OKLAHOMA
CareerTech

Introduction to Agriscience

Unit 14
Arc Welding and Oxyfuel Cutting

Student Edition

CIMC

AG3001

Unit 14
Arc Welding and Oxyfuel Cutting

Arc welding and cutting is one of the most versatile and useful agricultural mechanics skills, and it can be easily developed into a strong career choice. Welding and cutting are used for everything from creating art sculptures to constructing nuclear facilities. Ranchers and farmers use these skills to fabricate tools, build structures, and repair equipment. For those who choose metal fabrication and repair as a career, it is a profession with a rich past, a multi-faceted present, and a dynamic future.


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OBJECTIVES

1. Distinguish among the methods of welding.
2. Identify equipment used for shielded metal arc welding.
3. Demonstrate procedures for striking an arc and running a bead.
4. Identify equipment used for oxyfuel cutting.
5. Explain the purpose of oxygen and fuel gases used in oxyfuel cutting.
6. Discuss the oxyfuel cutting process.
7. Determine how to properly adjust an oxyfuel flame.
8. Demonstrate the procedure for cutting steel.
9. Discuss errors made when cutting steel.

KEY WORDS

AC
AC/DC
backfire
chipping hammer
DC
electrode
electrode holder
flashback
flux
ground clamp
kerf
metal inert gas
oxidation
scratching
shielded metal arc welding
slag
stringer bead
tapping
tungsten inert gas
weaving
wire brush

Welding Methods

Arc welding is the use of electric current as a heat source to bond metal together by fusion. The arc that generates the heat is an electrical discharge sustained between the electrode and the base metal. There are several types of arc welding processes, each of which uses a different welding machine.

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Shielded Metal Arc Welding

Shielded metal arc welding (SMAW) is also known as *stick welding*. With this type of arc welding, the welder uses an electrode. As the coating on the electrode burns, it creates a gaseous shield around the melted metal, which helps the base metal mix with the welding rod or electrode. SMAW work is done with AC, DC, or AC/DC welding machines.

AC (alternating current) machines are simple transformers that plug into normal 220V wiring. These welding machines are relatively inexpensive, suitable for most common uses, and simple to use. However, they offer the operator less control over the welding process.

DC (direct current) machines act as electrical generators. Some DC welders are operated by an internal combustible engine, which means they are mobile and can be used in places where electricity is not available. DC machines also have a manual control that allows the operator to change the direction of current flow in the welding circuit. The two possible directions are referred to as *straight polarity* and *reverse polarity.* Using this option allows the operator to modify the characteristics of the weld to suit the application.

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AC/DC welding machines allow the operator to use the type of current (AC or DC) most suitable for application. When powered by a gas or diesel engine, machines of this type can be used as portable generators as well. As the machine offers the operator more choices and greater control over the current used, it is both more complicated to use and suitable for a wider variety of situations.

SMAW welders allow the user to set the amperage level. The amperage setting affects the strength of the current flow and, therefore, the amount of heat produced. Welders used in agricultural mechanics usually have a range of 20 to 225 amps. Welders also require a certain amount of cooldown time when operating. The amount of time that a welder can be used before it must be allowed to cool down is called the *duty cycle*. This is expressed as the percentage of time in a 10-minute cycle that the welder can operate before it overheats.

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Metal Inert Gas Welding

Metal inert gas (MIG) machines use a combination of electricity and an inert shielding gas. The electrode is a consumable wire that is fed automatically from a spool. The wire moves through a gun nozzle, through which the shielding gas is also injected. MIG welding is especially suited for welding thin-gauge steel or for applications that require fast welding with good control of the weld. MIG welding is also referred to as *gas metal arc welding* or *GMAW*.

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Tungsten Inert Gas Welding

Tungsten inert gas (TIG) welding machines also use a combination of electricity and an inert gas. The electrode is considered non-consumable because it is made of tungsten, which has a very high melting point. The electrode is located inside the TIG torch. An inert gas, such as helium or argon, is injected from the torch and around the arc to shield the molten metal while welding. A filler rod is used in combination with the TIG torch. TIG machines use either AC or DC current. TIG welding is slower than MIG welding, but it offers the greatest amount of control of the weld. It is used in situations where high quality of the weld is essential. TIG welding is also referred to as *gas tungsten arc welding* or *GTAW*.

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Welding Equipment

As with most hands-on professions, welding requires knowledge of specialized terms and equipment. SMAW requires certain equipment in addition to the arc welding machine, regardless of the type of machine being used.

The ***electrode*** is the metal welding rod that is coated with flux. ***Flux*** provides a gas shield for the molten pool during the welding process, which helps fuse metals together. Different types of electrodes are available and are classified according to their use.

Also known as rods or sticks, SMAW electrodes are available in a variety of types. All electrodes, regardless of type, consist of a metal rod coated with flux. The diameter and tensile strength of the rod, the type of flux coating, and the metal that the rod is made of will vary according to the specific welding need. Common types of electrodes include mild steel, hard surfacing, high-carbon steel, and alloys/special purpose.

