A. Small-Batch Metal-Cored Welding Repair Consumables

by G. Castro, D.L. Olson, Colorado School of Mines; C.D. Dallam, D. Fedor, Lincoln Electric Company

Introduction

The development of a method to make small batches of maintenance metal-cored welding repair consumables in an efficient manner, so that the composition of the weld deposit can be easily altered by changing the amount of metal powders added to the core of the welding wire, is reported. For that purpose the metal transfer efficiency of elements such as manganese, silicon, titanium, chromium and nickel were analyzed individually. The chemical consistency of the experimental wire is important to obtain acceptable results. This project is intended to assist small-quantity wire producers to set up and use metal powder filling to make specialty alloy composition for repairing machinery.

Procedure

Solid welding wires are typically manufactured from twenty to thirty thousand pound ingot heats. Because of the high cost of altering production heat sizes and chemistries, vendors may require customers who desire standard mild-steel filler metal with slightly higher amounts of carbon or higher percentages of nickel, for example, to purchase the entire production ingot. To avoid having to purchase twenty thousand pounds of solid filler metal, users can go to metal-cored wire to obtain smaller quantities of filler metal with their desired chemistries. Vendors may offer tailor-made metal-cored wires in lots as small as one hundred to five thousand pounds. The smaller metal-cored lot sizes give a cost-effective method of developing specialized filler metal chemistries for specific applications.

Results and Discussion

The experimental results of this study consisted of data obtained from the chemical analysis of the metal-cored welding wire consumables and the chemical analysis of the deposited mutipass weldments. For the chemical analysis of the metal-cored welding wires, an inductively-coupled plama mass-spectrometer(ICP-MS) was used. The first observation that can be seen from the data obtained from the chemical analysis of the wires is that the predicted chemical composition is always higher than the measured composition. The chemical analysis of the weld deposits were determined by X-ray flourescence. To quantify the transfer of the alloying elements the parameter delta quantity is calculated. This parameter is the difference between the actual weld metal chemical content for a particular constituent and the elemental content of the wire for the same particualr constituent. It is also the efficiency of transference of an alloying element, which is reported and discussed in this study.

Conclusions

In the metal-cored welding wire process, there are losses of alloying elements by oxidation and evaporation. There is no possibility of gaining of alloying elements as it occurs in other welding processes. There are similarities in the curves of delta quantity and transfer efficiency for manganese, nickel and chromium: the magnitude of the delta quantity increases as the amount of ferromanganese, nickel and ferrochromium present in the metal-cored welding wire increases. Those same curves for titanium have different behavior: the transfer efficiency increases as the amount of ferrotitanium

present in the metal-cored welding wire increases. This suggests that manganese, nickel and chromium have similar transfer mechanism in the welding arc. A suggested mechanistic interpretation is offered. This investigation demonstrated the potential for a small powder-fed metal cored wire production unit to make specialty wires for field weld maintenance of high valued machinery.