Department of Education
SPTVE
Shielded Metal Arc Welding (SMAW) 9
Selecting Electrode
Quarter 2: Week 2 Module

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EXPECTATIONS

At the end of the module, you should be able to:

1. identify the factors of selecting electrode;
2. select appropriate electrode; and
3. determine the tensile strength, welding current, and welding position of an electrode.

PRE-TEST

A. Directions: Read the statement carefully and choose the letter of the correct answer. Write your answer using a separate sheet of paper.

1. What welding current is compatible with an electrode like E6013?
   A. AC C. AC and DC
   B. DC D. GTAW
2. The diameter of the electrode to be used in welding operation depends upon the _____.
   A. welding cureent C. type of base metal
   B. welding position D. thickness of the base metal
3. The symbol E-6013; 60 means
   A. flux coating C. welding current
   B. tensile strength D. welding position
4. The first step in choosing an electrode is look for _____.
   A. tensile strength C. welding position
   B. welding current D. base metal properties
5. The third digit in the symbol E-6013; 1 stands for
   A. flux coating C. welding current
   B. tensile strength D. welding position

B. Directions: Read the sentences carefully and write TRUE if the statement is correct and FALSE if the statement is wrong. Write your answer using separate sheet of paper.

1. An AC compatible electrode provides mild penetration and works well when bridging two joints or welding high speed, high current fillet welds in the horizontal position.
2. E6011 would work well with a steel of similar tensile strength.
3. DCEP compatible electrode has the ability to dig through rust, oil, paint and dirt.
4. To prevent cracking or other weld discontinuities, match the minimum tensile strength of the electrode to the tensile strength of the base metal.
5. All electrodes can be used both with AC or DC power sources.

LOOKING BACK

Directions: Read the sentences carefully and write TRUE if the statement is correct and FALSE if it is wrong. Write your answer using separate sheet of paper.

_____1. Tapping method is done by moving the electrode downward.

_____2. If electrode sticks to workpiece, use a quick twist to free it.

_____3. Tapping method is the simplest method for the beginner.

_____4. Scratching method is done by moving the electrode across the plate.

_____5. If arc goes out, electrode was lifted too low.

BRIEF INTRODUCTION

Electrodes are available in a wide range of types, each of which provides different mechanical properties and operates with a specific type of welding power source. There are several factors to consider in welding rod selection:

- Base metal properties
- Tensile strength
- Welding current
- Base metal thickness, shape and joint fit-up
- Welding position
- Specification and service conditions
- Environmental job conditions

Before you power up your machine and pick up your electrode holder, learn more about each of these factors.

1. Base Metal Properties

The first step in choosing an electrode is to determine your base metal composition. Your goal is to match (or closely match) the electrode composition to the base metal type, which will help ensure a strong weld. If you are in doubt about the composition of your base metal, ask yourself these questions:

- **What does the metal look like?** If you are working with a broken part or component, check for a coarse and grainy internal surface, which usually means the base material is a cast metal.
- **Is the metal magnetic?** If the base metal is magnetic, chances are good that the base metal is carbon steel or alloy steel. If the base metal is not magnetic,

the material could be manganese steel, 300 series austenitic stainless steel or a non-ferrous alloy such as aluminum, brass, copper, or titanium.

- **What kind of sparks does the metal give off when touched by a grinder?** As a rule of thumb, more flare in the sparks indicates a higher carbon content such as in A-36 grade steel.
- **Does a chisel "bite" into the base metal or bounce off?** A chisel will bite into a softer metal, such as mild steel or aluminum, and bounce off harder metals, such as high carbon steel, chrome-moly or cast iron.

2. Tensile Strength

To prevent cracking or other weld discontinuities, match the minimum tensile strength of the electrode to the tensile strength of the base metal. You can identify a stick electrode's tensile strength by referring to the first two digits of the AWS classification printed on the side of the electrode. For example, the number "60" on an E6011 electrode indicates that the filler metal produces a weld bead with a minimum tensile strength of 60,000 psi and, as a result, would work well with a steel of similar tensile strength.

