Stick Welding Electrodes

If you're new to welding, you might be a little confused about the difference between an electrode and a filler rod. In stick welding, the filler rod and the electrode are one and the same. Electricity supplied by a welding machine energizes the rod, which is attached to a metal clamp. An electric arc is produced, generating intense heat. This melts the tip of the rod into the molten pool within the joint on the base metal.

Stick Electrode Classification

Stick electrodes are sold for the following metals:

- **• mild steel**
- **• stainless steel**
- **• low-alloy steel**
- **• cast iron**
- **• aluminum**

AWS classifies stick electrodes according to several codes, depending on the metal type. One of the most common is AWS A5.1/A5.1M: Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding. E-7018 and E-6010 are examples of rods used by welders. Here's what the numbers indicate:

E - Electrode

70 - Tensile strength of the weld metal, measured in Pounds per Square Inch (PSI). ***Note: some countries substitute a metric unit for PSI.***

1 - This single digit number tells you the most difficult welding position you can use the electrode in. (1 = any position 2 = horizontal and flat; 3 = flat only; 4 = overhead, horizontal, vertical down and flat)

8 - Since this last digit is sometimes combined with the third number to derive information about an electrode, it can cause some confusion. The goal here is to communicate the flux/deoxiders and other ingredients used in the electrode coating. Coatings are designed for both the polarity of the power source and the welding position. Thus, you have to read the two digits together to know what's in the coating. The following chart gives you the recipe for all- position (1) and horizontal/flat (2) welding, along with the current types/polarities available for each rod designation.

Last 2 Digits in Stick Electrode Classification

Digit	Type of Coating	Welding Current
10	High cellulose sodium	DC+
11	High cellulose potassium	AC or DC+ or DC-
12	High titania sodium	AC or DC-
13	High titania potassium	AC or DC+
14	iron powder titania	AC or DC- or DC+
15	low hydrogen sodium	DC+
16	low hydrogen potassium	AC or DC+
27	iron powder iron oxide	AC or DC+ or DC-
18	iron powder low hydrogen	AC or DC+
20	High iron oxide	AC or DC+ or DC-
22	High iron oxide	AC or DC-
24	iron powder titania	AC or DC- or DC+
28	Low hydrogen potassium iron powder	AC or DC+

Here's a chart that describes six standard electrodes used for welding mild steel:

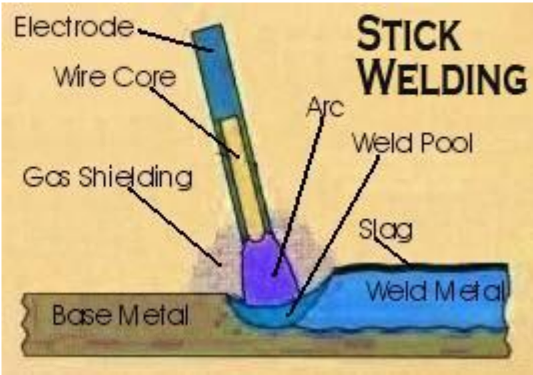
Electrode	Coating	Position	Current	Penetration	Tensile Strength
E-6010	High Cellulose Sodium	All Positions	DCEP	Deep	60,000 PSI
E-6011	High Cellulose Potassium	All Positions	DCEP AC	Deep	60,000 PSI
E-6012	High Titania Sodium	All Positions	DCEN AC	Medium	60,000 PSI
E-6013	High Titania Potassium	All Positions	DCEP DCEN AC	Shallow	60,000 PSI
E-7018	Iron Powder Low hydrogen	All Positions	DCEP AC	Shallow to Medium	70,000 PSI
E-7028	Iron Powder Low hydrogen	Flat Horizontal Fillets	DCEP AC	Shallow to Medium	70,000 PSI

Notice how the ingredients in the coating of the rod affect how the filler metal gets deposited in the weld, as well as the polarity required from the power source.