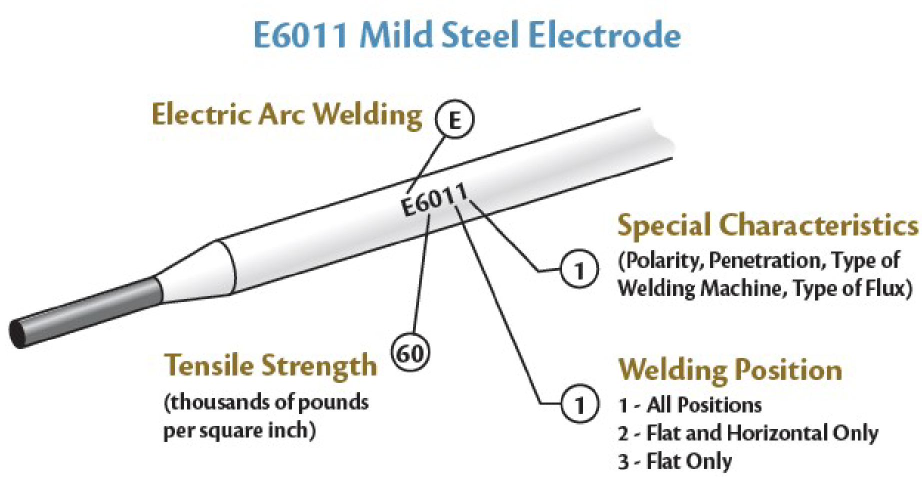
Electrodes are also classified according to the welding position and type of current with which they can be used. To easily identify an electrode's type, the American Welding Society (AWS) has developed a coding system. Most electrode manufacturers stamp this five-or six-digit code on the electrode coating.

- The letter "E" at the beginning of the code indicates that it is for electric arc welding.

- The next two digits indicate the tensile strength in thousands of pounds per square inch. The number 60 in this position means that a one-square-inch weld made with this electrode should withstand 60,000 pounds of tension. Some electrodes require a three-digit number to express this strength.

- The next number in the code indicates the welding position(s) in which the electrode should be used. The code "1" means that the electrode is usable in any welding position.

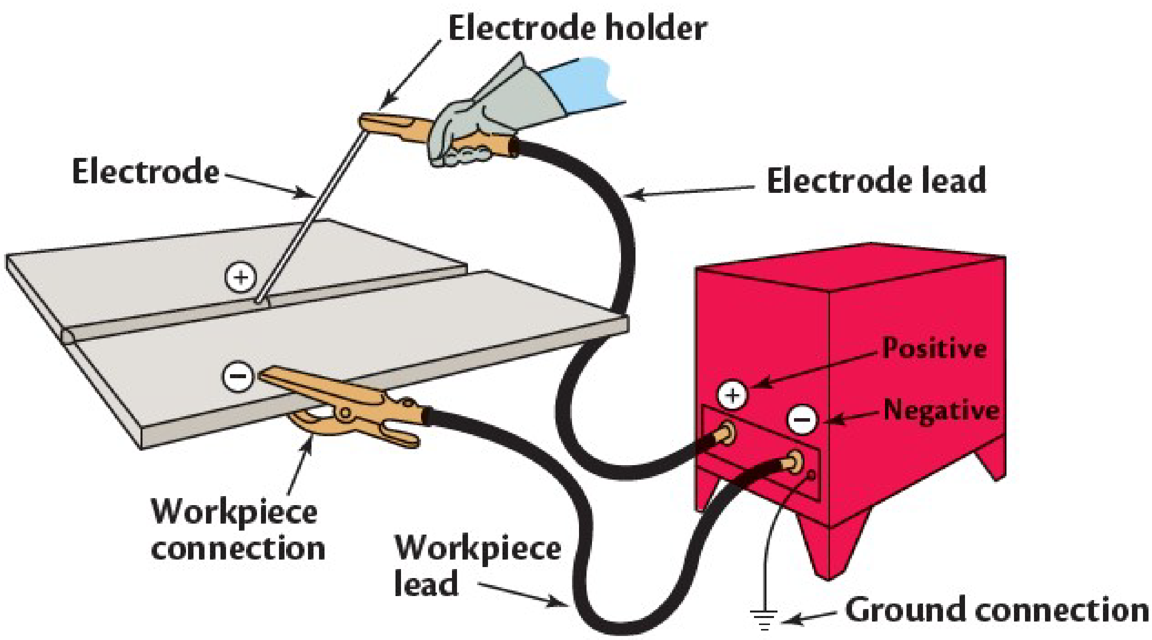
- The last number in the code indicates special characteristics of the electrode, such as the type of current to be used, the polarity, or the type of flux coating.



SAE IDEA:
Entrepreneurship
Design, build, and sell lawn ornaments.

Pocket guides and wall charts available through the AWS provide guidance in the exact meaning for the last two digits of the stamped electrode code. The most common types used in agricultural mechanics are E6011 and E6013, both of which are all-purpose, any position electrodes that can be used with AC or DC current. Newer high-strength metals require E7013.

The ***electrode holder*** is a clamp that grips the electrode. The handle of the electrode holder is insulated to protect the operator from electric shock. The ***ground clamp*** is a clamp attached by a cable to the arc welder. It completes the electrical current. Cables are used to connect the electrode holder and the ground clamp to the machine. Copper or aluminum wires are used for the core of the cable. These wires must be sized to carry the current produced at the maximum machine setting.



Striking an Arc and Running a Bead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Appropriate personal protective equipment (PPE) is needed when welding. A welding helmet with a properly shaded lens, safety glasses or goggles, leather welding gloves, leather apron, sleeves or jacket, and steel-toed leather boots should be worn for protection.

When welding, it is important to understand how the process works and what you are seeing when you look at a weld. This will help you create good welds and improve your work as you gain experience. With welding equipment in place and the arc welder turned on, the welding process begins by striking an arc with the electrode. The arc is kept burning by keeping the electrode an appropriate distance from the base metal. The operator moves the end of the electrode slowly across the base metal to form a bead. The electrode should be kept at about a 15- to 30-degree angle from perpendicular in the direction of travel. Right-handed welders weld from left to right, and left-handed welders weld from right to left.

SAE IDEA:
Placement
Work as an auto, truck, or tractor mechanic assistant.

