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RECLAMATION OF MOISTURIZED FLUX IN SUBMERGED ARC WELDING

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Abstract— **Large joint areas with fewer passes and minimal preparation with high deposition rates is possible in submerged arc welding. Deposition rates approaching 45 kg/h have been reported this compares to 5 kg/h (max) for shielded metal arc welding. In general, one kg of flux is consumed for every kg of weld metal deposited in submerged arc welding.**

There are two important parameters in submerged arc welding, the flux and the wire, that may be supplied separately. The arc, end of electrode and molten pool remain completely hidden are invisible being submerged under a blanket of flux.

A general problem that may occur is the absorption of moisture by the fluxes during storage. The amount of moisture absorbed being dependent upon the atmospheric conditions and time of exposure. Sometimes moisturized flux generated during submerged arc welding is thrown away as a waste.

The study revealed to recycle the moisturized flux. Moisturized flux has been processed in such a manner that allows it to be used as a flux. Additionally it is always important and useful to reduce waste and to move towards "ZERO WASTE CONCEPT".

Keywords— **Submerged arc welding, flux, agglomerated flux, fused flux, recycling, redrying**

I. Introduction

The future is bright for SAW. As entire cultures industrialize throughout the world, the applications that lend themselves to the process will grow as well. While the current technology is already poised to handle new demands with speed and precision, manufacturers will continue to look at what else can be done to help make SAW users efficient and competitive.

In the same way the industry has improved the power and application systems, so too have the consumable materials been updated to meet current requirements.

Flux manufacture and delivery also have stepped up to match the production demands of SAW. Tubular-cored flux can be application-specific and provide additional strength and quality to the weld.

Flux used for submerged arc welding is another source of hydrogen. Flux can be treated as same as electrode coatings, especially if high strength steel is to be submerged arc welded. Dirty or fused flux should not be reused as if the flux contains moisture; flux heating becomes essential, hence it become essential to put new flux in a holding oven for storage.

Research has established enough information for the flux manufacturer to recognize the importance of controlling the moisture in flux.

Weisman[1] has estimated that, in general, one kg of flux is consumed for every kg of weld metal deposited in submerged arc welding.

Pandey et al[2] investigated the influence of submerged arc welding (SAW) parameters and flux basicity index on the weld chemistry and transfer of elements manganese, silicon, carbon and sulpher. Five fluxes and different values of the welding parameters were being used for the study.

An artificial neural network (ANN) model was developed by Y. K. Yousif[3] for the analysis and simulation of the correlation between the friction stir welding (FSW) parameters of aluminum (Al) plates and mechanical properties.

Ana et al[4] conducted a study for chemical and structural characterization of fluxes used in submerged arc welding process, which enabled one to quantify the ions that might be present in the plasma arc due to fluxes.

Literature depicts that ample work has been done to study the effect of parameter variation, base metal and flux composition on electrode melting rate during SAW. Robinson[5] pointed out that significant factor controlling SAW electrode melting rate were current, composition used, electrode extension, electrode diameter and flux.

Fleck et al[6] found that filler material and flux composition in SAW would influence the growth of austenite considerably.

Vinod Kumar et al[7] developed a method of recycling the flux-dust and given the concept of waste to wealth. He stated a significant amount of flux gets converted in very fine particles, termed as flux dust, due to transportation and handling. Welding defects like porosity occur if welding is performed without removing these fine particles from the flux. The study was conducted for developing agglomerated flux by utilizing wasted flux dust of the parent commercial acidic flux.

M. A. Quintana et al [8] had conducted a research based on the effect of intermixed weld metal on mechanical properties. The effect of such unexpected variations in chemical composition can be undesirable changes in the mechanical properties of the weld metal. While a great deal of study has been devoted to dilution effects from base metals, only limited study has been conducted on the effects of intermixing weld metals deposited by different processes /electrode types. Most arc welding processes rely on a protective slag and/or a shielding gas to protect the weld metal from the atmosphere during welding.

A granular material, known as flux, plays a vital role in submerged arc welding; flux may cost 50% of the total welding consumable cost in submerged arc welding. A general problem that may occur is the absorption of moisture by the fluxes during storage. The amount of moisture absorbed being dependent upon the atmospheric conditions and time of exposure.

So an attempt has been made to recycle the moisturized Flux. Flux has been processed in such a manner that allows it to be used as new flux.

II. PROBLEM FORMULATION

The basic function of the fluxes are to establish the electrical characteristics of the electrode, to stabilize the arc, control the deposition and metallurgy of the weld deposit as well as supply additional filler material and to control weld bead shape. Fluxes also produce a gas shield to protect the molten filler metal being projected across the arc gap.