The welding trade also divides stick electrodes into four general groups. These groups are based on chemical additives in the flux coating which is designed to shield the weld pool. Not only to prevent oxidation, and porosity, but also to meet the needs of the welder's position:

1. **Fast Freeze (0,1) - Used for overhead welding**
2. **Fill Freeze (2,3,4)**
3. **Fast Fill (21-27) - Limited to flat and horizontal position**
4. **Low Hydrogen (18, 28) - Limits porosity**

These four categories are not easy for welding students to grasp at first, due perhaps to the lack of creativity in the naming conventions. Yet it helps to become familiar with the terminology, and to remember that not all stick rods work for every situation.



Another confusing concept concerns polarity in welding. Notice in the two charts shown earlier that there are three choices available under "Current". AC represents the familiar alternating current, which is an acceptable option for all the electrodes listed there, except E-6010. The other two options, which pertain to DC (direct current), require a little explanation.

DCEP or DC+ "Electrode Positive" - This is also known as "reverse polarity" and is the choice for most stick welding. Although electrons inevitably flow through a circuit from its negative to positive sides, you can effectively reverse the current by switching the connections of your electrode holder and the work clamp. (On most industrial sticking welding machines nowadays, DCEP is either the default setting or accomplished by manipulating the controls to choose AC, DCEP or DCEN.

The objective for using DCEP is to put 70% of the heat (that's generated by the electric arc) at the tip of the electrode, which can melt it with a vengeance into the joint. The other 30% ends up dispersed around the work piece.

DCEN or DC- "Electrode Negative" - This is "straight polarity". Now 70% of the heat gets focused on the work plates, and only 30% reaches the tip of the electrode. This situation is desirable when working with thin metal stock or a joint that doesn't require deep penetration.

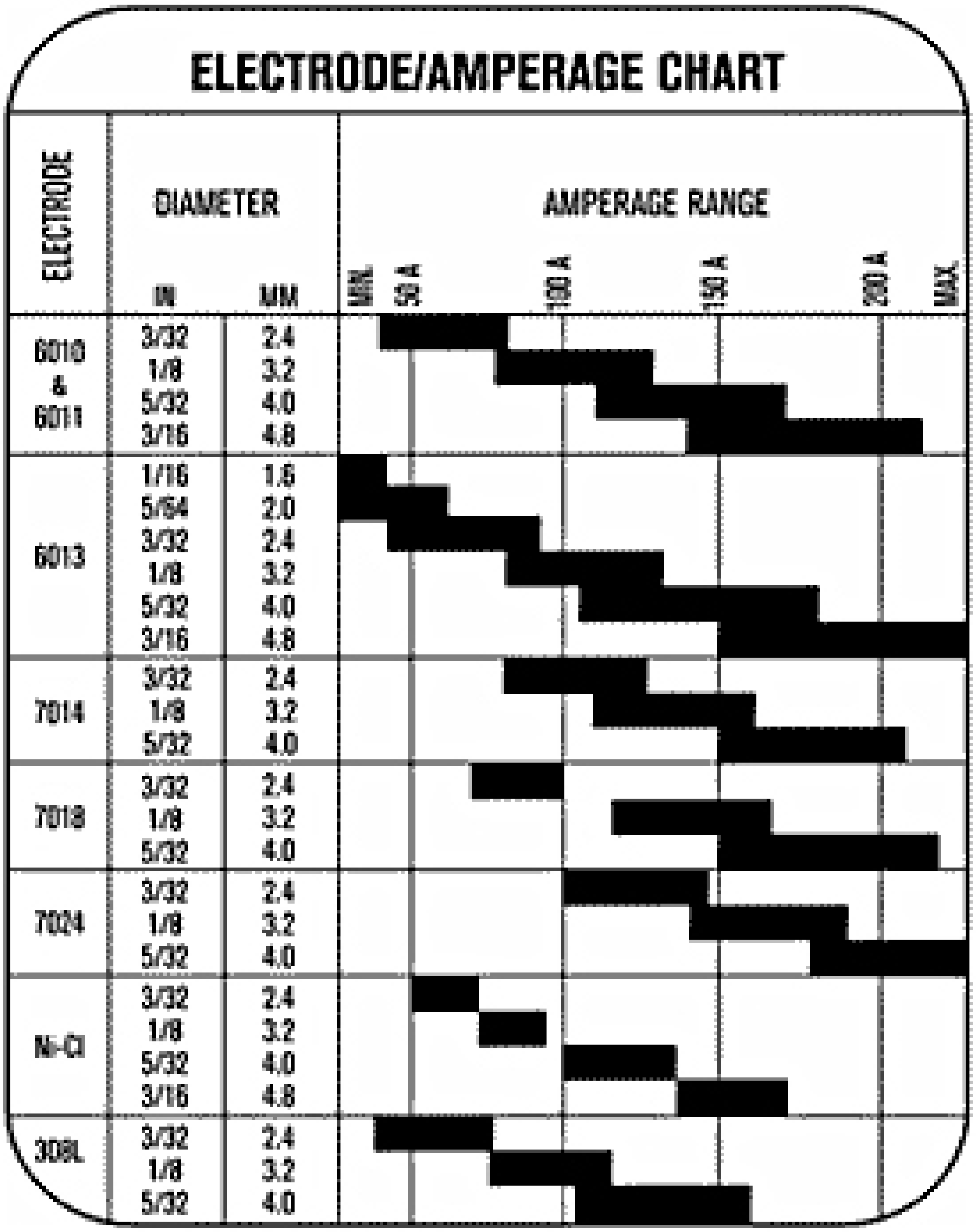
DCEN is also the choice of polarity for most TIG machines when welding on metals other than aluminum; TIG welding aluminum prefers AC as its current polarity.