The arc burns at temperatures between 6,000-9,000°F. Heat from the arc melts the base metal and the electrode, creating a molten pool or puddle of melted metal. Melting the base metal causes penetration below the surface, which fuses the metal together. Heat from the arc also burns the flux from the electrode. This creates the gaseous shield that protects the molten pool of metal from the effects of the surrounding air. This gaseous shield also stabilizes the arc. In addition to the effects of the gaseous shield, flux promotes fusion of the metals during welding. It also serves to float non-metallic impurities out of the molten puddle. As the weld cools, the burned flux and these impurities float to the top of the weld and create a layer called ***slag***.

A ***chipping hammer*** is used to knock away slag, and a ***wire brush*** is used to remove slag, clean metal in preparation for welding, or clean beads after welding. A grinder with a wire wheel is sometimes used. Tongs or pliers are used to handle metal that is still hot from welding.

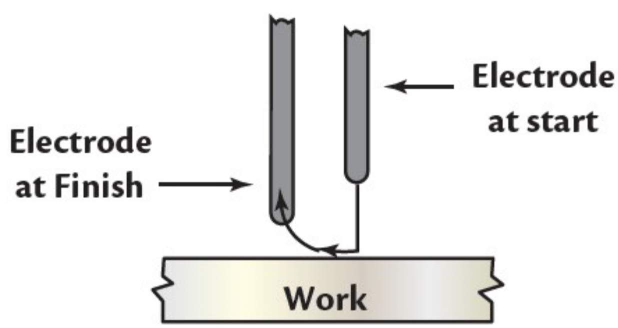
As the metal cools, you will see the weld and the slag. The penetration of the weld cannot be observed with the naked eye. This requires the use of X-ray equipment. There is much more to welding than just making pieces of metal stick together. However, striking an arc and running a bead are basic welding skills that you must have before doing any welding job.

Striking an Arc

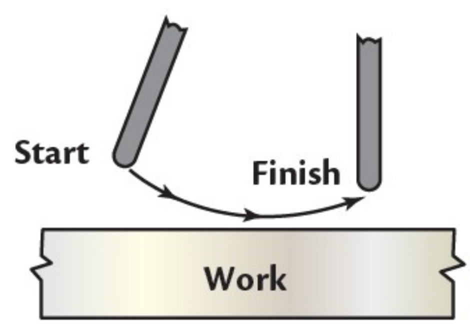
There are two methods for establishing an arc, scratching or tapping. Either one is acceptable. The ***tapping*** method works by touching the electrode to the base metal and quickly raising it. The ***scratching*** method works by touching the electrode to the base metal in a scratching motion like striking a match.

If the electrode gets stuck to the base metal, which will happen if it is left close to the metal for too long, you can either pull it off or release the electrode from the electrode holder. **Do not turn off the welder before releasing the electrode, as this will damage the machine.** Once you have established an arc, you will need to monitor its length. The length should be between 1/8 and 1/16 of an inch.

If the arc is too short, the electrode may stick to the base metal. If the arc is too long, you will hear an erratic sound. An arc of the correct length produces a frying sound, and the machine will have a steady hum.



Tapping



Scratching

Running a Bead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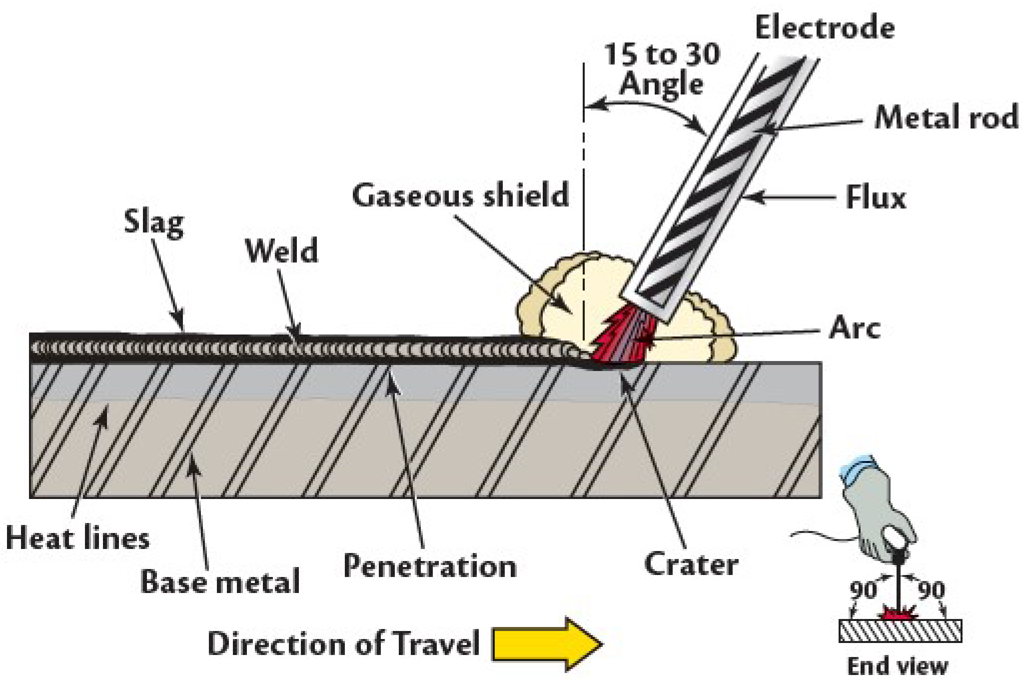
The simplest type of bead is called a ***stringer bead***. To do this, the electrode is moved along a straight line. To develop this skill, you will need to practice using a steady arm motion, keeping the electrode at the proper angle, and feeding the electrode as you monitor the arc and the puddle, or pool of melted metal. As your skill at welding develops, you will want to practice ***weaving***. Frequently, you will need to make wider beads or control the heat of the arc by moving the electrode in a weaving pattern. Welders use different weaving patterns such as circles, crescents, or triangles for different needs.

