Unit C: Agricultural Power Systems

Lesson 5: Using Small Engines

Student Learning Objectives:

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

1. Identify the reasons why small engines are widely used.
2. Describe how small engines can be classified.
3. Identify common service jobs performed on small engines.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

Johnson, Donald M., et al. *Mechanical Technology in Agriculture*. Danville, Illinois: Interstate Publishers, Inc. 1998. (Textbook, Chapters 11 & 12)

Turner, J. Howard. *Care and Operation of Small Gasoline Engines*. Athens, Georgia, AAVIM, 1990. (Student Manual, Parts I and II)

Herren, Ray V., and Elmer L. Cooper. *Agricultural Mechanics Fundamentals and Applications*. Albany, New York: Delmar Publishers, Inc., 2002. (Textbook, Chapter 30)

Phipps, Lloyd J., et al. *Introduction to Agricultural Mechanics*, Second Edition. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2004. (Textbook and Activity Manual, Chapter 18)

List of Equipment, Tools, Supplies, and Facilities:

- Writing surface
- PowerPoint Projector
- PowerPoint Slides
- Transparency Masters

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Blow-by
- Degreaser
- Dry-filter type air cleaners
- Horizontal crankshaft engine
- Multi-position crankshaft engine
- Oiled-filter type air cleaners
- Service intervals
- Vertical crankshaft engine

Interest Approach:

Ask the class what some jobs are that utilize small engines. Then pose the question, how could we accomplish these tasks without small engines?

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Identify the reasons why small engines are widely used.
Anticipated Problem: Why are small engines so widely used?

(PowerPoint Slide 3)

I. A small engine is one that is 25 horsepower or less. Several million small engines are now in use throughout the United States. They are used around the home, farm, and business to accomplish tasks that other equipment cannot do. There are other reasons why small engines are popular. Even with their popularity, small engines do experience problems.

A. Small engines are popular for a number of reasons.

(PowerPoint Slide 4)

1. Small engines are compact in their design. The fact that they do not take up a great deal of space enables them to be used with a variety of types of equipment.
2. These engines are lightweight. Because small engines are relatively light, they can be used in a variety of settings.
3. Small engines are relatively easy to service and repair. With a basic knowledge of engine systems, most homeowners can service their own equipment.
4. Small engines are affordable. Because of advanced engineering and mass production, small engines can be purchased at reasonable prices.

B. When small engines do not perform well, it usually has to do with improper service, operation, or maintenance. Some common reasons that cause trouble in small engines are:

(PowerPoint Slide 5)

1. Often small engines operate near the ground where dirt and dust are more likely to get into them. This leads to rapid wear if the engine is not serviced properly.
2. Small engines are often abused by overloading. Owners commonly use small engines and equipment in jobs for which they are not intended.
3. Few small engines receive the proper service or regular maintenance that is provided for larger engines. Because small engines are relatively affordable, owners do not devote the same time in their care as they do to larger, more expensive engines and equipment.

Display TM: 5-1 to illustrate the types of equipment that use small engines. Through classroom discussion, have students add to the list.

Objective 2: Describe how small engines can be classified.
Anticipated Problem: How are small engines classified?

(PowerPoint Slide 6)

II. Small engines are designed for a variety of uses in different settings. In order to understand them, it is important to understand how small engines may be classified. The following are two broad classifications.

A. Small engines may be classified by the position of their crankshafts. In an internal combustion engine, a fuel-air mixture combusts within a cylinder. This combustion forces the piston to move. The piston is connected to the crankshaft which converts linear motion to rotary motion. All crankshafts operate at right angles to the pistons. The crankshaft may be in one of three positions.

(PowerPoint Slides 7 and 8)

1. Vertical—a ***vertical crankshaft engine*** has its cylinder in a horizontal position. It is used when mounting a power blade directly to the shaft as in a lawnmower.
2. Horizontal—a ***horizontal crankshaft engine*** may have its cylinder in a vertical, horizontal, or intermediate position. A horizontal crankshaft engine is best used for supplying power to a horizontal transmission shaft. Such engines are often used on small tractors.
3. Multi-position—a ***multi-position crankshaft engine*** will operate in any position. But, the piston must still be at a right angle to the position of the crankshaft. This type of engine is used on chain saws or on equipment where the operating position may be at extreme angles.

