What is Submerged Arc Flux?

Granular flux used in welding is a type of granular insulative materiall that is made up of numerous small particles. In Submerged Arc Welding (SAW), the granular flux provides a blanket over the weld, which protects against sparks and spatter. In SAW, the granular flux is frequently the means for achieving high deposition rates. The flux is also instrumental in producing the type of quality weld that is common in this particular welding process.

Functions of Flux in Sub Arc Welding

The effect of gravity on the flux feeding into the weld area and the molten weld pool limits the versatility of Submerged Arc Welding. This process must be performed in the flat and horizontal fillet positions only, except in special cases. These special cases include vertical and horizontal welds using special equipment, such as belts or shoes, to hold the flux in position.

The granular flux used in SAW serves several functions. In addition to providing a protective cover over the weld, the flux shields and cleans the molten puddle. The flux also affects the chemical composition of the weld metal, the weld bead shape, and the mechanical properties of the weld.

Another function of granular flux is to act as a barrier that holds the heat in and concentrates the heat into the weld area to promote deep penetration.

Types of Granular Fluxes

The methods used to manufacture fluxes determine the flux types. There are fused fluxes, bonded fluxes, agglomerated fluxes, and mechanically mixed fluxes.

When manufacturing *fused fluxes,* raw materials are melted into a liquid state with a high temperature electric furnace. The material is then cooled and crushed or ground into the desired particle size.

When making *bonded fluxes,* the ingredients are dry mixed, then glued together with a liquid binder. This binder may be a liquid such as sodium silicate. After the particles are bonded, they are baked and then sifted through a sieve to attain flux particles of the desired size.

Agglomerated fluxes are manufactured much the same way that bonded fluxes are made. However, instead of a liquid binder, a ceramic binder is used. A higher drying temperature is used, too. (The higher drying temperature limits the use of deoxidizers and alloy elements.)

Fluxes that are *mechanically mixed* are combinations of two or more bonded or agglomerated fluxes. Although mechanically mixed fluxes make it possible to create special mixtures for more sensitive welds, these fluxes may separate during storage, use, and recovery of flux.

Fused Fluxes versus Bonded Fluxes

Among the various types of fluxes use in Submerged Arc Welding are the fused flux and the bonded flux. Each of these fluxes offers some advantages and some disadvantages.

Fused Fluxes

When making fused fluxes, the raw materials are dry mixed together, and then they are fused or melted into a liquid state by using a high temperature furnace. After fusion is complete, the fluxes are cooled. This may be accomplished by using a stream of water or with big chill blocks.

Once the fluxes are cooled, they are crushed or ground into particles. A variety of particle sizes are made to ensure optimal performance for different applications.

Advantages of fused fluxes include:

The non-hygroscopic flux particles do not absorb moisture and, therefore, any surface moisture can be eliminated merely by drying the particles at a low temperature oven setting of 300 degrees F.

Low temperature drying of condensation on the fused flux particles provides better protection against hydrogen cracking.

Flux particles create welds that are chemically consistent.

Recycling of fused flux particles through the flux recovery systems can be achieved without losing sizing or composition.

A disadvantage of fused fluxes is that the high temperature used during the manufacture process makes it difficult to add alloys and deoxidizers.

Bonded Fluxes

The manufacture of bonded fluxes involves combining the dry ingredients, then using a liquid binder such as sodium silicate or potassium silicate to glue the ingredients together. After the bonded mix is made into pellets, the pellets are baked at a low oven temperature. Once the drying of the pellets is complete, the pellets are broken up by using a sieve to attain the desired particle size. The particles are then packaged for shipping.

Advantages of bonded fluxes include:

Deoxidizers are present in bonded fluxes, protecting against rust and mill scale. These deoxidizers also help to prevent welds from becoming porous.

Alloys can be added to bonded fluxes. Alloy elements may improve chemical and mechanical properties of the flux.

Bonded fluxes allow for a thicker flux layer when welding.

Bonded fluxes can be identified by color.

Bonded fluxes typically provide better peeling properties than fused fluxes.

There are at least two disadvantages of using bonded fluxes. These are:

They absorb moisture.

They can change in composition due to segregation or loss of fine particle size.