To run a practice bead, you must first set up your equipment in a safe and suitable manner. With your machine set to the proper amperage, your PPE in place, a piece of practice metal in front of you, and the correct electrode type in your electrode holder, you are ready to begin running a bead using the following process:

- Turn on the machine.
- Yell “Cover!” to alert others to the presence of the arc so they can look away or cover their eyes.
- Lower your helmet.
- Strike an arc on the base metal near the beginning of the bead.
- Hold the electrode perpendicular to the base metal, angled slightly in the direction of travel. If you are right-handed, move the electrode from left to right. If you are left-handed, move from right to left.
- Move the electrode across the base metal at an even speed, monitoring your arc length as you go.
- Use a speed that produces a bead width two to three times the diameter of the electrode.

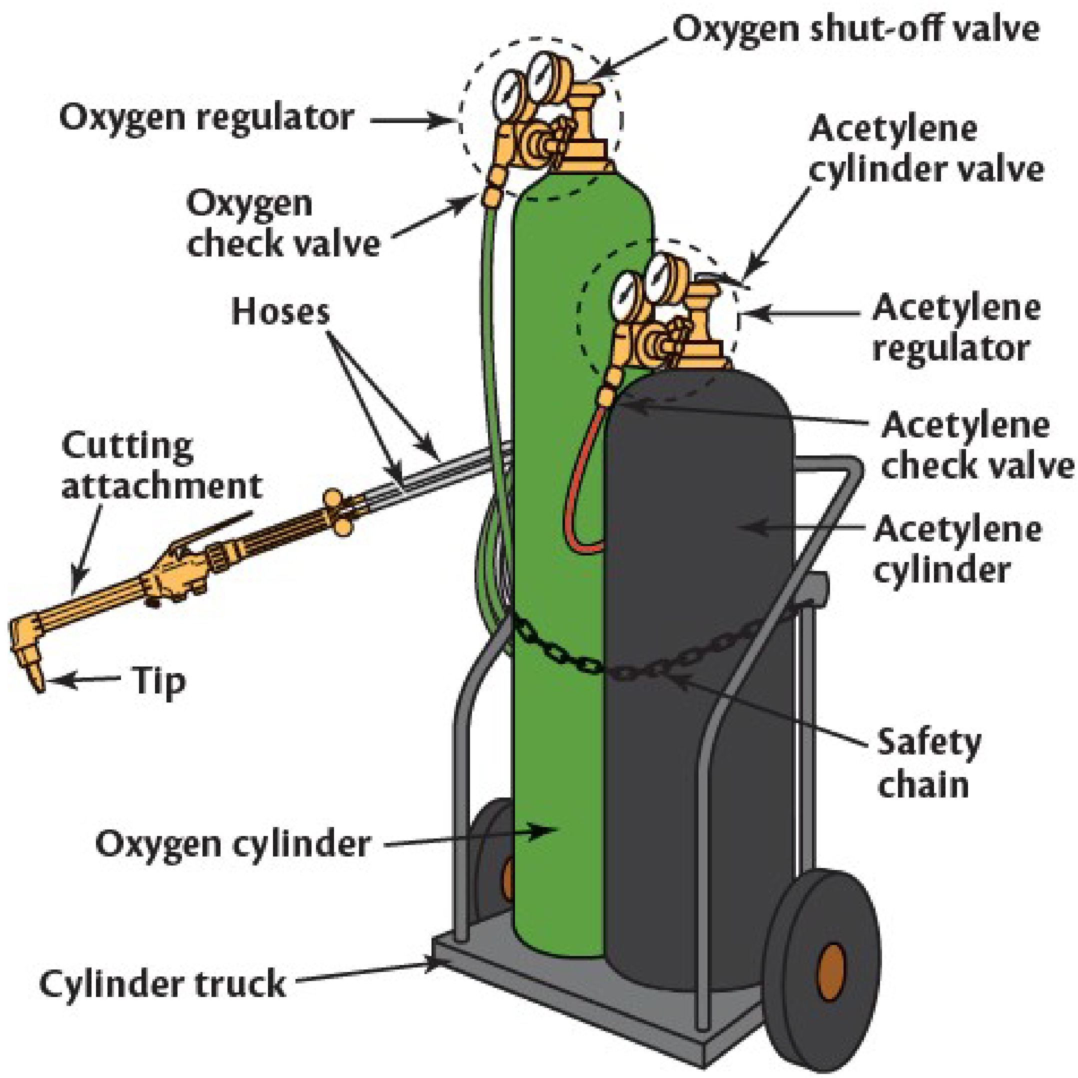
- Feed the electrode evenly.
- Lift the electrode quickly to stop.
- Turn off the machine.

The machine can overheat if turned on and off repeatedly. Allow the machine to cool before shutting it off. The completed bead should be cleaned of slag and examined for quality.



Cutting Equipment

An oxyfuel cutting rig consists of a truck (cart), cylinders, torch, regulators, and hoses. Auxiliary equipment for safety and lighting the flame is also used. Knowing about each part of the equipment is very important from a safety standpoint.



Gas cylinder

Gas or fuel cylinders are usually black. Acetylene is a common fuel used for cutting, and because acetylene cannot be stored under pressure greater than 15 psi, the interior of the acetylene cylinder is filled with a porous material and liquid acetone. The acetone absorbs the acetylene gas and renders it stable. There is also a reserve capacity left in the acetylene cylinder, since the gas expands when the temperature rises.

- **Gas cylinder valve** – The gas cylinder valve should never be opened more than 1 ½ turns; 3/4 of a turn is preferable. This allows the operator to close the valve quickly in an emergency.

