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MEM 261: WORKSHOP PRACTICE II

CHAPTER 2

INTRODUCTION TO GAS WELDING, ARC WELDING AND PLASMA CUTTING

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OBJECTIVES & LEARNING OUTCOMES

1. Acquire basic knowledge on arc welding and gas welding and its operating.
2. Differentiate between arc welding, gas welding and its application.
3. Justify which welding operation is relevant to certain task.
4. Acknowledge safety procedure when handling with this equipment.

2. INTRODUCTION

WHAT IS WELDING? – A material joining process in which 2 or more parts coalescence at their contacting surfaces by a suitable application of heat and/or pressure.

TYPES OF WELDING: a. Gas welding. (Used chemical energy-heat)
b. Arc welding. (Used electrical energy-heat)
c. Spot welding.

- **Heat:** used to bring the joint being welded to a liquid state.
- **Shielding gases:** used to protect the molten-weld pool and the weld area against oxidation.
- **Filler rods:** used in oxyfuel-gas and arc welding to fill the weld area.

- **Selection of welding types.**
  - **a. Work piece material.**
  - **b. Work piece thickness, size and shape.**
  - **c. Type of joint.**
  - **d. Strength required.**
  - **e. Change in product appearance caused by welding.**

APPLICATION? – Manufacture of automobile bodies, furniture machine frame, general repair work, ship building and etc…

- **There are a lot of welding equipment and usually they are now robotic and computer controlled with programmable features.**

➢ Basic types of weld joint.

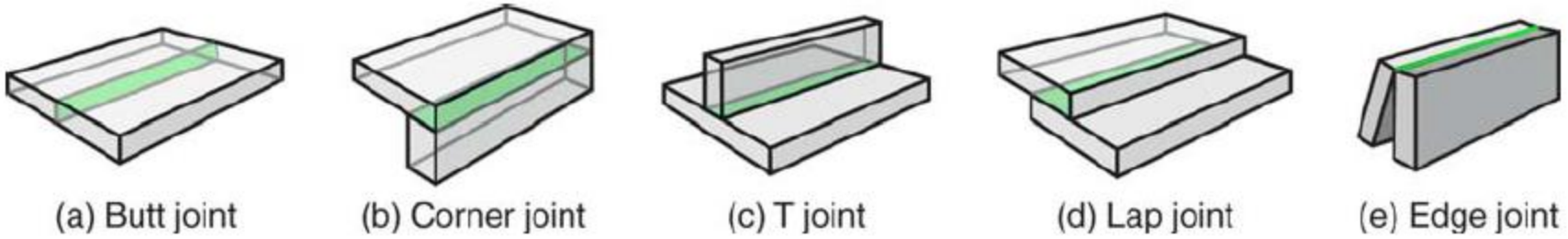


Figure 6.1 Basic types of weld joint

Butt joint : The parts lie in the same plane and are joined at their edges.

Corner joint : The parts in a corner joint form a right angle and are joined at the corner of the angle.

Lap joint : Consist of two overlapping parts.

Tee joint : One part if perpendicular to the other in the approximate shape of the letter T.

Edge joint : A joint between the edges of two or more parallel or mainly parallel members.

2. 1 WELDING TYPES

2.1.1 Gas Welding. (Oxy-acetylene gas welding-OAW)

WHAT? – Any welding process that uses a fuel gas combined with oxygen to produce a flame which a source of a heat that use to melt the metals at the joint.

- **Hydrogen and methylecetylene can be used in gas welding but most common fuel gas is acetylene.**

APPLICATION? – Structural sheet-metal fabrication, automotive bodies and various repair work.

PRO & CON? – Pro: Simple, portable & cheap.
Con: Low welding speed & not suitable for titanium or zirconum (reactive metal)