3. Welding Current

Some electrodes can be used with only AC or DC power sources while other electrodes are compatible with both. To determine the correct current type for an electrode, refer to the fourth digit of the AWS classification, which represents the type of coating and type of compatible welding current (see Figure 1).

FIGURE 1

Fourth Digit	Type of Coating	Welding Current
0	Cellulose Sodium	DCEP
1	Cellulose Potassium	AC or DCEP
2	Titania Sodium	AC or DCEN
3	Titania Potassium	AC, DCEP or DCEN
4	Iron Powder Titania	AC, DCEP or DCEN
8	Iron Powder Low Hydrogen	AC or DCEP

DCEP – Direct Current Electrode Positive DCEN – Direct Current Electrode Negative

Refer to the fourth digit of the AWS classification to determine the compatible welding current.

The type of current you use also influences the penetration profile of the resulting weld. For example, a DCEP compatible electrode, such as an E6010, delivers deep penetration and produces an extremely tight arc. It also has the ability to "dig" through rust, oil, paint and dirt. A DCEN compatible electrode, such as an E6012, provides mild penetration and works well when bridging two joints or welding high speed, high current fillet welds in the horizontal position.

An AC compatible electrode, such as an E6013, produces a soft arc with medium penetration and should be used to weld clean, new sheet metal.

4. Base Metal Thickness, Shape and Joint Fit-Up

Thick materials require an electrode with maximum ductility and low hydrogen to prevent weld cracking. Electrodes with AWS classification numbers ending in 15, 16 or 18 provide excellent low–hydrogen properties and good toughness (high impact values) to accommodate for residual stress.

For thin materials, you will need an electrode that produces soft arcs, such as a 6013. Also, smaller diameter electrodes will provide shallow penetration to help prevent burn-through on thinner materials.

You will also want to assess the joint design and fit-up. If you are working on a joint with a tight fit-up or one that is not beveled, use an electrode that provides a digging arc to ensure sufficient penetration, such as an E6010 or E6011. For materials with wide root openings, select an electrode, such as an E6012, that creates a concave weld face suitable for bridging gaps and making groove welds.

5. Welding Position

To determine what position(s) the electrode is qualified for, refer to the third digit in AWS classification. Here is how you decipher the qualified electrode position:

1 = flat, horizontal, vertical, and overhead
2 = flat and horizontal only

For example, a 7018 electrode can be used in the flat, horizontal, vertical, and overhead positions.

6. Specification and Service Conditions

Make sure to assess the conditions that the welded part will encounter throughout its service. If it will be used in high heat or low temperature environments subjected to repetitive shock loading, a low hydrogen electrode with higher ductility will reduce the chance of weld cracking. Also, be certain to check for welding specifications if you are working on critical applications such as pressure vessel or boiler fabrication. In most cases, these welding specifications will require you to use specific types of electrodes.

7. Environmental Job Conditions

To achieve the best results, you should always remove excessive mill scale, rust, moisture, paint and grease. Clean base metals help prevent porosity and increase travel speeds. If cleaning your base metal is not possible, E6010 or E6011 electrodes deliver a deep penetrating arc that can cut through contaminants.

Example: Reading an electrode using E7018.

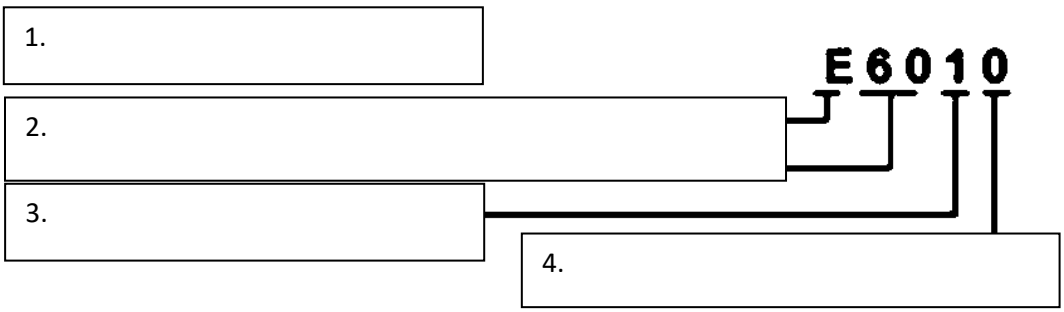
E – stands for Electrode
70 – stands for tensile strength [70,000 psi]
1 – stands for welding position [1 – all position]
8 – stands for the welding current to be used [AC or DCEP]

Psi – means pounds per square inch
AC – alternating current
DCEP – direct current electrode positive

ACTIVITIES

A. **Directions:** Label the parts of AWS classification and complete the table. Write your answer using a separate sheet of paper.

