ENERGY FOR EVERYONE
propane

Power Technology Applications of Propane Fuel

LESSON 11
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 propane engine applications in agriculture.
2. Evaluate propane as a fuel for power generation in agriculture.
3. Explain the basic concepts of modern propane fuel systems.

NATIONAL SCIENCE STANDARDS ADDRESSED IN THIS LESSON

All students should develop an understanding of:

Physical Science: Content Standard B

- Chemical reactions
- Interactions of energy and matter

Science and Technology: Content Standard C

- Abilities of technological design

LIST OF RESOURCES

The following resources may be useful in teaching this lesson:

- Auto.HowStuffWorks.com/LPG5.htm
- Propane.com/Agriculture
- Energy.gov
- animatedengines.com/otto.html
- NPGA.org
- 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. combustion
2. diesel engine
3. explosion
4. gasoline engine
5. internal-combustion engine

TELL STUDENTS...

"In this lesson, you will learn about propane engine applications in agriculture and will be able to evaluate propane as a fuel for power generation. You will also be expected to explain the basic concepts of modern propane fuel systems."

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. Ask students what they know about how power is generated. Ask what a windmill, a waterwheel, a steam engine, and a car motor have in common.
2. Explain that they all use some form of energy in the environment to turn a rod and generate power.
3. Ask the students how power generated by propane might be the same and might be different from the power sources named above.

Summary of Content and Teaching Strategies

OBJECTIVE 1

Identify propane engine applications in agriculture.

ANTICIPATED PROBLEM

Where can a propane engine be used in agriculture?

Propane can serve as the fuel for an ***internal-combustion engine*** if minor adaptations are made to the engine. An internal-combustion engine converts chemical energy in fuel to mechanical energy through a series of small explosions.

A. These explosions are a form of ***combustion*** (a reaction between a fuel and an oxidant that produces heat and light).

B. When the combustion produces the movement of high-pressure gases, it is called an ***explosion***.

C. Combustion in an engine occurs when fuel under pressure is ignited. This mechanical energy moves pistons up and down cylinders, creating a rotating motion when the pistons are connected to a crankshaft.

D. A ***diesel engine*** is an internal-combustion engine that burns diesel fuel.

E. A ***gasoline engine*** is an internal-combustion engine that burns gasoline. An engine that runs on propane can be used almost anywhere that a diesel or gasoline engine can be used and in additional places (e.g., power tractors, forklifts, conveyor belts, threshers, irrigation engines, and other agricultural machines).

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Ask the students to list engine uses in agriculture.
2. Ask them to share their ideas. Write their responses on the board, and discuss fuel options.
3. Visit Auto.HowStuffWorks.com/LPG5.htm to show an example of the process of converting a car so it can run on propane.

OBJECTIVE 2

Evaluate propane as a fuel for power generation in agriculture.

ANTICIPATED PROBLEM

How does propane compare to other fuels for power generation?

Propane is superior to most other fuel sources because of its cleanliness, reliability, convenience, and cost.

A. Cleanliness
   1. Propane burns cleaner than most other fuels, so a well-maintained propane generator, forklift, or other machine can be used indoors without concern regarding toxic fumes. A properly running propane engine emits carbon dioxide and water.
   2. Because of its low boiling point, propane vaporizes immediately upon release. It will not pool or leave a residue, making it a safe choice to power irrigation systems. Propane is also nontoxic and insoluble in water, so it cannot contaminate aquifers or other groundwater supplies.

B. Reliability
   1. Propane keeps engines reliable and free of residue because it burns so cleanly. It also has a longer shelf life than gasoline or diesel; this enables consumers to stock up.
   2. Propane ignites at a low temperature and does not need to be kept heated for use, especially in cold weather. Propane engines are ready immediately. Diesel-fueled engines, on the other hand, are notoriously hard to start in cold weather.

C. Convenience
   1. Propane is stored in containers that are easily transported, extremely safe and durable, and simple to have filled or exchanged at gas stations. Because it can be compressed to a great degree, a cylinder of propane will provide much more energy than a similar container of gasoline or diesel.
      a. Natural gas, a close relative of propane, is a reliable fuel source for some applications.
      b. The major natural gas limitation is that it must be piped in, and the user must be near a natural gas pipeline to obtain service. Unfortunately, farms are rarely near natural gas pipelines.
   2. Propane engines never need to be recharged and do not need to be connected to a power source, unlike those powered by electricity. In fact, propane engines can be taken miles from the nearest power source without a problem. Propane tanks can be stored in different areas around large farms so a convenient, safe, and reliable fuel source is always within reach.