➢ Apparatus in oxyfuel gas welding

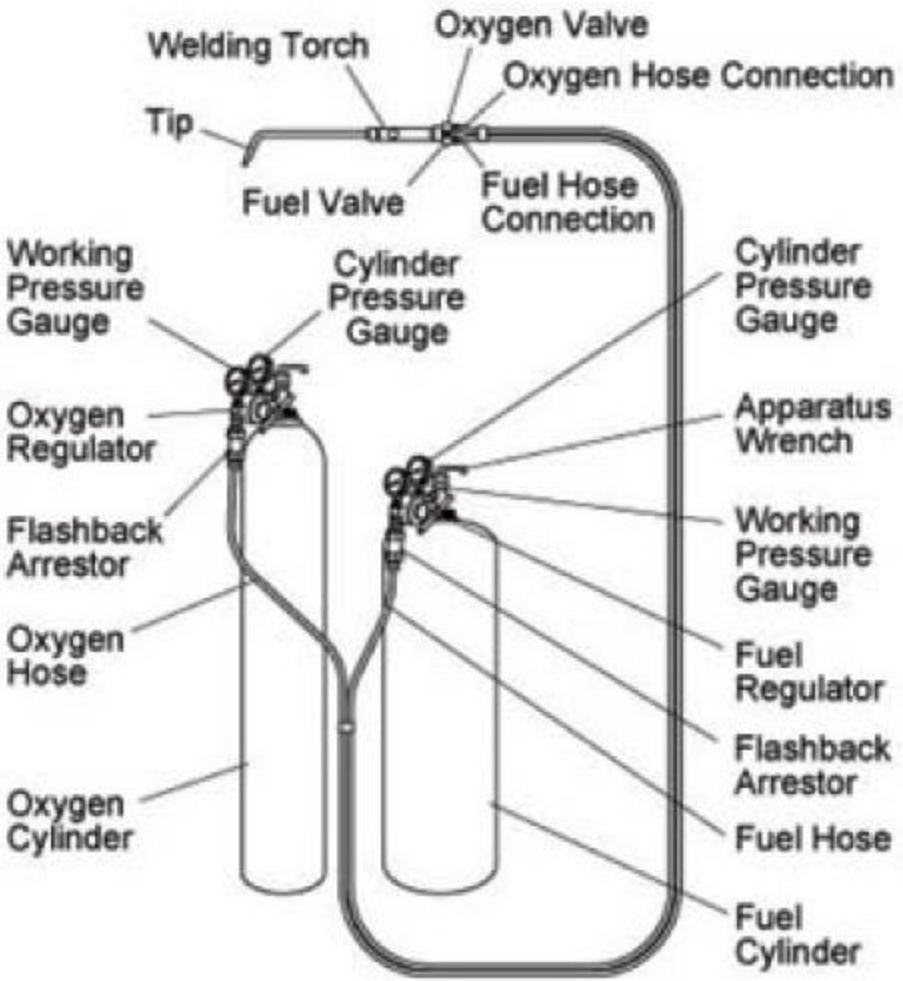
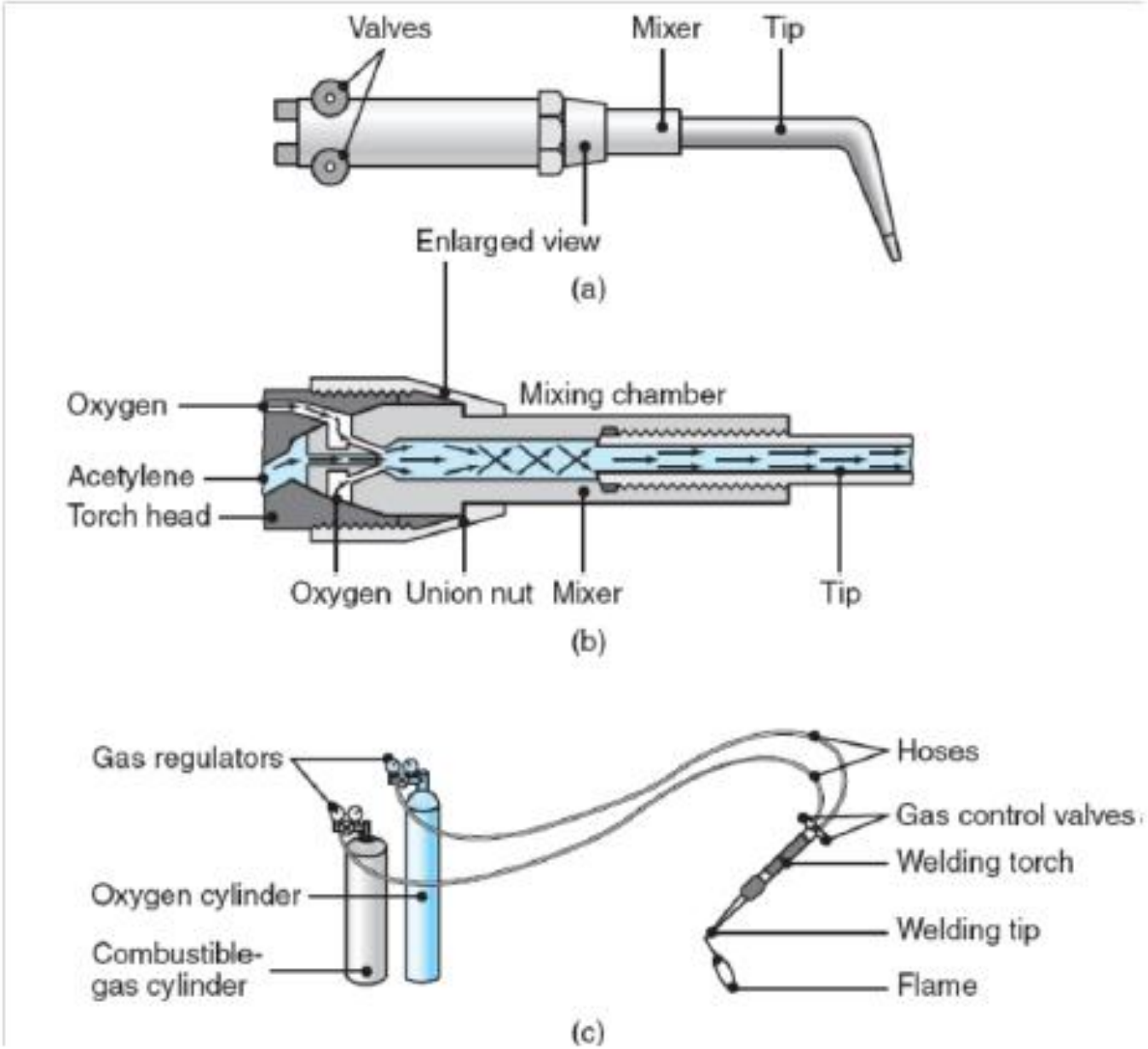
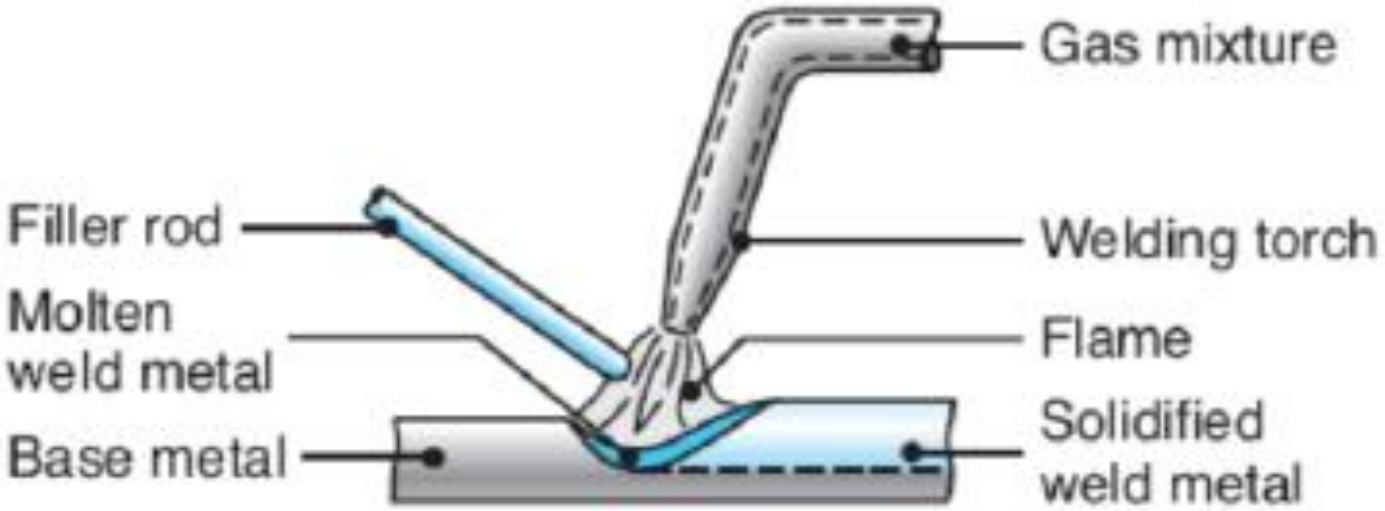