B. Small gas engines may be classified by the number of power strokes per crankshaft revolution.

(PowerPoint Slides 9 and 10)

1. Four-stroke cycle engines operate through four strokes as the crankshaft revolves. These four strokes are intake, compression, power, and exhaust. Four-stroke engines can be recognized by the presence of an oil pump and the fact that it has an oil filler cap or plug where oil can be added to the crankcase. Since a four-stroke engine depends on an oil pump, the angle at which it is operated is important. If the engine is tilted too much, oil cannot be distributed properly.
2. Two-stroke cycle engines accomplish a cycle in two strokes as the crankshaft revolves. The two strokes are: Stroke 1—compression and intake, Stroke 2—power and exhaust. Since the two-stroke engine uses the crankcase for storing a reserve charge of the fuel-air mixture for the next stroke, the crankcase cannot be used only as an oil compartment for lubricating the engine. Instead, lubrication is supplied by oil that is mixed with gasoline. Two-stroke engines have a sealed crankcase but no oil pump. Since there is no oil pump, the engine receives lubrication by oil suspended in the fuel-air mixture in the crankcase. For this reason, two-stroke engines can be operated on more extreme angles than four-stroke engines.

Use TM: 5-2 to illustrate crankshaft positions. Follow this up by displaying TM: 5-3 to demonstrate what happens to oil supply in two- and four- stroke engines when they are operated at extreme angles.

Objective 3: Identify common service jobs performed on small engines.

Anticipated Problem: What are some of the common service jobs performed on small engines?

(PowerPoint Slide 11)

III. Small engine owners expect their engines to perform trouble-free. In order for them to do so, they must be serviced regularly. The periods of time between the performances of service jobs are called ***service intervals***. Service intervals will vary based on manufacturer recommendations and the conditions under which the engine is operated. Some service jobs are done only one a year. Others should be carried out a number of times during the year. The following are common service jobs associated with small engines.

(PowerPoint Slide 12)

A. Cleaning the engine—the average temperature of burned gases inside a cylinder is about 3600° F. About one third of the heat is given off through the cooling system, one third is distributed through the exhaust system, and the other third is used to develop power. The engine should be routinely checked for dirt and abrasives. When dirt mixes with oil and gets into the lubrication area of the engine, a harmful grinding mixture develops. This will cause rapid wear on engine parts that slide against each other. Additional areas where the presence of dirt is harmful include:

1. The exhaust system—mufflers and exhaust ports should be inspected and cleaned regularly. A ***degreaser*** is a fast acting solvent available in an aerosol can. It is good for cleaning hard to reach places.
2. The cooling system—on air-cooled engines, the blower shroud, baffles, intake screen, and cylinder fins should be inspected for obstructions. These obstructions reduce air flow and can lead to engine overheating. If obstructions are encountered, they should be removed with compressed air, a solvent, or a wire brush. On liquid cooled small engines, the fluid level of the radiator should be checked.

B. Servicing carburetor air cleaners—the carburetor air cleaner is one of the most important parts on the engine. Servicing air cleaners mainly consists of cleaning or replacing the filter element. There are two types of air cleaners used on small gas engines. When serviced properly, they do a good job of removing harmful dirt from the air entering the engine. The two types of air cleaners are:

(PowerPoint Slides 13 and 14)

1. An ***oiled-filter type air cleaner*** is made of a sponge-like filtering material called polyurethane. The polyurethane is coated with oil before being installed. The oil on the filter allows air to pass through to the engine, but catches dirt particles and prevents them from entering the engine. Such

filters can be cleaned by submerging them in a bucket filled with hot water and household detergent. The filter should be allowed to dry, then coated with oil and reinstalled.