- **Gas regulator** – The gas regulator is attached to the cylinder outlet (or manifold outlet) to regulate gas pressure to the torch. Gauges on the regulator show the pressure of fuel gas in the cylinder and the amount of pressure being supplied to the torch.

- **Gas hose** – The fuel gas hose is color coded red or black. It is attached to the regulator and supplies gas from the cylinder to the torch.

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Oxygen cylinder – Oxygen cylinders are usually green. The oxygen is compressed and stored under high pressure.

- **Oxygen cylinder valve** – Oxygen is released by opening the valve. The oxygen valve should be opened all the way to prevent oxygen from leaking.

- **Oxygen regulator** – The oxygen regulator is attached to the cylinder outlet (or manifold outlet) to control gas pressure to the torch. Gauges show the amount of pressure in the cylinder (how full it is) and the pressure being supplied to the torch.

- **Oxygen hose** – The oxygen hose is color coded green. It is attached to the oxygen regulator and supplies oxygen from the cylinder to the torch.

- **Oxygen and gas check valves** – Check valves are installed between the hose and torch to prevent backflow if a reverse flow starts. Without a check valve, fuel and oxygen could cause combustion in the hose and regulator. A flashback arrestor connects in the same way as a check valve and includes a trap that is spring loaded, which cuts the gas flow in the event of a flashback.

Safety chain – The safety chain is used to keep the cylinders upright and stable.

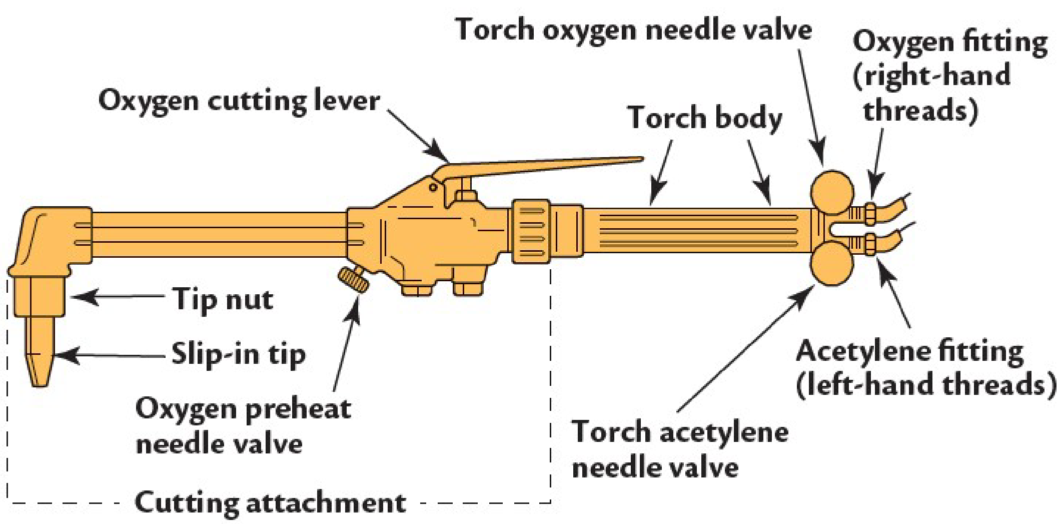
Cylinder truck – The cylinder truck holds the cylinders and allows safe movement of the entire rig.

Torch Handle

- **Control valves** – The torch handle separates into a "Y" formation to allow attachment of the oxygen and fuel gas hoses. The supply of each gas is controlled separately. Each valve attachment is labeled "OXY" or "GAS" to ensure that the proper supply hose is attached. In addition, the oxygen fitting uses right-hand threads and the fuel gas fitting uses left-hand threads.

- **Barrel** – The oxygen and gas are kept separate within the barrel of the torch handle. Oxygen and fuel gas travel through tubes inside the barrel.

- **Torch head** – The torch head is threaded to accept attachments and is designed to be gas-tight. The oxygen and fuel gas are still separated as they move through the torch head into the attachment.



Cutting Attachment

- **Coupling nut** – The coupling nut is used to connect the cutting attachment securely to the torch handle. Oxygen and fuel gas travel separately through this connection.
- **Mixing chamber** – Oxygen and fuel gas are mixed within this tube. The mixture flows out of the tip of the cutting attachment to feed the flame.
- **Oxygen preheat valve** – This valve controls the supply of oxygen from the supply hose. When the cutting attachment is used, the oxygen control valve on the torch body should be opened slowly to regulate the amount of oxygen in the flame.
- **Oxygen tube** – Pure oxygen is fed through this tube. It flows out of a separate opening in the tip of the cutting attachment.
- **Oxygen cutting lever** – Depressing this lever allows oxygen to travel through the oxygen tube. This high-pressure stream of oxygen is what cuts the preheated metal.
- **Cutting head** – The cutting head is designed to accept different types of cutting tips, which are securely attached with a tip nut. The cutting head also keeps the mixed gas and cutting oxygen streams separate.
- **Tip** – The tip has tiny holes that allow mixed gas and cutting oxygen to exit separately. Different sized tips are used for different cutting operations.

Auxiliary Equipment

- **Flint lighter** – The flint lighter is used to create a spark to light the torch.
- **Welding goggles** – Goggles used for oxyfuel cutting must have a No. 4 or darker-shaded lens.
- **Shaded face shield** – A shaded face shield may be used in place of welding goggles.
- **Safety glasses** – Safety glasses must be worn at all times.
- **Gloves** – Leather gloves protect the operator’s hands and forearms from molten metal and sparks.