Figure 6.2 Apparatus in oxyfuel gas welding


Valves
Mixer
Tip
Enlarged view
(a)
Oxygen
Acetylene
Torch head
Mixing chamber
Oxygen
Union nut
Mixer
Tip
(b)
Gas regulators
Hoses
Gas control valves
Welding torch
Oxygen cylinder
Welding tip
Combustible-gas cylinder
Flame
(c)

2.1.1 Gas Welding. (Oxy-acetylene gas welding-OAW)



➢ **Flames**

Flames are the most important aspect in OAW. The correct type of flame is essential to the good welding result. The flames must be in proper size, shape and condition in order to operate with maximum efficiency.

➢ **Flames type**

The proportion of acetylene and oxygen in the gas mixture is an important factor in oxyfuel-gas welding. It also decided the type of the flame.

a. Neutral flame.

b. Oxidixing flame.

c. Carburizing or reducing flame.

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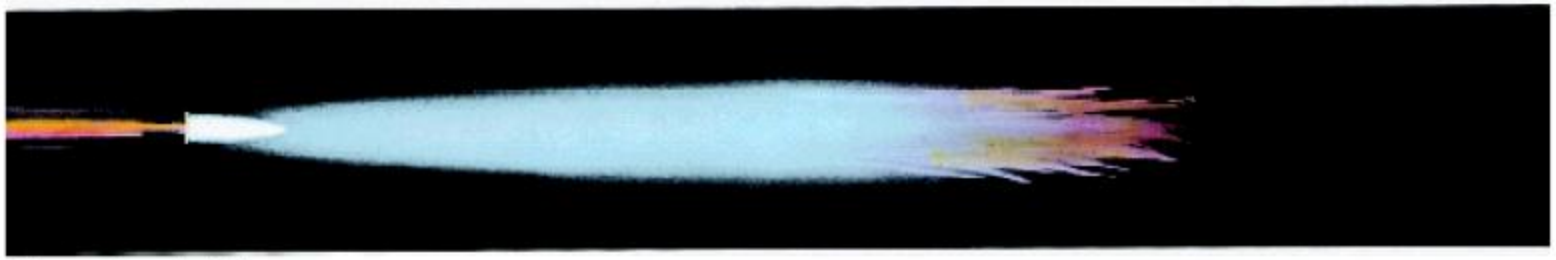
- **Neutral flame**

  a. Ratio of oxygen and acetylene (1:1).

  b. Term "Neutral" because there is no chemical effect on the metal being welded.

  c. Commonly used for: 1. Mild steel.
  2. Stainless steel.
  3. Cast iron.
  4. Copper.
  5. Aluminum.



Neutral Flame
(Acetylene and oxygen.) Temperature 5589°F (3087°C). For fusion welding of steel and cast iron.

- **Oxidizing flame**

  a. Ratio of oxygen and acetylene (oxygen>acetylene).

  b. It will oxidize or burn some of the metal being welded. To have this flame set carburizing flame first then convert it into neutral flame then reduce the supply of acetylene. It burn with a harsh sound. (Temp: 6300 °F)

  c. Commonly used for: 1. Copper base metal.
  2. Zink base metal.
  3. Manganese steel and cast iron.