About the Submerged Arc Welding (SAW) Process

Submerged Arc Welding (SAW) is a common welding process that is commonly used in the structural and vessel construction industries. Originally developed by the Linde - Union Carbide Company, it is commonly used in beam, boom, tractor, and multi-head type rigs. Also known as Sub Arc or SAW, this process uses a blanket of granular fusible flux beneath which both the weld and the arc zone are protected or "submerged." This flux blanket offers the following advantages:

1. Guards against atmospheric contamination
2. Stabilizes the arc during welding
3. Prevents splatter and sparks from flying about
4. Suppresses radiation and fumes that are typical of the shielded metal arc welding process (SMAW)

How it works

Sub Arc welding requires a continuously-fed tubular or consumable solid electrode and may be fully automatic or semi-automatic. The arc is flat and is maintained between the end of a bare wire electrode and the weld. The electrode is constantly fed into the arc and as it is melted, a layer of granular flux provides a protective cover beneath which the welding occurs. The blanket is created as some of the flux becomes molten. This fusible flux may consist of lime, silica, manganese oxide, calcium fluoride, and other compounds. In a molten or melted state, the flux becomes conductive. This allows it to supply a constant current between the electrode and the welding work. The remainder of the flux is recovered and reused, unless it has become contaminated.

In the automatic version of SAW, the process is performed with a set of rollers driven by a controlled motor to ensure that the wire is fed into the arc at a speed rate that is equivalent to the rate at which the electrode is melted. The arc length remains constant as a result. The SAW process is usually automated; however, there are semi-automated systems available, too.

Properly performed Sub Arc welding should consistently result in mechanical properties that are at least equal to that of the base metal. Ductility and impact resistance should be good, and bead appearance should be uniform.

Variables of the SAW Process

There are some key variables of the submerged arc welding process. These variables include:

The arc voltage
The wire feed speed
Travel speed
Contact tip to work (CTTW) or electrode stick-out (ESO)
Polarity and current type (may be either AC or DC), as well as variable balance AC current

Equipment

In automatic submerged arc welding, there are three types of guns that are generally used. These include the side flux delivery gun, the deep groove gun, and the concentrated flux delivery gun.

The concentrated flux delivery gun deposits the flux around the wire. With both the side flux delivery gun and the deep groove gun, the flux is fed from an overhead gravity hopper to the gun's flux shut-off assembly.

The type of gun chosen for a certain job may be dependent upon the joint design and/or the welding operator's preference.

Material applications

SAW material applications include carbon steels, low alloy steels, stainless steels, nickel-based alloys, and surfacing applications (wear-facing, buildup, and corrosion-resistant overlay of steels). SAW is frequently used in heavy structural construction. It is also used in the pressure vessel industry, chemical plants, and shipbuilding.

Properly performed Sub-Arc welding should consistently result in mechanical properties that are at least equal to that of the base metal. Ductility and impact resistance should be good, and bead appearance should be uniform.

Variations of the Submerged Arc Welding Process

The submerged arc welding process may be varied in a number of ways to give it more capabilities. These include, but are not limited to, varying the number of wires and power sources, adding iron powder to the flux, and using a strip electrode for surfacing.

Multi-wire systems offer advantages, because the use of more electrodes can improve deposition rates and travel speeds. The utilization of more than one electrode in submerged arc welding may be accomplished with either a single power source or separate power sources for each wire.

The use of **multiple power sources** with two or more electrodes allows for the utilization of different polarities on the electrodes. Also, with separate power sources for two electrodes, alternating current may be used on one, while direct current is used on the other electrode. Typically, when three wires are used in the tandem position (one electrode is placed in front of the other), alternating current is used. The electrodes are connected to three-phase power systems, which are used for making high-speed longitudinal seams on large pipes and fabricated beams.

Adding iron powder to the flux increases deposition rates of submerged arc welding, but it does not decrease the properties of the weld metal.

The utilization of a strip electrode for surfacing may be done to save money. This particular welding system uses the strip electrode and flux to make a corrosion-resistant overlay on a less expensive base material such as stainless steel. During this procedure, a wide, uniform bead is produced that has minimum penetration. The uniform bead is necessary to provide a smooth overall surface. The strip welding system is often used for overlaying the inside of vessels. The flux that is used in strip surfacing is made specifically for that purpose.

Advantages of Submerged Arc Welding

Some of the advantages of submerged arc welding include:

Strong, sound welds are readily made
Minimal welding fume is emitted
Minimal arc light is emitted
SAW is suitable for both indoor and outdoor works
Less distortion
Deep weld penetration
Minimal edge preparation
High deposition rates are possible
Thick materials may be welded
At least half or more of the flux is recoverable

Disadvantages of Submerged Arc Welding

There are a few limitations with submerged arc welding. One issue is that welding can normally be performed only in the flat position. The use of a granular flux and the fluidity of the molten weld pool mean that welding is limited to positions 1F, 1G, and 2F.