There's a lot of confusion about DCEN and DCEP. As a general rule of thumb, TIG likes DCEN, while Stick Welding likes DCEP.

Although stick welding is primarily used on carbon steel, you can purchase rods to weld some stainless steels and aluminum. The most common rod for stainless steel is 308, which works for base metals that are classified as either 304 or 308 using the AISI standard. Stainless steels, incidentally, are classified using three-digit numbers, falling mostly in the 200, 300 and 400 range. A common aluminum stick rod is 4043. Aluminum classifications are identified by AISI 4000, 5000 and 6000 series numbers.

Once a welder has decided on an acceptable electrode, there are two more decisions to make. What diameter of electrode should be used, and what current range is right for this diameter?

Consumable sellers usually provide a chart that lists allowable amperage, based on rod diameter. Here's an example:



Here's a more general range of current settings for a variety of stick welding rods. Notice that the table recommends less current when welding in the vertical or overhead position.

Typical Welding Parameters of Mild Steel & Low Alloy SMAW (Electrodes)				
Diameter of Rod		Voltage (V)	Amperage (A)	
Inches	Millimeters		Flat	Vertical & Overhead
3/32	2.4	21 – 25	65 – 80	65 – 75
1/8	3.2	21 – 25	90 – 110	80 – 95
5/32	4.0	21 – 26	135 – 160	120 – 140
3/16	4.8	22 – 26	160 – 210	140 – 160

Choosing the right diameter of the rod depends on the type of joint you're creating and the thickness of the base metal. (The coating around the electrode doesn't count as part of its diameter, just the weld metal inside.) Since larger-diameter electrodes produce larger-sized welds, you wouldn't want to use a 3/16" rod on metal that's 1/8" thick, and lap joints require a lot less penetration and weld buildup than a beveled groove joint.

Finally, heat is a major concern when welding metals other than carbon steel, so the allowable current range factors heavily into choosing the right rod for stainless steel, other alloyed metals and aluminum.

Care and Storage of Electrodes

Low-hydrogen stick electrodes (e.g. E-7018) require a special storage environment because of their coatings (flux). Welders have to keep these rods dry, since moisture in the air (humidity, H_2O) contains hydrogen.

So long as the welding rods remain sealed inside the box where they were originally packaged in, no special handling is required. Once the seal is broken, extra care must be taken. In the field, it's common practice to warm batches of rod in an oven at 250 degrees for about 30 minutes to an hour before use. A welder fetches a handful of warm rods at a time, places them in an electrode pouch, and then goes off to his/her work location. Rods shouldn't be heated more than three times in an oven, so it's a good practice to estimate your needs wisely on a daily basis.