Oxidizing Flame
(Acetylene and excess oxygen.) For braze welding with bronze rod.

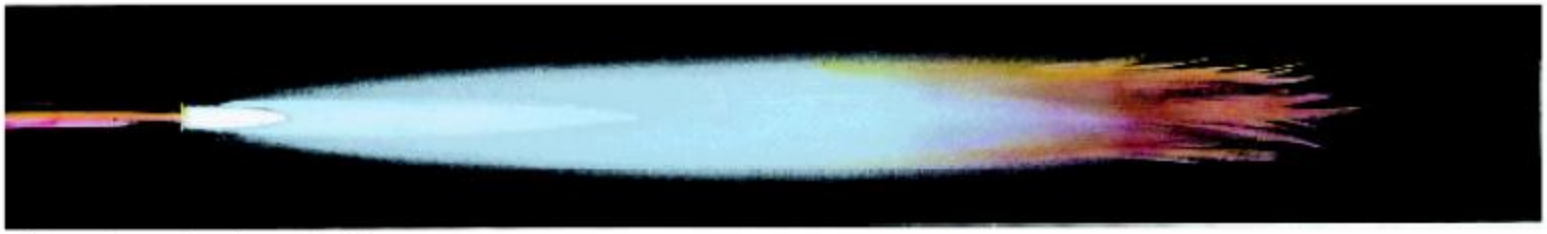
- **Carburizing flame**

  a. Ratio of oxygen and acetylene (oxygen<acetylene).

  b. Can be recognized by acetylene feather which exists between the inner core and outer envelope.

  c. Commonly used for: 1. Aluminum.
  2. Nickel ion.

  d. Cannot be used to welding metal that absorb carbon such iron and steel cause will produce iron carbide (brittle substance).



Carburizing Flame
(Excess acetylene with oxygen.) Used for hard-facing and welding white metal.

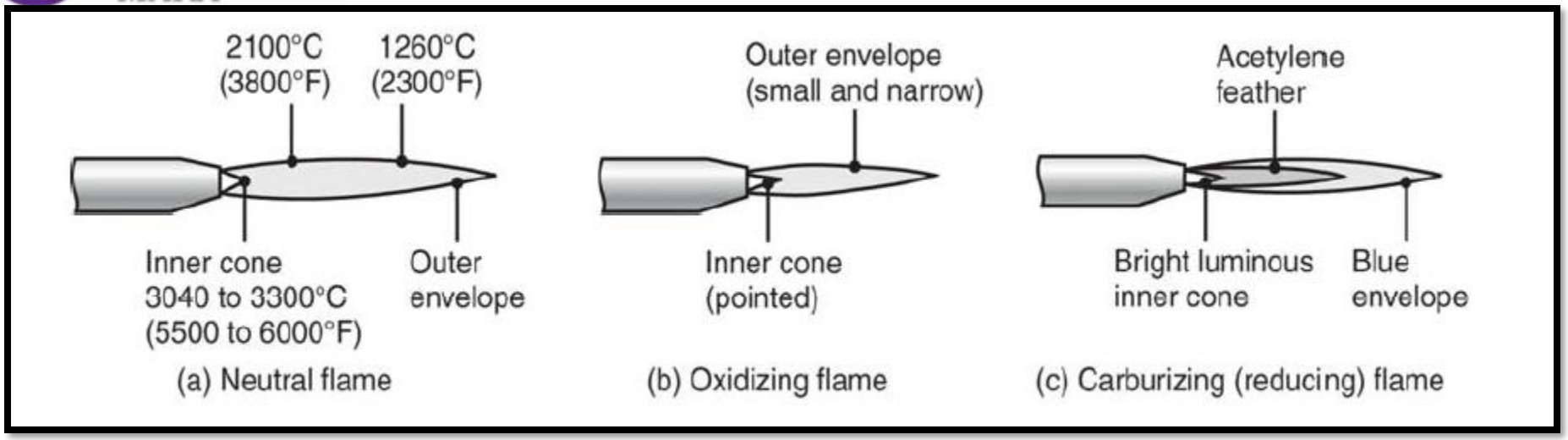


Figure 6.3 Flames differences

➢ Gas welding procedure:

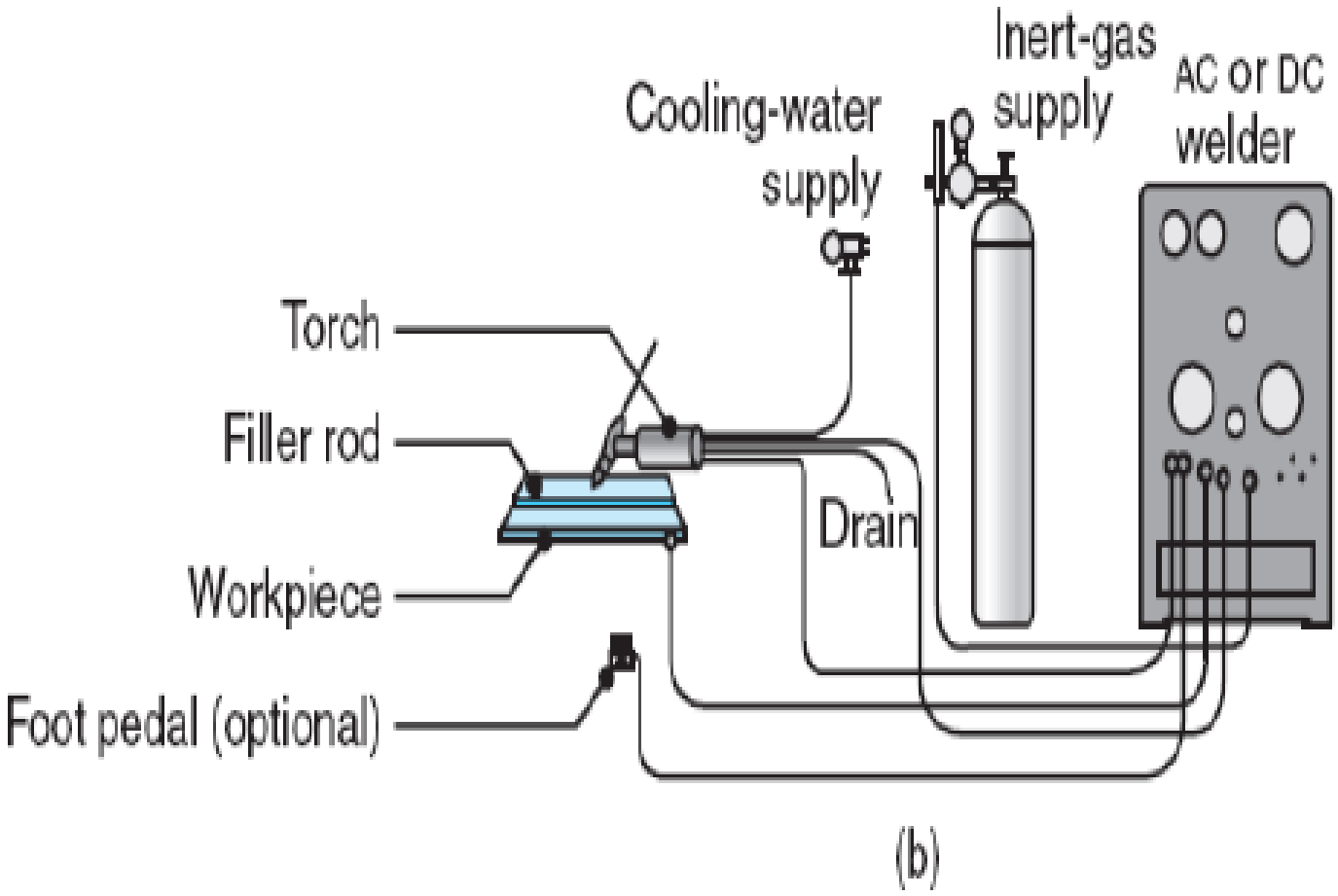
1. Prepare the edges to be joined and establish and maintain their proper position by using clamps and fixtures.
2. Open the acetylene valve and ignite the gas at the tip of the torch. Open the oxygen valve and adjust the flame for that particular operation.
3. Hold the torch at about 45° from the plane of the workpiece with the inner flame near the workpiece and the filler rod at about 30° to 40°.
4. Touch the filler rod to the joint and control its movement along the joint length by observing the rate of melting and filling of the joint.

2.1.2 Arc Welding. (AW)

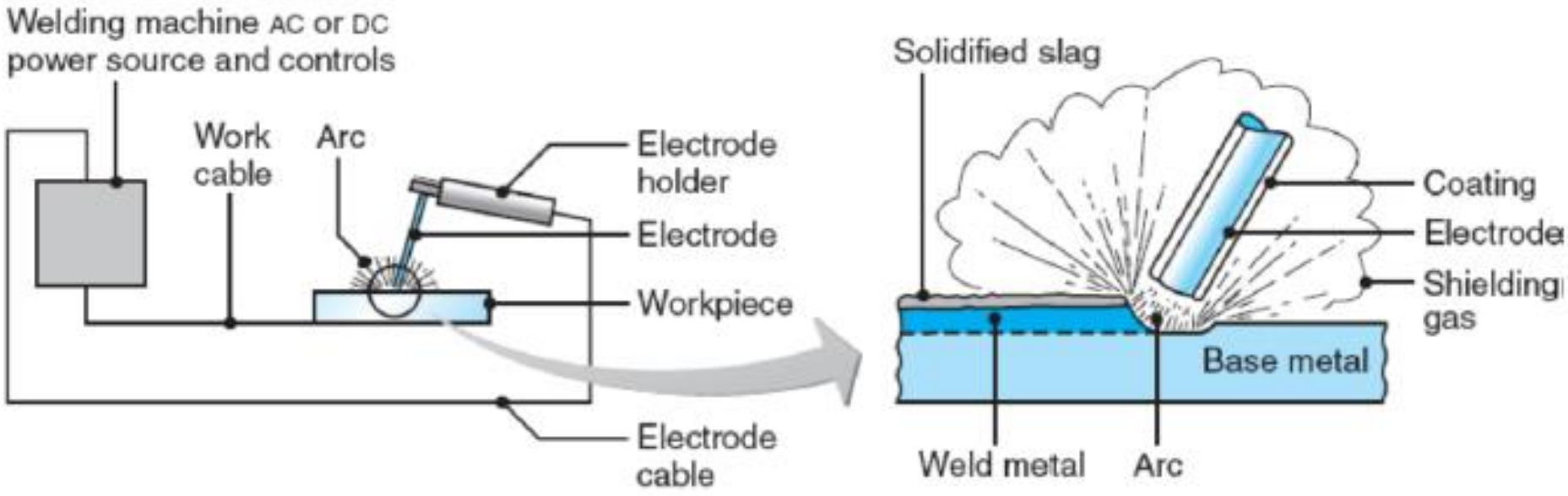
WHAT? – Developed in mid-1800s, the heat is from electrical energy. Need either consumable or nonconsumable electrode. An arch is produced between the tip of the electrode and the workpiece to be welded by using AC or DC power supply.

