How to Check the Quality of SMAW Electrodes Before Fabrication

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Shield metal arc welding (SMAW) electrodes are the most popular filler metals in the world, offering the widest range of alloy types and brands available in the global market. Each country has its own SMAW electrode specifications; however, American Welding Society (AWS) specifications are widely accepted. Carbon steel SMAW electrodes, for example, have two major AWS specifications, AWS A5.1, for mild carbon steel electrodes, and AWS A5.5 for low-alloy steel electrodes. These specifications classify electrodes per the following:

- Tensile strength grade of a deposit metal
- Micro-alloying elements concentrations of a deposit metal
- Diffusible hydrogen content of a deposit metal
- Welding electrical characteristics, i.e. AC/DC
- Flux coating type
- Positional welding capability

The classification format and designators are detailed in every AWS A5 specification. Figure 1 illustrates the classification of a 70ksi mild carbon steel electrode.

While SMAW electrodes manufacturing specifications are specifically designed by filler metal companies to reliably produce quality electrodes that satisfy the requirements of AWS A5 specifications, it is always important to confirm electrode quality in the field to ensure stream-lined fabrication. The required steps are as follows:

1. Packaging Examination

SMAW electrodes are usually packaged in cans or tubes, and some critical types of electrodes are also vacuum-sealed in a hermetic foil. After a batch of SMAW electrodes is received, a sample pack should be randomly picked from the shipment. The packaging integrity should first be examined to identify any damage, as a broken package could result in moisture absorption by the electrodes. For example, the flux coating of a "H4R"-designated electrode can absorb moisture from the environment, causing the moisture content to exceed the specified 0.3% maximum upper limit. Consequently, this package may not be able to satisfy the H4 requirement of low-hydrogen electrodes. This excessive moisture pick-up may also generate a large amount of spatter,

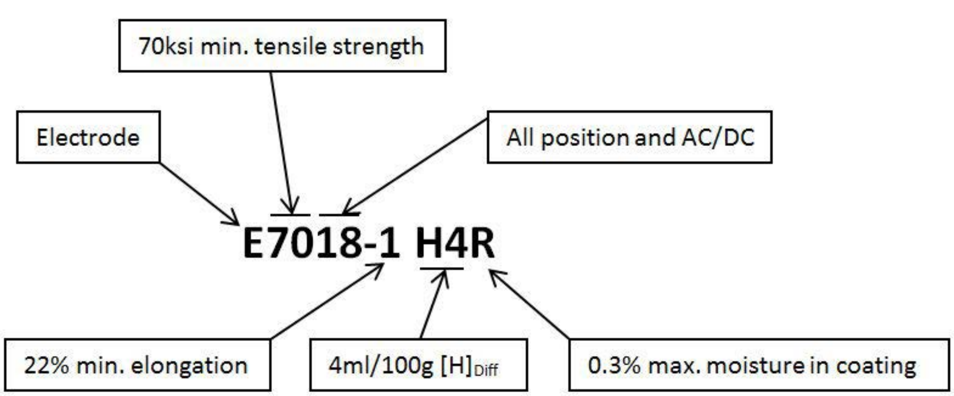

Figure 1: AWS classification of a 70ksi mild carbon steel electrode

and the resulting spatter clean-up will add time and cost to the fabrication operation. Moisture pick-up may also negatively affect arc stability, and may result in porosity. In extreme cases, rusty stubs of electrodes may be found, which should prohibit the use of the entire batch.

2. Surface Quality Examination

Most SMAW electrodes are manufactured by an extrusion process. While it is rare to manufacture electrodes using the classic dipping process, this method is still used by a few manufacturers to produce special electrodes. The extrusion production consists of five major steps:

- Dry flux mixing
- Wet mix blending
- Cylindrical dough pressing
- Electrode extrusion
- Electrodes drying and baking

Usually, potassium and/or sodium silicate liquid(s) are blended with a dry flux mix. It is critical to use a right amount of silicate liquid(s) with a controlled viscosity to achieve uniform wet mix blending. The wet mix is then pressed to generate cylindrical dough to be loaded in an extruding chamber. The extrudability of the dough is critical, and is directly determined by the wet mix blending process. The flux coating is then extruded onto the core wire under a pressure between 3000-5000 psi.

The quality of an extrusion process is evident on the surface of the electrode flux coating. A twisted flux coating is an indication that the electrode may have been too wet. This may be caused by an excessive amount of silicate liquid(s) blended in the wet mix. This twist may result in eccentricity between the core wire and the flux coating, which may then negatively affect the stability of the welding arc. As such, a handful of electrodes must always be visually examined to check for this issue.

When checking for eccentricity at the tip of an electrode, attention should also be paid to the integrity of the flux coating. If the flux coating is broken at the tip, it may indicate that the flux coating or the bonding between the core wire and coating is not strong enough. The strength of the coating is directly related to the flux formulation and the binder(s) used to make the wet mix. Some filler metal manufacturers have proprietary coating strength testers for QA control. If cracks are found on an electrode coating, it indicates a poor electrode baking process. Generally speaking, flux coating defects are indicative of quality issues.

Flux formulas are often adjusted to reduce cost. A change in the coating color may result, indicating an alteration or re-formulation of the raw materials used. If abnormal welding behavior is observed when using a color-changed electrodes, it should be reported without delay.

3. Labels

Usually, the AWS classification of an electrode is imprinted on the coating near the electrode stub. It is important to check the imprinted label on the electrode and the product label shown on package with respect to the purchase order to prevent the wrong electrode from being used..

It is a typical practice to use H4 low hydrogen electrodes to make critical seam-welds. Therefore, it is important to check the diffusible hydrogen designator imprinted on an electrode coating and a product label to prevent welding with an electrode with the wrong diffusible hydrogen designation.

Similarly, it is a good practice to check the labels to distinguish a low-carbon graded stainless-steel electrode (with a “L” designator behind the composition designators) from a regular-carbon graded stainless-steel electrode.

4. Straightness of the electrode

Before electrode extrusion, the core wires are sized down by a die train from a large-diameter bare-wire coil. They are then cut in length after a wire straightening operation. Occasionally, some core wires are not straightened well and may be slightly bent. When those bent wires pass through an extrusion die, eccentricity may result. The electrode could also be bent by a non-uniform pressure distribution on the dough in the extrusion chamber. This is more prevalent in extruders which use vertical pressing. Electrodes can be effectively examined by rolling them on a table top, as excessive wobbling indicates a lack of straightness. The eccentricity which results from bent electrodes may negatively affect the welding performance.

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