Gases Used in Oxyfuel Cutting

The terms *oxygas* or *oxyfuel* refer to a mixture of oxygen with a fuel gas. This mixture is combustible and is used to create a very hot flame. The oxyfuel flame can be used for several applications, such as welding, cutting, brazing, soldering, heating, and flame hardening.

Role of Oxygen

Oxygen is a colorless, odorless, tasteless gas. It is an essential component of the oxyfuel mixture. Oxygen itself is not flammable, but it supports and sustains combustion. Remember that one way to put a fire out is to smother it or deprive it of oxygen. Pure oxygen, when combined with a combustible fuel gas, greatly intensifies the temperature of the flame. By mixing oxygen with a fuel gas in the right proportions, a very hot flame can be produced, capable of melting metal. In addition to its role in sustaining combustion, oxygen in the oxyfuel mixture combines with iron when working with ferrous metals (metals that come from iron ore). This combination is called ***oxidation*** and results in the consumption of the oxidized element. Burning and rust are both examples of oxidation.

Fuel Gases

There are several fuel gases used in oxyfuel welding and cutting. Each has its own characteristics, flame temperature, and suitable uses. The characteristics of various types of fuel gases are described in the table below. Acetylene is the fuel gas most used in schools, and it is the most versatile for gas welding operations. Propane is often used as a fuel gas on farms and in rural areas, as it is easily accessible and is often less expensive than acetylene. MAPP® gas (a registered trademark of Air Reduction Company, Inc.) is used mostly in industry.

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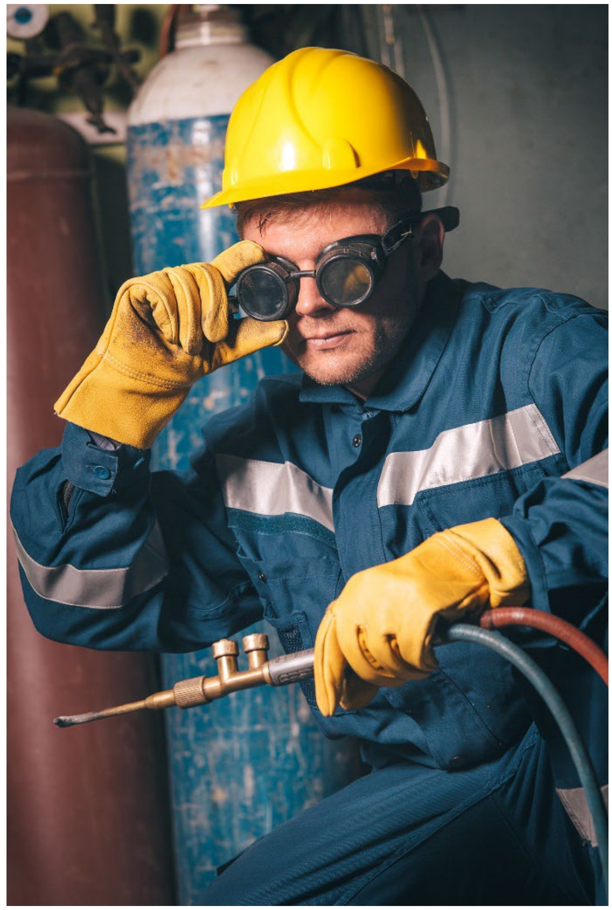
Type of fuel gas	Flame temperature with oxygen (in degrees Fahrenheit)	Characteristics	Suitable uses
Acetylene	5720 to 6300	Unstable under pressures above 15 psi Distinct odor Colorless Low toxicity	Welding Cutting Brazing Smoldering
MAPP® gas	5301 to 6000	Stable Distinct odor Colorless Low toxicity	Cutting Brazing Smoldering
Propane (LPG)	4579 to 5300	Stable Distinct odor (artificially added) Colorless Low toxicity	Cutting Brazing Smoldering
Natural gas	4600	Stable Distinct odor (artificially added) Colorless Low toxicity	Cutting Brazing Smoldering

Oxyfuel Cutting Process

The use of an oxyfuel flame for welding and cutting metal dates to the early 1900s. Because the equipment is portable and the amount of heat can be varied and controlled, oxyfuel equipment is extremely useful for agricultural producers. It is also used in many manufacturing, construction, and service industries.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Oxyfuel cutting is used on ferrous alloys such as steel because iron has the property of burning in the presence of pure oxygen. The cutting process occurs in two steps:

1. The metal to be cut is preheated with the flame of the cutting torch to a cherry red color. This color indicates that the metal is hot enough to burn when pure oxygen is introduced. The temperature of the metal must be between 1600°F and 1800°F to burn. This temperature is lower than that required to melt the metal; and

2. A stream of pure oxygen is introduced by depressing the oxygen-cutting lever on the cutting torch. This shoots oxygen at the heated metal, which ignites and burns away where the oxygen hits it.

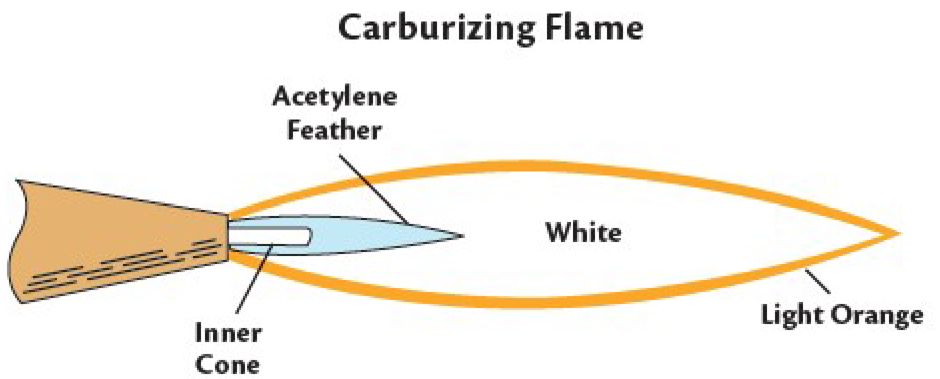
The slit in the metal that results from this process is called a ***kerf***. Slag and residue from the burned metal are forced out of the kerf by the force of the oxygen stream. Nonferrous metals can be cut in a similar fashion using a plasma arc cutter.