READING AN ELECTRODE



AWS Classification	Tensile Strength	Welding Position	Welding Current
E6010	(5)	(9)	(13)
E6011	(6)	(10)	(14)
E6012	(7)	(11)	(15)
E6013	(8)	(12)	(16)

B. **Directions:** Match column A with column B and choose the letter of the correct answer. Write your answer using a separate sheet of paper.

COLUMN A	COLUMN B
1. Your goal is to match the electrode composition to the base metal type, which will help ensure a strong weld.	A. E6010

2. The first two digits of the AWS classification printed on the side of the electrode.	B. welding position
3. The fourth digit of the AWS classification.	C. base metal properties
4. This kind of electrode delivers deep penetration and produces an extremely tight arc.	D. welding current
5. The third digit in AWS classification.	E. E6013
6. This kind of electrode produces soft arc with medium penetration and should be used to weld clean, new sheet metal.	F. tensile strength
7. This kind of electrode creates a concave weld face suitable for bridging gaps and making groove welds.	G. carbon steel or alloy steel
8. Base metal is magnetic.	H. environmental job conditions
9. Base metal is not magnetic.	I. E6012
10. Clean base metals help prevent porosity and increase travel speeds.	J. manganese steel

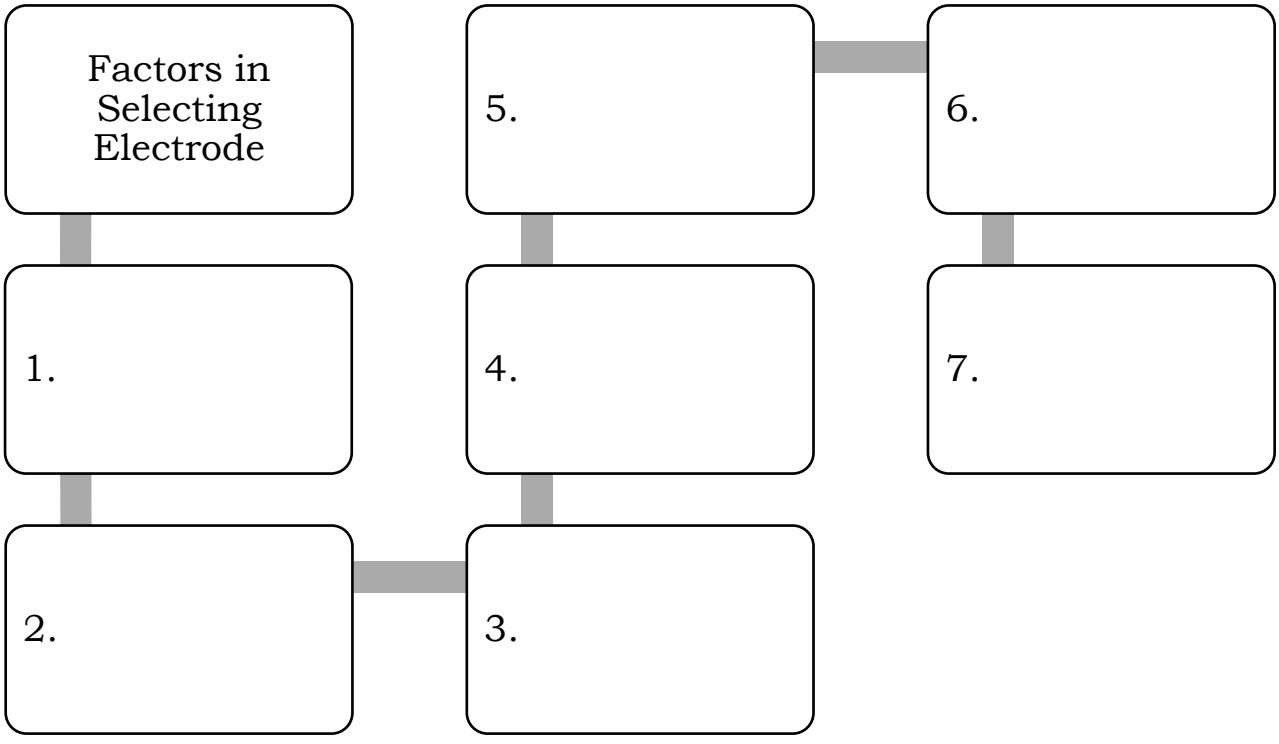
REMEMBER

- In selecting electrode, consider the following factors:
  -base metal properties
  -tensile strength
  -welding current
  - base metal thickness, shape and joint fit-up
  -welding position
  - specification and service conditions
  -environmental job conditions
- Consideration of the above factors will help you overcome the challenges of selecting the correct stick electrode for your particular application. However, given the wide range of available electrodes, several solutions may

exist for one application. If you need additional assistance with electrode selection, your local welding supply distributor or a company representative of a reputable filler metal manufacturer can serve as an excellent resource.

CHECK YOUR UNDERSTANDING

Directions: Complete the graphic organizer. Identify the factors in selecting electrode. Use separate sheet of paper for your answer.



POST TEST

A. Directions: Read the statement carefully and choose the letter of the correct answer. Write your answer using a separate sheet of paper.

1. The symbol E-6013; 60 means
   A. flux coating C. welding current
   B. tensile strength D. welding position
2. The third digit in the symbol E-6013; 1 stands for
   A. flux coating C. welding current
   B. tensile strength D. welding position