2. ***Dry-filter type air cleaners*** consist of a porous filtering material usually made of paper or fiber. They have a filter with very small openings that prevent harmful particles from passing through. They do not depend on oil to catch the particles. If the filter is made of paper, it can be cleaned by tapping it on a flat surface to dislodge trapped particles. At that same point, it may become necessary to replace the paper filter due to wear. If the filter is made of felt or fiber, compressed air should first be used to dislodge trapped dirt. It can then be washed in soapy water, allowed to dry, and reinstalled.

C. Lubricating small engines—proper lubrication is extremely important. Without lubrications, the pistons and bearings would seize. It is vital to understand the functions oil plays in an engine and the proper guidelines for lubricating engines.

(PowerPoint Slide 15)

1. Engine oil is vital to engine life for the following reasons:
   a. Oil reduces friction between moving parts. It provides a cushion and helps prevent scoring and fusing of metal caused by heat and abrasion.
   b. Oil reduces heat—heat is caused by friction between moving parts. Since oil reduces friction, it also reduces heat.
   c. Oil cleans—special detergents are added to most oils to help keep the engine clean.
   d. Oil helps seal piston rings and prevent blow-by. Blow-by refers to gases under pressure that leak by the piston rings during combustion and the power stroke.
2. Lubricating engines differs based on the type of engine. These differences are as follows:
   a. Four cycle engines are lubricated from an oil reservoir. The oil should be checked on a regular basis. Checking the oil involves removing the dipstick, wiping it clean, reinserting it, and removing it to determine if the oil is at the appropriate level. Other small engines may only have a plug to remove and visually check to determine if the oil is at the appropriate level. If the oil level is low, more should be added to the oil reservoir. If the oil is dirty, it should be changed by draining the crankcase of oil and replacing it with a new supply.
   b. Two-cycle engines are lubricated by specific types of oil in the fuel. The mixture passes through the crankcase and into the cylinder. It is important to use the correct type of oil in the correct proportions based on manufacturer specifications. Using the wrong types of oil will cause poor combustion, and the formation of gum, varnishes, and carbon deposits. Too little oil may cause poor lubrication and lead to increased wear on moving parts.

(PowerPoint Slides 16 and 17)

D. Servicing spark plugs—the spark plug makes it possible for a spark to occur inside the combustion chamber. The fuel-air mixture in the combustion chamber is ignited by the spark. Anything that inhibits the flow of the current through the spark plug and across the spark plug gap will affect the operation of the engine. Oil deposits on the spark plug tip may inhibit the flow of current. Spark plugs should be inspected regularly by first removing the spark plug wire and then removing the spark plug. The plug should be inspected for oily deposits and cleaned if necessary. If the deposits are hard, they may be scraped off with a small knife. Threads should be cleaned with a wire brush. The plug should then be checked for the proper gap before being reinstalled.

Display TM: 5-4 to illustrate the difference between the two main types of air cleaners. Follow this up by displaying TM: 5-5 to assist students in understanding the function of a spark plug. The best reinforcement may be to walk students through the service jobs discussed above using an engine.

Review/Summary: The review and summary of the lesson may be accomplished by viewing the transparency masters with the students. **(PowerPoint Slide 18)** A discussion should be performed with students before proceeding with the laboratory activities and testing.

Evaluation: Evaluation of student performance should focus on understanding of the lesson's learning objectives. A sample written test is attached to assist in evaluation of student comprehension.

Answers to Sample Test:

Matching

1. D
2. F
3. E
4. C
5. A
6. B

Fill-in-the-blank

1. Portability
2. Cable
3. Many
4. Oxygen

Short Answer

Student safety essay from Objective 3.

Sample Test

Using Small Engines

Name: _____

Matching: *Match each word with the correct definition.*

a. four-cycle engine	d. two-cycle engine
b. horizontal shaft engine	e. vertical shaft engine
c. maintenance	f. troubleshooting

_____ 1. Determining what is wrong with an engine so that the problems can be corrected.

_____ 2. Configuration of the crankshaft is the up and down position.

_____ 3. Completes the intake, compression, power, and exhaust in two strokes.

_____ 4. Doing the tasks that keep the engine in good condition.

_____ 5. Requires four complete cycles of the piston in the cylinder for intake, compression, power, and exhaust.

_____ 6. The crankshaft is sideways in the engine.

Fill-in-the-blank*: Complete the following statements*.