Adjusting an Oxyfuel Flame

The correct type of flame for heating, cutting, and welding with oxyfuel equipment is called a *neutral flame*. It is established by adjusting the mix of oxygen and fuel gas at the torch needle valves to achieve the correct balance of gases. You should analyze the flame to determine if the mixture has too much fuel gas (carburizing flame), too much oxygen (oxidizing flame), or is correctly balanced (neutral flame).

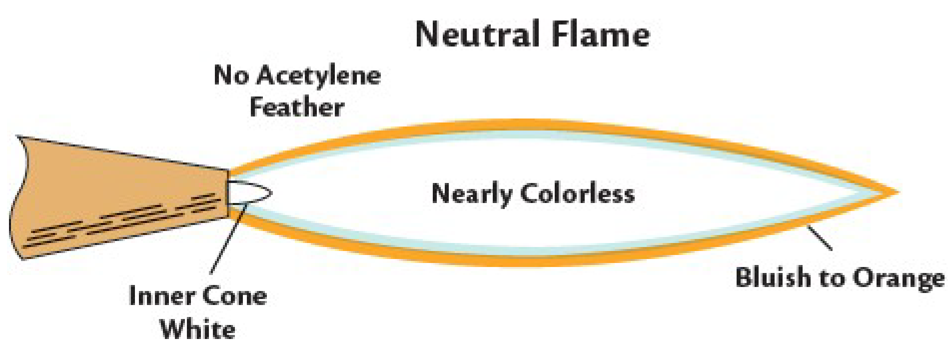
Carburizing Flame

This type of flame will show three parts — a white inner cone, a blue gas feather, and a white outer flame with a light orange edge. The carburizing flame (sometimes called a *carbonizing flame*) has excess gas in the mixture. It is cooler than the other types of flames.



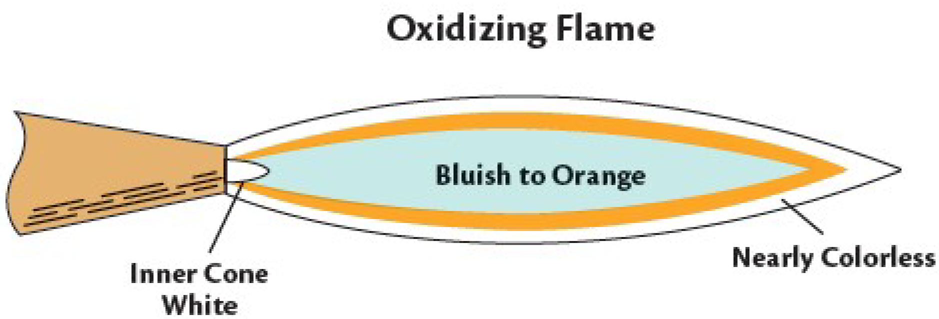
Neutral Flame

This type of flame shows two parts — a white inner cone and an outer flame that is nearly colorless with a bluish to orange edge. The gas feather grows smaller as the amount of gas in the mixture is reduced until it essentially matches the size of the inner cone and disappears. This is the correct type of flame to use for cutting.



Oxidizing Flame

This type of flame also shows two parts — a short, white inner cone and an outer flame that is bluish to orange with a nearly colorless outer edge. You will also hear a whistling sound associated with this type of flame. This flame has excess oxygen in the mixture. It is hotter than the other types of flame, and it will burn metal, causing it to become brittle.



Cutting Steel

Cutting steel is a skill that is developed with practice. Long cuts, circular cuts, or patterned cuts require devices to assist in controlling the movement of the torch. However, you should know and practice the basic technique for making straight cuts before moving on to more difficult types of cuts.

Occasionally, backfire and flashback can occur when using oxyfuel equipment. ***Backfire*** is a condition in which the torch flame momentarily burns back into the tip. It is characterized by a loud snap or pop. Usually the flame is blown out, although it may continue to burn. Backfire may be caused by several conditions including a dirty tip, insufficient pressure, or overheating of the tip caused by bringing the tip too close to the molten puddle. If a torch backfires, notify your instructor. The condition that caused it must be corrected before continuing to work. Backfire can sometimes cause a more dangerous condition known as *flashback*.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PROCEDURE FOR CUTTING STEEL

1. Mark the metal to be cut.
2. Position the metal over a slag box.
3. Light the torch and establish a neutral flame.
4. Preheat the metal. Point the tip at an angle toward the edge of the plate at the point where you will begin your cut. The tips of the preheat cones should be about 1/8 inch from the metal. Hold the torch here until the metal becomes a bright red.
5. Rotate the torch tip to an upright position perpendicular to the surface to be cut. Depress the oxygen cutting lever.
6. Rotate the tip backward at a slight angle so the cutting oxygen is directed first at the corner of the metal to be cut.
7. Without moving forward, rotate the tip back through the perpendicular position until the tip is pointing at a very slight angle in the direction of the cut. The tips of the preheat flames should remain about 1/8 inch from the metal.
8. Move the torch smoothly forward along the mark to be cut. Maintain the slight angle of the tip in the direction of the cut.
9. Continue a steady motion forward until the cut is complete and the torch tip has cleared the edge of the metal. Release the cutting oxygen lever.

