D. The Effect of Flux Ingredients on Flux-Cored Arc Welding of Titanium

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Introduction

Efforts have been made to establish the viability of using the Flux-Cored Arc Welding process to produce acceptable welds when welding Grade 2 titanium. The use of the Flux-Cored Arc Welding process vs. the GTAW process allows for greater flexibility when performing in-situ and field repairs and reduces costs due to decreased reliance on shielding gases and can increase productivity. Studies were conducted to determine the effect of flux ingredients on weld characteristics.

Procedure

Using the flux system developed by Perez, Liu and Wells for the GTAW process (AWS 2002) as a basis, consumables were created to examine the effect of individual flux ingredients. The effects of the individual flux ingredients were tested by varying the amounts of individual flux ingredients while examining the effect on weld bead morphology, arc stability and weld chemistry. Specific flux ingredients studied include calcium fluoride, magnesium fluoride, calcium chloride, vanadium, and aluminum. In conjunction with Dr. Kook-Soo Bang, flux systems were developed to enhance arc stability and penetration using the flux-assisted GTAW process and were transferred to the flux-cored arc welding process.

Results and Discussion

Previous welding of titanium required extensive protection from the atmosphere by using primary, secondary and backside shielding gas. It has been hypothesizsed that the use of a flux system would help reduce reliance on shielding gases in three ways. First, the flus system would generate gases during welding to displace air from the arc environment. Second, flux ingredients would introduce a killing effect in the weld metal removing contaminants such as oxygen and nitrogen. Last, the flux system would create a slag layer, protecting the solidified weld metal from contaminating during cooling. The research focused on identifying ingredients to protect/clean the weld metal and ingredients that promote good weld bead properties and arc stability. The consumable developed by Chirieleison, Liu, Wells and Luckowski reduces the dependence on shielding gases, which reduces welding costs significantly. The results of this research include a current-voltage map for using a titanium consumable in the flux-cored arc welding process, co-relations plots demonstrating the effects of individual flux ingredients on weld properties and the development of new flux systems that produce acceptable welds for flux-cored arc welding of titanium.

Conclusions

The research demonstrated in this presentation can be utilized by those who have a need to produce titanium welds that meet ASTM standards for contamination. This research would be ideal for those who want to weld in-situ where space is limited because the dependance on auxillary shielding gas has been reduced. Repair welds to be made in the field could also take advantage of this research.. The need to weld thick sections that often proves difficult with GTAW can utilize the FCAW process for increased efficiency.