1. Small gasoline engines are the choice of power for all industries that require low horsepower and _____.
2. Disconnect the spark plug _____ when making any adjustments on machines to prevent accidental engine starting.
3. There are _____ career opportunities for those individuals with small engine repair skills.
4. An engine requires fuel, _____, and heat to run.

Short Answer*: Answer the following question*.

Essay: Discuss in detail as many safety considerations as you can that deal with the operation and service of small gasoline engines.

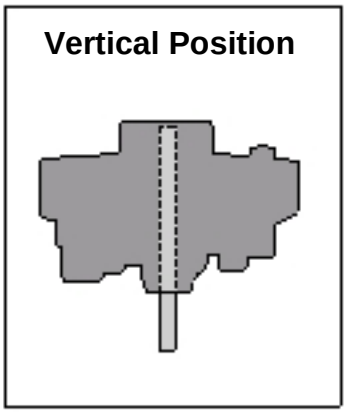
TM: 5-1

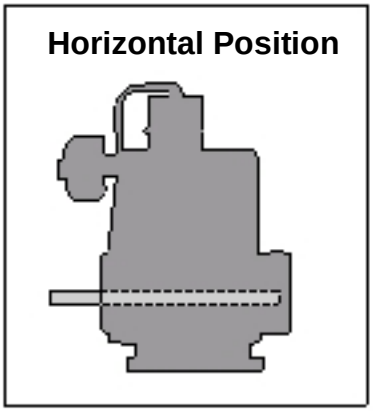
EXAMPLES OF EQUIPMENT THAT USE SMALL ENGINES

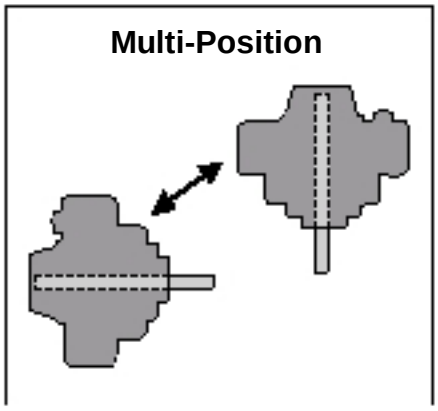
- Generators
- Irrigation Pumps
- Air Compressors
- Feed Grinders
- Sprayers
- Chain Saws
- Tillers
- Post Hole Diggers
- Snow Blowers
- Lawn Mowers
- Weedeaters