Figure 6.4 Power supply

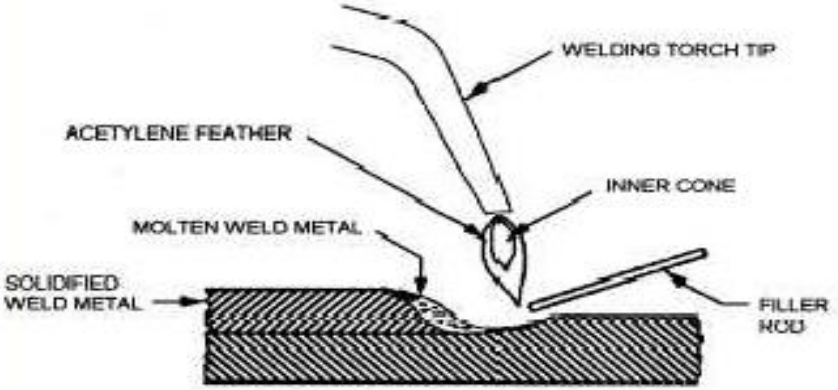
2.1.2 Arc Welding. (AW)

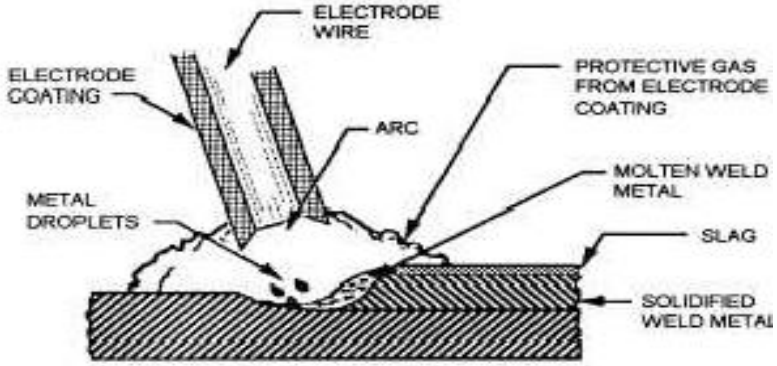


2.1.2 Arc Welding. (AW)



GAS WELDING vs ARC WELDING





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➢ Power supply

a. Provides an electric current to perform arc welding operation.

b. High current needed (>80 ampere).

c. A welding power can be simple as car battery and complicated as a modern machine with additional logic to assist in the welding process.

Arc welding (AW) is a fusion-welding process in which coalescence of the metals is achieved by the heat from an electric arc between an electrode and the work.

- To initiate the arc in an AW process, the electrode is brought into contact with the work and is then quickly separated from it by a short distance. The electric energy from the arc thus formed produces temperatures of 5500°C (10,000°F) or higher, sufficiently hot to melt any metal.

- A pool of molten metal, consisting of base metal(s) and filler metal (if one is used) is formed near the tip of the electrode. In most arc-welding processes, filler metal is added during the operation to increase the volume and strength of the weld joint. As the electrode is moved along the joint, the molten weld pool solidifies in its wake.

TYPES? – **a. Shield metal arc welding (SMAW)**

b. Gas metal arc welding. (GMAW @ metal inert gas welding, MIG)

c. Gas tungsten arc welding. (GTAW @ tungsten inert gas welding, TIG)

2.1.3 Spot Welding. (AW)

WHAT? – Used to join 2 sheet of metal by lap joint. Form small nugget at the interface. Thickness until 3mm.

APPLICATION? – Mass production of automobiles, appliances and metal furniture.

PRINCIPLE? –
1. Apply pressure to work piece.
2. Current is passed through the joint for certain period of time to melt the joint.
3. Electric current stop but the pressure remain until solidification complete.