As storage and handling of the flux is not easier, the prime focus should be for storage and handling. In general granules of flux should not come in contact of water since weld cracking can result. Fluxes can be contaminated through atmospheric moisture so exposure should be limited. When not in use flux hopper should be covered or otherwise protected from atmosphere.

Most of the Special Metals fluxes are supplied in air tight plastic buckets with an 'O' ring seal in the lid[9]. The 'O' ring seal is an effective moisture barrier that works when the bucket is both opened and re-sealed correctly to allow the 'O' ring to seat properly.

To open the bucket of flux, the embossed tab on the lid must be pulled, or cut free, and then peeled loose from the lid. This removes a thin ring of plastic from the circumference of the lid. Once this ring of plastic is removed, the lid is quickly and easily opened and resealed. Properly seating the 'O' ring is necessary in order to prevent any flux that remains in the bucket from absorbing moisture.

Unopened flux bags must be stored in maintained storage conditions with temperature 20°C, +/- 10°C and relative humidity as low as possible but not exceeding 60% max. Fluxes should not be stored longer than 3 years.

After an 8 hours shift, the content of unheated flux hoppers must, is placed in a drying cabinet or heated flux hopper at a temperature of 150°C +/- 25°C.

Moisture and oil must be removed from the compressed air used in the re-cycling system. Addition of new flux must be done with the proportion of at least one part new flux to one parts re-cycled flux. Foreign material, such as millscale and slag, must be removed by a suitable system, such as sieving or magnetic separator.

Moisturized flux has been processed in such a manner that allows it to be used as a new flux and its effect on chemistry of weld metal has been investigated.

III. EXPERIMENTAL PROCEDURE

Reclamation of flux was processed successfully as during continuous welding operations unused flux was recycled and returned to the flux hopper for re-use.

Slag and metallic particles were removed from the recycled flux and discarded prior to using recycled flux by passing it through 10-mesh screen to convert into small pellets. The flux was crushed and subsequently milled in a ball mill to convert into powder form. Alloying elements and deoxidizers were added and mixed mechanically.

Any unused flux was removed from the welding machine hopper and stored in a heated hopper at 140°C for a period of 20 hours or furthermore, if the flux has somehow picked up moisture, redrying can return flux to its original moisture content as given in Table I.

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TABLE I
REDRYING OF FLUX

Flux	Temperature °C	Time hours
Agglomerated fluxes	300 +/- 25	2-4
Fused fluxes	200 +/- 50	2-4

Re-drying must be done either in equipment that turns the flux so that the moisture can evaporate easily or in an oven on shallow plates with a flux height not exceeding 2 inch (5 cm). Re-dried flux, not immediately used, must be stored at 150°C +/- 25°C before use.

This flux was then mixed with twice its volume of new flux prior to reuse. Forced air recycling systems was used with the assurance that such systems use only dry air and that the flux particles are not damaged or degraded by using high air flow rates (which can result in the formation of large quantities of dust) thus only dry air must be used in forced air recycling systems to prevent moisture pick up by the flux.

IV. RESULT AND DISCUSSION

Fluxes readily attract moisture from the atmosphere. This moisture is a major cause of weld cracking and porosity. While plain water itself wouldn't damage the weld, the heat and arc break down water into its basic elements, hydrogen and oxygen. These elements in or near the molten weld are defect carriers that pose a significant threat to the quality of the weld. In addition to water, there are other hydrogen contamination sources such as oil and grease, dirt, and coatings.

Atomic hydrogen produced from the moisture at the arc diffuses in the weld, goes into solution and settles in the atomic structural voids. If the metal cools rapidly enough, not all the hydrogen is absorbed. Some migrates to the heat-affected zone of the parent metal, some forms gas pockets or evaporates, and some helps form other undesirable impurities in the weld.

Preventing hydrogen embrittlement is critical. Detecting a defect is difficult and frequently found only after the weld is put into service. High strength steels, depending on high carbon content or low martensitic transformation properties, demand close watch for the possibilities of hydrogen absorption during welding. Heat drives out moisture, so turn on the heat.

V. CONCLUSIONS

Moisturized flux of submerged arc welding can be recycled and redried. The flux behaviour of the developed flux was found to be satisfactory.

The chemical composition of the all-weld metal, by using the developed flux, is comparable with the all weld metal, laid by using the respective parent flux[7] as shown in Table II.

TABLE III

Element	**Carbon**	**Mn**	**Si**	**S**	**P**
Develeoped flux	0.050	1.53	2.4	0.017	0.016
Parent Flux	0.058	1.6	2.4	0.018	0.018

CHEMICAL COMPOSTION OF FLUX LAID BY DEVELOPED AND PARENT FLUX, %

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