TM: 5-2

CRANKSHAFT POSITIONS



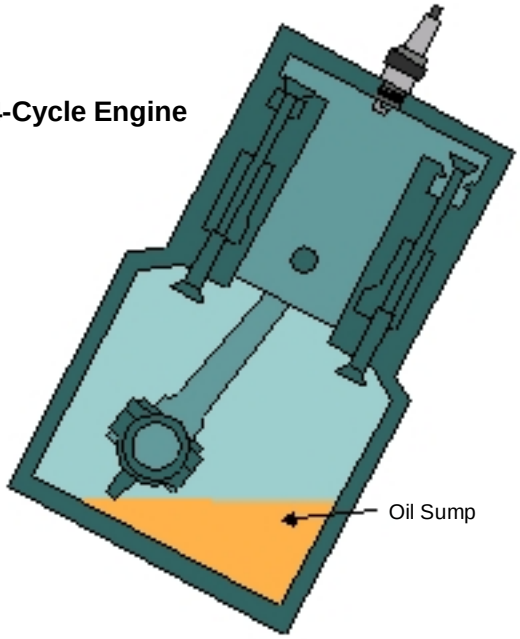




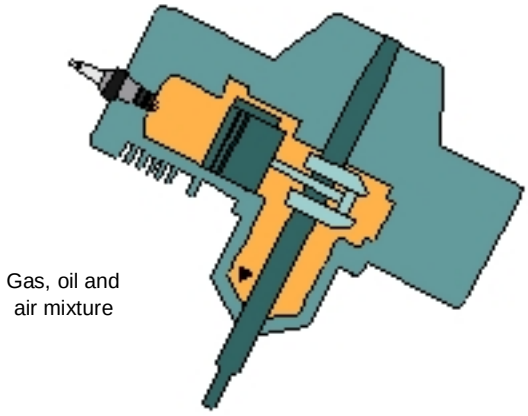
TM: 5-3

EXTREME ANGLES OF OPERATION AND OIL SUPPLY

4-Cycle Engine

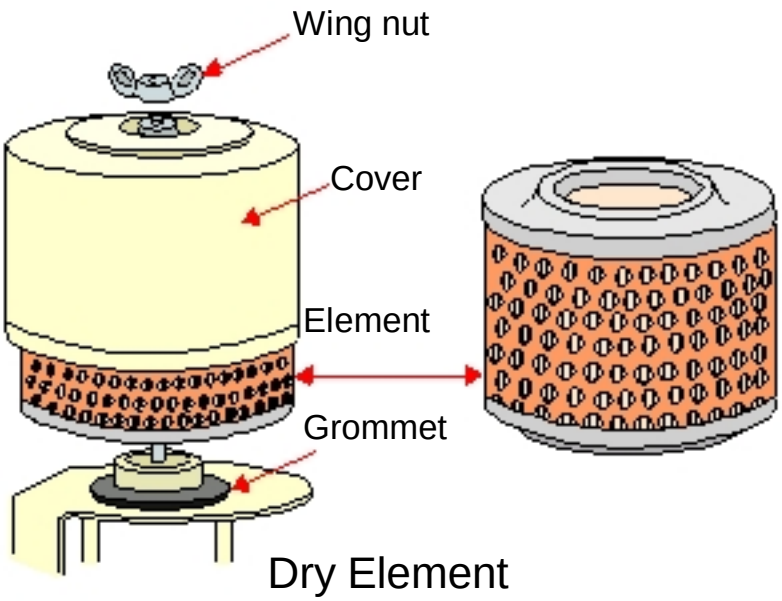


2-Cycle Engine

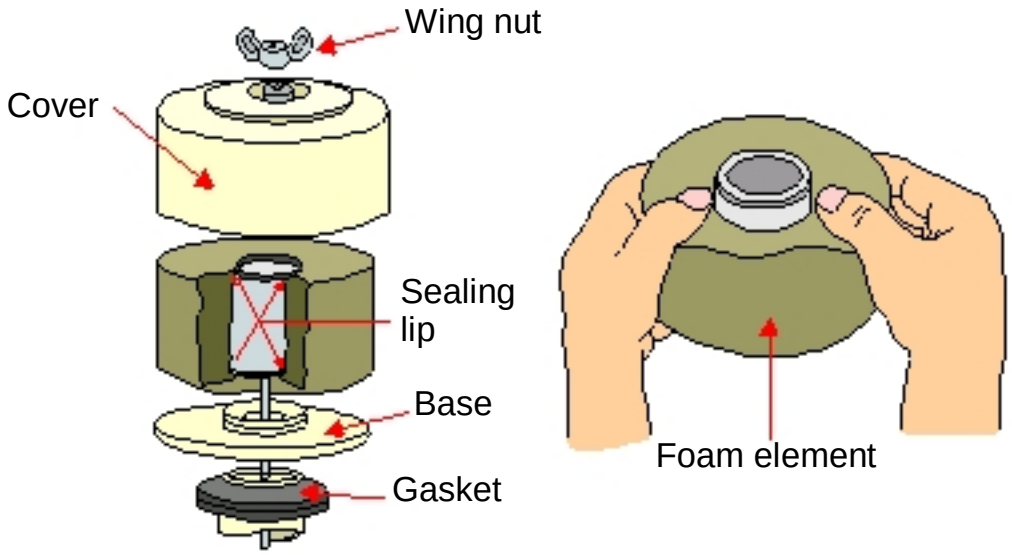


TM: 5-4

TYPES OF AIR CLEANERS



Dry Element



Oil Foam

TM: 5-5

SPARK PLUG OPERATION