

## **Flux-Cored-Wire TIG Welding**

B. Yan, Tianjin Steel Inc., P. R. China

### **Introduction**

Conventional Tungsten Inert Gas (TIG) arc welding suffers from the following disadvantages: (a) low productivity; (b) relative shallow penetration; and (c) the high sensitivity of the surface condition and chemical composition of the base metal. Although hot-wire TIG arc welding can improve the welding productivity in some range compared with conventional “cold wire” TIG welding, the deposition rate of wire melting is limited due to the magnetic blow phenomenon, and penetration may not be improved. Another variant of conventional TIG welding, Active Flux TIG Welding, was proposed and developed for welding of stainless steel materials. However, this welding method cannot be used in the welding of alloy steels. This present work is aimed at developing a flux-cored-wire TIG (FC-TIG) arc welding. This welding method provides not only high quality welds but also a competitive productivity with conventional GMAW processes in welding of high strength low alloy (HSLA) steels.

### **Procedure**

A series of butt welds for the FC-TIG arc welding experiments with different compound flux were conducted in the flat position on 1/4 in. thick HSLA steel plates with a 3/16 in. tightly butt root face and bevel at 60° including joining angle. In these welding trials, pure argon was employed as a shielding gas and welding parameters (such as current, travel speed and filler metal speed) were set at a constant value. The evaluation criteria of the flux cored wire: weld microstructure, mechanical properties, and penetration. Based on the plasma spectral theory and Stark Broadened Linewidth [Ref. 1] diagnosis method, the electron density of the FC-TIG arc was measured experimentally.

## **Results and Discussion**

A series of statistical experiments were conducted to determine what compounds and alloy elements in the flux cored wire for TIG welding of HSLA steels may meet the evaluation criteria, the weld mechanical properties and penetration. Experimental results demonstrated that a flux cored wire as a filler metal for TIG arc welding may bring the following benefits: (a) substantial improvement of the composition and microstructure of the weld due to increase of alloy element transfer efficiency; (b) making a sound, crack-free and porosity-free weld; (c) significant increase of weld penetration compared with conventional “cold wire” TIG arc welding method; and (d) high deposition rate of filler metal, approximately 24lbs./hr. In the study, “Spectral Line Broadening by Plasma”, Stark’s diagnosis method of ion spectrum was used to measure the electron density of the FC-TIG arc and conventional TIG arc. Test results show that some of the compound in flux cored wire can increase the electronic density of the TIG arc due to the vaporized elements atom. This is possible one of reasons increased penetration of the FC-TIG arc.

## **Conclusions**

The FC-TIG arc welding method can significantly improve weld quality, and the penetration and deposition rate of the filler metal for the welding of the HSLA steels. The tests using the Ion Spectrum Diagnosis technique prove the electron density of the FC-TIG arc increase compared with the conventional TIG arc.

## **References**

1. H. R. Criem, Spectral Line Broadening by Plasma, 1974, NY Academic, P182-246.