What is subarc flux and what is submerged arc welding (SAW)?

Submerged arc welding (SAW) is a common welding process that is frequently used in the structural and vessel construction industries. The process requires a tubular or consumable solid electrode that is continuously fed into the work area using fully-automatic or semi-automatic methods. As the electrode is fed into the arc and melted, a layer of granular material provides a protective cover beneath which the welding occurs. Called flux, this fusible material consists of lime, silica, manganese oxide, calcium fluoride, and other compounds. The flux forms a hardened layer after it is heated and becomes molten. In this melted state the flux becomes conductive, thus enabling it to supply a constant current between the electrode and the welding work. The remainder of the flux is recovered and reused, unless it has become contaminated.

The granular flux used in SAW serves several functions. In addition to providing a protective cover over the weld, the flux shields and cleans the molten puddle. The flux also affects the chemical composition of the weld metal, the weld bead shape, and the mechanical properties of the weld. Another function of granular flux is to act as a barrier that contains and concentrates the heat into the weld area thus enabling deeper weld penetration.

Why do I need to store subarc flux in a heated oven?

In order to answer this question, it is pertinent to describe the four types of welding fluxes that are commonly available: fused, bonded, agglomerated and pre-mixed fluxes.

Fused — this type of flux is non-hygroscopic (does not absorb moisture from the air). Any surface moisture on the particles can be removed at a low temperature oven setting of 300°F.

Bonded — this type of flux is hygroscopic (absorbs moisture from the air) and is comprised of a combination of dry ingredients that are glued together with a liquid binder, then baked at a low oven temperature.

Agglomerated — this type of flux is hygroscopic and is manufactured the same way as bonded fluxes only a ceramic binder is used instead of a liquid binder.

Pre-Mixed — this type of flux is hygroscopic and is simply a combination of two or more bonded or agglomerated fluxes.

Just as stick welding electrodes readily pick up moisture from the surrounding atmosphere, the same applies to bonded welding fluxes that are comprised mostly of dry, powdered ingredients. As described above, the purpose of flux is to clean and shield the weld area from impurities. If moisture has contaminated the flux, hydrogen is released into the metal when heat is applied. When the weld cools, it can become brittle, crack and/or develop pinholes. Moisture-contaminated flux can also accelerate corrosion to certain metals like aluminum and must be kept dry throughout the welding process.

Welding flux holding ovens and rebake ovens are an indispensable addition to any subarc welding operation to help ensure quality welds. Our flux holding ovens and rebake ovens are suitable for almost any flux heating application that is required for today’s professionals.

What are the proper storage and rebaking guidelines for subarc flux?

For specific storage and rebake temperature guidelines, we recommend contacting the welding consumable manufacturer directly. It is also important to check with local welding codes and/or ask a welding inspector to provide some information. Welding standards change frequently, and each manufacturer often provides a different recommendation regarding welding consumable storage. Check the packaging and also manufacturer websites for information. Keen offers a wide range of products to handle almost any welding consumable storage requirement.

What is the difference between subarc flux holding/storage and subarc flux rebaking/reconditioning?

Generally, there are two involved with the proper maintenance of subarc welding flux: holding (also called storing) and rebaking (also called reconditioning).

The holding process refers to the long-term* heated storage of welding flux to maintain factory-fresh dryness. Storing the flux at elevated temperatures prevents atmospheric moisture contamination of the hygroscopic granules. There are various temperature requirements according to the type of flux and also that are also set forth by welding codes. **For specific holding temperature guidelines, please contact the manufacturer of your welding consumable.**

The rebaking process refers to the short-term*, high temperature heating of subarc flux that has been contaminated by atmospheric moisture. The rebaking process "reconditions" the welding flux, meaning it bakes out the moisture that has been absorbed thus restoring the flux so it is suitable for reuse. **For specific rebake temperature guidelines, please contact the manufacturer of your consumable.**

* - In relation to our products, we consider long-term to mean 24 hours/day 7 days/week.

What are the key differences between welding flux holding ovens and welding flux rebake ovens?

Keen ovens are specifically designed according to the temperature range of the process, and the amount of subarc flux to be stored. The standard holding ovens are designed to accommodate a maximum temperature of 550F and the rebake ovens are designed to reach 999F. The higher temperature ovens have larger wall thicknesses to accommodate more insulation and digital programmable temperature controllers.