Flashback occurs when the flame burns back into the torch body. It is characterized by a shrill hissing sound. The flame may disappear, and smoke or sparks are emitted from the torch tip. If flashback occurs, you must act quickly to cut off the gases fueling the flame.

Perform these steps immediately upon indication of flashback. If using a cutting attachment, you should:

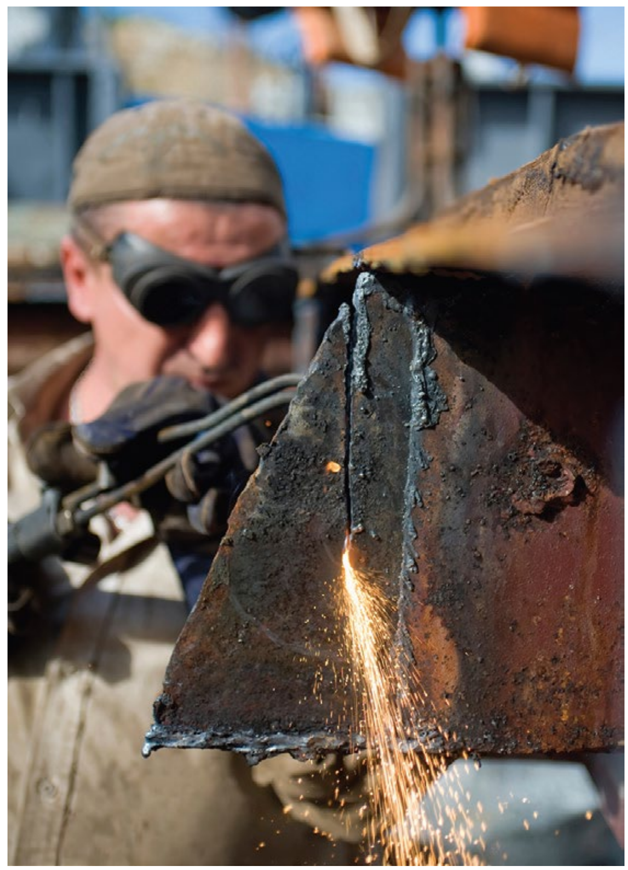
- Close the oxygen preheat valve.
- Close the torch fuel gas valve.
- Close the oxygen torch valve.
- Release the oxygen regulator screw.
- Release the fuel gas regulator screw.

SAE IDEA:
Research
Study the possible modifications in agriculture equipment for people with disabilities.

If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, quickly shut off the oxygen cylinder valve and the fuel gas cylinder valve. Then notify your instructor. Once the unit is turned off, allow the cutting attachment to cool (flashback will make it very hot). Examine the unit for problems that may have caused the flashback and correct them if found. If flashback reoccurs, the unit should be examined by a qualified repair person.

Errors Made When Cutting Steel

There is a right way and a wrong way to cut metal. You can determine what type of errors you are making by examining your completed cuts. The characteristics of the cut will show if errors involving any of these factors have occurred. Four factors contribute to the quality of an oxyfuel cut — travel speed, cutting oxygen pressure, preheat, and clearance of the torch tip. A quality cut has clean and square edges on the top and bottom. The surface of the cut is smooth with uniform vertical drag lines that bend back slightly at the bottom.



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Travel Speed

A cut made with the travel speed too fast will have excessive slag on the bottom edge of the cut. The surface of the cut is rough with the drag lines slanting away from the direction of the cut. There may be uncut metal present. A cut made with the travel speed too slow also will have excessive slag on the bottom edge. The lower section of the surface is gouged, while the upper section is smooth.

Oxygen Pressure

A cut made with too much cutting oxygen pressure will leave a top edge uneven or dished. The surface of the cut shows irregular drag lines. A cut made with not enough cutting oxygen pressure will have excessive slag on the bottom edge of the cut. The surface of the cut will be relatively smooth, but the drag lines will slant away from the direction of travel. The cut may be incomplete at the bottom.

Preheat

A cut made with too much preheat will have a melted and rounded top edge with slag on the bottom edge. The surface is smooth with regular drag lines. A cut made with too little preheat will leave a cut with the top edge out of square and the bottom edge irregular. The drag lines are well defined with some pitting or gouging.

Clearance

A cut made with the cutting tip too far from the metal will result in the top edge of the cut being flared, and the drag lines on the surface will be vertical. A cut made with the cutting tip too close to the metal will leave a rough top edge, and the drag lines on the surface will be irregular. There may also be gouging.

SAE IDEA:
Exploratory
Interview area agriculture producers about the changes in technology over the past 50 years.

UNIT SUMMARY

Arc welding and oxyfuel cutting are skills that are highly valuable in agriculture. The ability to create new products or repair machinery is beneficial to the agricultural producer. It often saves time and money to complete a project on site rather than taking a piece of equipment to a repair shop. It is important to remember safety practices when welding or cutting, as it can be dangerous. There are various types of machines and equipment to be used depending upon the job and type of metal and knowing the uses of each can lead to a stronger weld or smoother cut. Just as in any learned skill, welding and cutting will take practice to master.

UNIT REVIEW

1. Name three welding methods and the differences in each.
2. Compare the machines used in shielded metal arc welding.
3. What is an electrode?
4. Draw an example of an electrode and label the code.
5. What are the two methods to striking an arc?
6. Describe the process of running a welding bead.
7. What color are the gas and oxygen hoses on a cutting assembly?
8. Name four gases used in oxyfuel cutting.
9. What are the uses for acetylene and natural gas?
10. What are the two steps that occur in the cutting process?
11. Name the differences between the three oxyfuel gas flames.
12. How does flashback occur when cutting metal?
13. What are the causes of error in cutting steel? Explain.