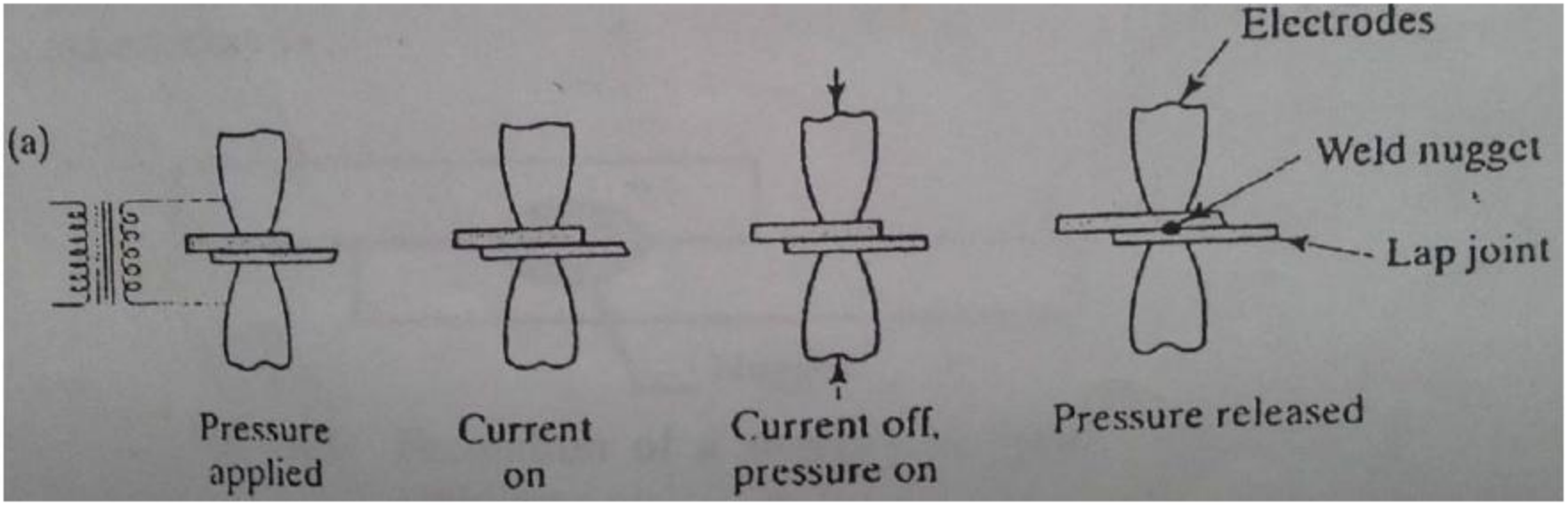


Figure 6.5 Spot welding

PRO & CON? – Pro: Little skill required, high production, heating area small (less energy) & able to weld different thickness.

Con: Complex equipment (high price) & limited to lap joint only.

2. 2 FILLER

- When welding two pieces of metal together, we often have to leave a space between the joint.
- The material that is added to fill this space during the welding process is known as the filler material (or filler metal).
- Filler metals are used to supply additional metal to the weld zone during welding.
- Filler metal that does not conduct an electric current during the welding process and often used for gas welding.
- They are available as filler rods or filler wire and may be bare or coated with flux.
    - i) Coated Filler Metal → Rods of this type of filler metal consists the coating of flux material.
    - ii) Bare Filler Metal → No coating of flux.
- Typically, filler metal is in the form of rod, 90 mm long and diameter ranging from 1.6 mm to 9.5 mm.

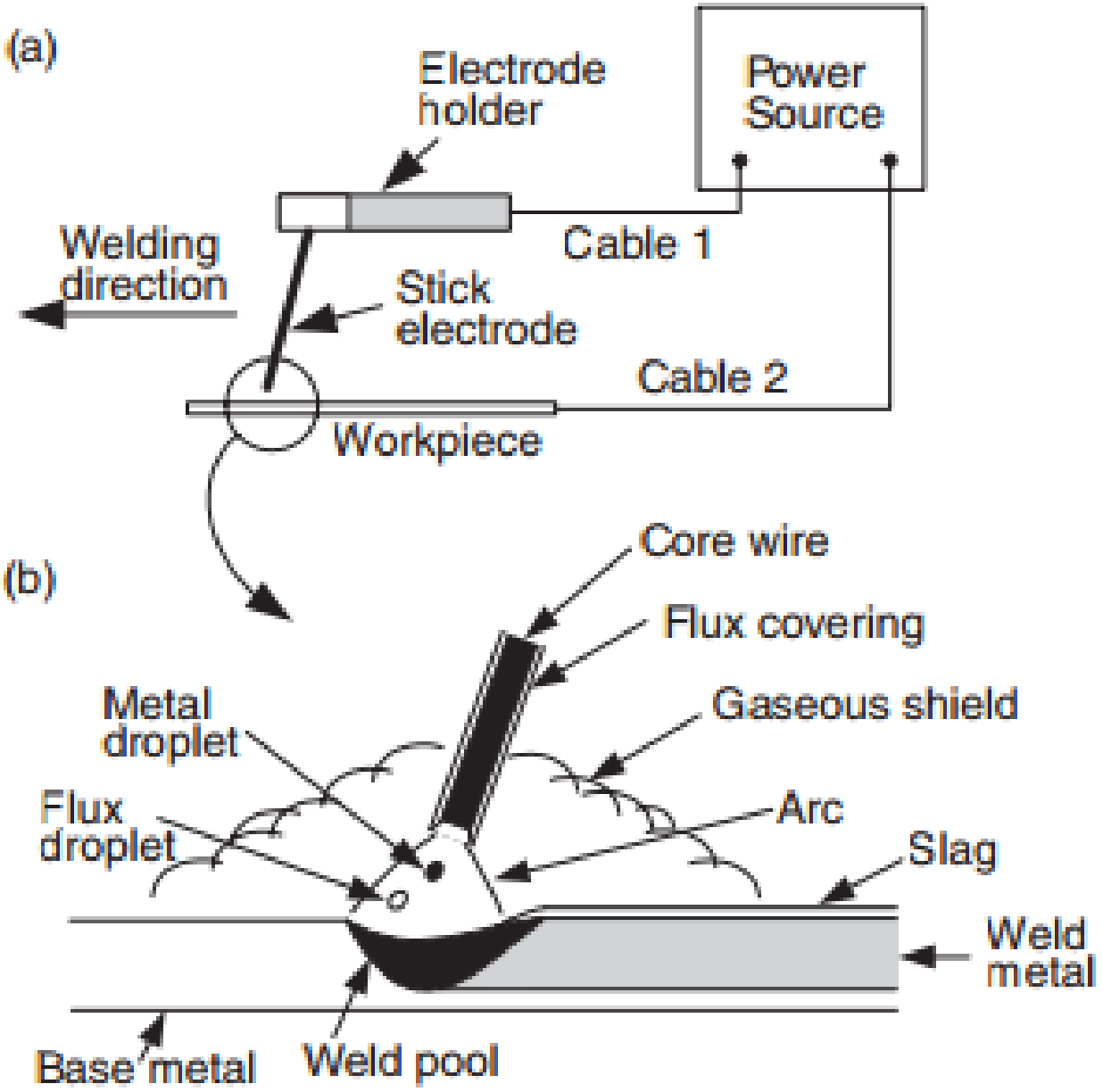
➢ Example of welding rod vs welding metal