3. The diameter of the electrode to be used in welding operation depends upon the _____.
   a. welding cureent C. type of base metal
   b. welding position D. thickness of the base metal
4. The first step in choosing an electrode is look for _____.
   A. tensile strength C. welding position
   B. welding current D. base metal properties
5. What welding current is compatible with an electrode like E6013?
   A. AC C. AC and DC
   B. DC D. GTAW

B. Directions: Read the sentences carefully and write TRUE if the statement is correct or FALSE if is wrong. Write your answer using separate sheet of paper.

1. To prevent cracking or other weld discontinuities, match the minimum tensile strength of the electrode to the tensile strength of the base metal.
2. E6011 would work well with a steel of similar tensile strength.
3. All electrodes can be used both with AC or DC power sources.
4. DCEP compatible electrode has the ability to dig through rust, oil, paint and dirt.
5. An AC compatible electrode provides mild penetration and works well when bridging two joints or welding high speed, high current fillet welds in the horizontal position.

C. Directions: Read the following situations. Fill in the blanks with the correct answer. Use separate paper for your answer.

1. James is working with a broken part or component. He checked the coarse and grainy internal surface, which usually means that the base metal is _____.
2. Chloe used thick materials and an electrode with maximum ductility and low hydrogen to prevent _____.
3. Ben used thin materials for his work. The electrode he can used for a thin material is _____.
4. Samuel and John are working on a joint with a tight fit-up or one that is not beveled. They used an electrode that provides a digging arc to ensure sufficient penetration like _____.

5. Elijah is looking for an electrode that he can used for the materials with wide root openings.

REFERENCES:

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Welding Technology, 2nd Edition, Gower A. Kennedy

Welding Guide Fabrication Shop, Ismael V. Palabrica

Metal Works 1, SEDP Series, Industrial Technology

Basic Manual Metal Arc Welding, National Training Center for Technical Education and Staff Development

Welding Principles and Applications, Larry Jeffus and Harold V. Johnson

Key to Correction

Pretest

1. A
2. D
3. B
4. D
5. D
6. FALSE
7. TRUE
8. TRUE
9. TRUE
10. FALSE

Posttest

A.
1. B
2. D
3. D
4. D
5. A

B.
1. TRUE
2. TRUE
3. FALSE
4. TRUE
5. FALSE

C.
1. CAST METAL
2. WELD CRACKING
3. E6013
4. E6010/E6011
5. E6012