D. Cost-benefit
   1. Many users who switch machinery to propane find that the machines require less maintenance.
   2. Propane machines are generally more efficient in power usage than the same or very similar machines that run on gasoline, diesel, or electric power.
   3. Some propane-powered machines (e.g., propane-powered forklifts) are less expensive than their alternatively powered counterparts and last longer

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Discuss what factors are important in choosing a power source and how cost factors into a purchasing decision.
2. Ask students what fuels they use, and discuss the advantages and disadvantages of each.

OBJECTIVE 3

Explain the basic concepts of modern propane fuel systems.

ANTICIPATED PROBLEM

How do modern propane fuel systems work?

Propane-powered systems work in an almost identical manner to engines powered by gasoline or diesel. The gas is released into a chamber and combusted; this drives a piston. The up-and-down movement of the piston inside a cylinder rotates a magnet within a copper coil. The rotation of the magnet within the coil generates electricity or provides direct power by its own rotation.

A. A conversion to run on propane requires adaptations to the engine: modifications to the carburetor, the addition of a vacuum-controlled flow regulator, and a means to connect to the portable tank. With the high price of fuel, many farmers consider converting engines to propane. Therefore, engine conversion materials and parts are usually sold as a kit.

B. Some engines are designed and sold to run on propane.

C. A converted or designed propane engine operates like any other internal combustion engine. However, the following must be considered:

   1. Sources and how to re-fuel
   2. Any need for additional space
   3. Whether the cost of conversion is economically viable, depending on the cost of diesel or gasoline

SUGGESTED TECHNIQUES TO HELP STUDENTS MASTER THIS OBJECTIVE

1. Visit AnimatedEngines.com, and open the "Four Stroke" page to demonstrate how a simple engine works.
2. Discuss the types of fuel it could use.

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. a
2. c
3. e
4. b
5. d

PART TWO: SHORT ANSWER

1. Propane has a better yield than diesel, is easier to start in cold weather, is more environmentally friendly, and provides a longer engine life.
2. Propane is especially well-suited for agriculture because it is easy to transport and store, will work under difficult conditions, and is more economical than other power supplies. Agricultural producers rarely have access to natural gas.
3. Answers can include but are not limited to tractors, forklifts, conveyor belts, threshers, irrigation engines, dryers, heaters, and baking ovens.

PART THREE: COMPLETION

1. internal-combustion
2. low
3. pipeline
4. insoluble
5. increases

NAME: _____

Power Technology Applications of Propane Fuel

PART ONE: MATCHING

INSTRUCTIONS: Match the term with the correct definition.

a. gasoline engine
b. internal-combustion engine
c. combustion
d. diesel engine
e. explosion

_____ 1. An internal-combustion engine that burns gasoline

_____ 2. A reaction between a fuel and an oxidant that produces heat and light

_____ 3. A reaction between a fuel and an oxidant that produces heat, light, and high-pressure gases

_____ 4. A machine that converts chemical energy in fuel to mechanical energy through a series of small explosions

_____ 5. An internal-combustion engine that burns diesel

PART TWO: SHORT ANSWER

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

1. What benefits does propane provide over diesel?

2. Why is propane ideal for agricultural use?

3. List three uses for propane on a farm.

PART THREE: COMPLETION

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

1. Propane can be used in _____ engines after a few modifications.

1. Propane vaporizes (boils) at a very _____ temperature.

1. To use natural gas, the consumer must be near a(n)_____ .

1. Propane is _____ in water, so it will not contaminate the water supply.

1. Because propane leaves no residue, it _____ engine life.

NAME: _____

Power Technologies Exploration

PURPOSE

The purpose of this activity is to analyze how an internal-combustion engine generates power.

OBJECTIVE

Explain how an internal-combustion engine works and how fuel is converted to energy.

