy-efficient heating through radiant heat transfer

_____ 8. The measure of heat energy required to increase the temperature of a specific substance by one degree or one temperature interval

_____ 9. Gases that trap heat in the atmosphere and increase the earth's natural temperature

_____ 10. Fans that blow warm air from a burner over a heat exchanger into the space to be warmed

PART TWO: SHORT ANSWER

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

1. What are two types of water heaters that are used frequently?

2. Why are infrared brooders more efficient for raising baby chicks?

PART THREE: COMPLETION

INSTRUCTIONS: Provide the word or words to complete the following statements:

1. Propane has long been recognized as a "_____" energy.
2. BTU stands for _____.
3. The measure of heat energy required to raise the temperature of a specific substance by one degree or one temperature interval is _____.
4. _____or instantaneous water heaters do not heat water continuously.
5. Propane generally emits less _____ than gasoline, diesel, and electricity.

Heating Equipment

Vented Propane Greenhouse Heater

Convection Space Heater

Radiant (Infrared) Brooder

NAME: _____

Heat Loss from Greenhouses

PURPOSE

The purpose of this activity is to demonstrate the calculation of heat loss in agricultural applications.

OBJECTIVE

Calculate the heat loss in a greenhouse.

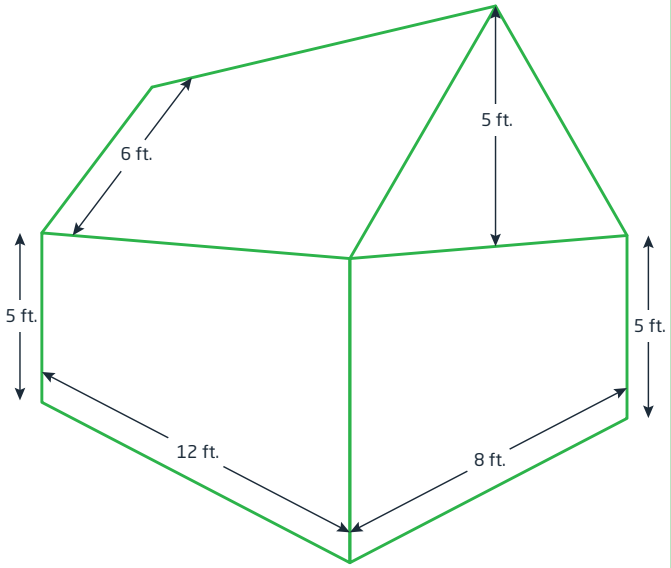
MATERIALS

Writing utensil

PROCEDURE

Answer the following questions based on the information provided below.

Greenhouse Covering	BTU Heat-Loss Factor
6 mil polyethylene	1.15
3 mm glass (single layer)	1.13
6 mm twin-wall polycarbonate	0.65
Polycarbonate /fiberglass	1.20



1. Using the greenhouse measurements in the drawing, determine the surface area of the greenhouse. Show your work in the provided space.

2. This greenhouse is covered with fiberglass. What is the BTU heat-loss factor?

3. Suppose the lowest temperature in your area is 20°F. The lowest temperature you want in your greenhouse is 60°F. Determine the degree difference.

4. Determine the total BTU lost per hour for this greenhouse.
   (surface area) x (BTU heat-loss factor) x (degree difference)

5. How many BTU will be used per day on the coldest day of the year? This assumes that the temperature remains at 20°F for the 24-hour period.

6. How many gallons of propane will you need to keep your greenhouse heated for the coldest day of the year, assuming that the temperature remains at 20°F for the 24-hour period?
   (1 gallon of propane = 91,000 BTU)