Metal to be welded	*Composition of welding rod*
(a) Iron rich steels	(a) More 'C' Si, Mn less 'P' and 'S'
(b) Stainless steel	(b) Should have 'Cr' and 'V'.
(c) Copper	(c) Copper rods with phorphorus.
(d) Aluminium and its alloy	(d) Rods of same metal containing some silicon.

➡ Filler metal composition should be same as that of the material to be welded. Sometimes additional alloying elements are added to them to improve mechanical properties of weldment.

2. 3 FLUX

- Flux is a substance which is nearly inert at room temperature, but which becomes strongly reducing at elevated temperatures, preventing the formation of metal oxides.
- The role of flux is typically dual: dissolving of the oxides on the metal surface, which facilitates wetting by molten metal, and acting as an oxygen barrier by coating the hot surface, preventing its oxidation.
- Before performing any welding process, the base metal must be cleaned form impurities such as oxide because this will weaken the weldment. Flux is used to convert the oxides and nitrides to slag that can be removed from welding zone easily.
- Fluxes come in the form of a paste, powder, or liquid. Typical flux : SiO_2, TiO_2, FeO, MgO, Al_2O_3
- Flux can be supplied through coating of electrode or coating on filler metal or separately.
- Different fluxes are used for welding of different metals. For the welding of copper and its alloy sodium nitrate, sodium carbonates are used as flux. For welding of aluminum or its alloy chloride of sodium, potassium, lithium or barium are used.


(a)
Electrode holder
Power Source
Welding direction
Cable 1
Stick electrode
Cable 2
Workpiece
(b)
Core wire
Flux covering
Metal droplet
Gaseous shield
Flux droplet
Arc
Slag
Weld metal
Base metal
Weld pool

2. 4 ELECTRODE

WHAT? – Metal rod which conducts a current from electrode holder to the base metal. Used in electric arc welding.

TYPES? – a. Consumable b. Non-consumable

- **Non-consumable**

➡Only used as a conductor for the electrical current.
➡Electrode is made of tungsten which resist melting by the arc.
➡A nonconsumable electrode is gradually depleted during the welding process.
➡For arc welding processes that utilize nonconsumable electrodes, any filler metal used in the operation must be supplied by means of a separate wire that is fed into the weld pool.

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➢ Consumable

- Consumable electrodes not only used as a conductor for the electrical current, but it provides the source of the filler metal in arc welding.
- These electrodes are available in two principal forms of wire and rods (also called sticks).
- These electrodes are available in two principal forms: rods (also called sticks) and wire.
- Welding rods are typically 225 to 450 mm (9—18 in.) long and 9.5 mm (3/8 in.) or less in diameter.
- The problem with consumable welding rods, at least in production welding operations, is that they must be changed periodically, reducing arc time of the welder
- Consumable weld wire has the advantage that it can be continuously fed into the weld pool from spools containing long lengths of wire, thus avoiding the frequent interruptions that occur when using welding sticks.
- In both rod and wire forms, the electrode is consumed by the arc during the welding process and added to the weld joint as metal.

Figure 6.6 Various welding electrodes and electrode holder

Consumable electrodes can further be classified into two categories :

i) Coated electrode

- The most popular arc welding electrodes.
- No additional filler metal and flux are required with them.
- Purposes of electrode's coating : It forms a gas shield to prevent impurities in the atmosphere from getting into the weld and form separable slag from metal impurities.

ii) Bare electrode

- Rarely used (only in MIG)
- Simple rods made of filler metal with no coating over them.
- Flux is required additionally.

2. 4 WELDING OVERALL SAFETY GUIDE

1. Because of the heat sources, such as open flames, arcs, sparks, and hot metal used in welding and related operations, fire and explosion hazards are always present in the work area.
2. Welding processes should be carried out away from all combustible materials, including flammable fluids, vapors, gases, fuel, wood and textiles.
3. Protection of the operator's eyes, face, and body against sparks, spatter, and infrared and ultraviolet radiation is essential.
4. Several types of safety equipment and protective clothing are available and should be used.
5. Welding and related methods and machinery that use electricity as a source of energy also present hazards.
6. Proper installation and maintenance of equipment and training of personnel are essential.
7. Proper ventilation systems must be installed and maintained.
8. Never look at the arc with the naked eye.
9. Stand on dry footing when welding.
10. Keep area around welder clean.

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