MATERIALS

- Computer with internet access
- Printer
- Otto engine example from animatedengines.com/otto.html
- Magnetic shake flashlight and diagram
- Writing utensil
- Paper
- VM-A, VM-B, and VM-C

PROCEDURE

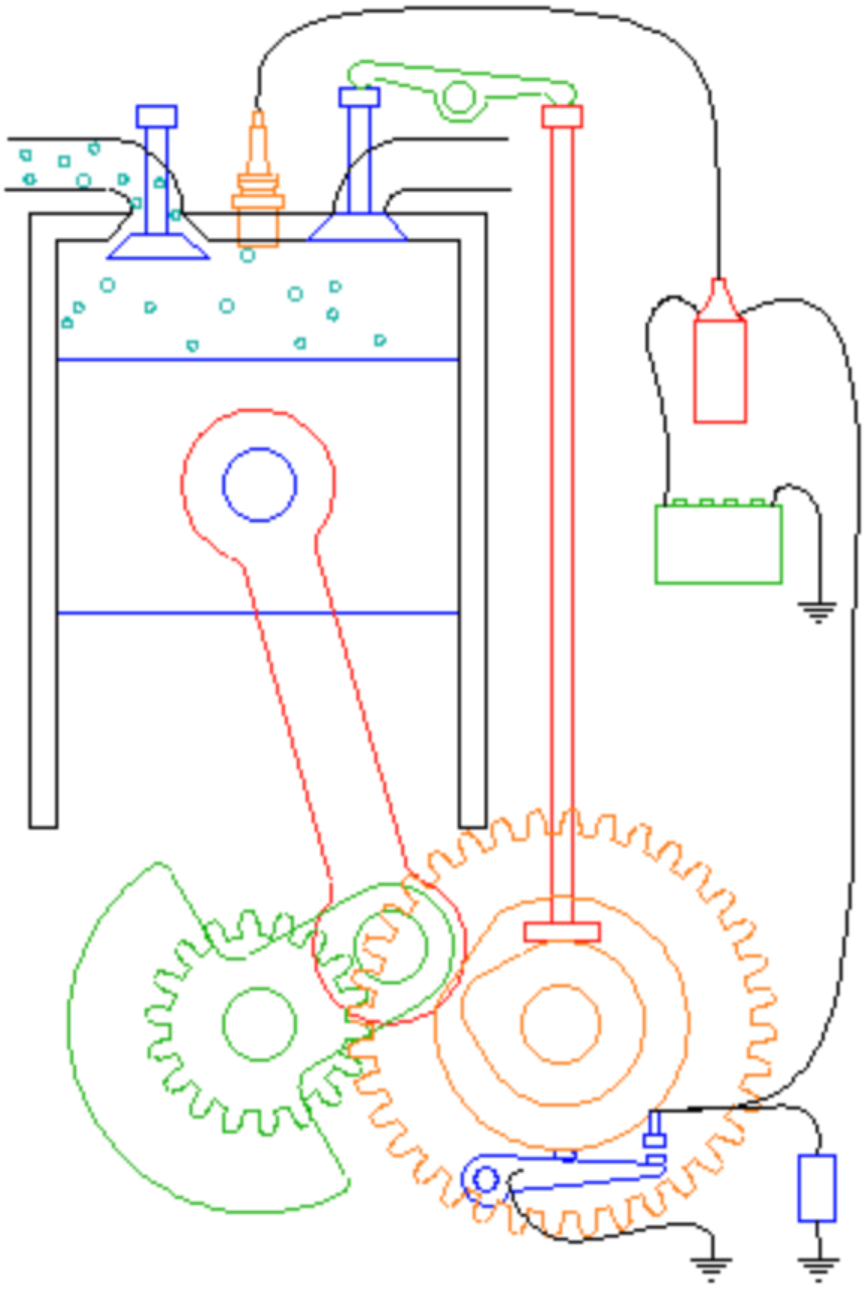
1. Analyze the Otto engine diagram. It is important to study how it works.
2. In your own words, explain the engine processes.
3. Operate the hand-powered flashlight. Use the diagram to explain that as the magnet travels up and down the tube, it pushes electrons through the copper wire, creating electricity.
4. Explain what would happen if a magnet in a copper coil was attached to the rotating rod on the engine instead of being attached to an axle. Will the spinning magnet push electrons through the coil to create electricity? Explain.
5. Write a report about your Otto engine and hand-powered flashlight observations. Include the answers to the follow-up questions below.

FOLLOW-UP QUESTIONS

1. Does the fuel used in an Otto engine matter? Why or why not? What would make some fuels (e.g., propane or gasoline) better than other fuels (e.g., coal or wood)?

2. Can other devices be used to create electricity by the same principles used in the hand-powered flashlight? Explain how waterwheels or steam engines might create electricity.

OTTO Engine (Four Stroke ENGINE)



Magnetic Flashlight

Magnetic Flashlight Diagram