A. Electron Beam Diagnostics And Weld Transfer

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Introduction

Transferring electron beam welding parameters between different welders can be a costly and time consuming process. In the past, weld parameters have been separately determined for each machine, requiring the completion of expensive weld parameter studies. To better transfer electron beam welding parameters, an Enhanced Modified Faraday Cup (EMFC) diagnostic tool has been developed and tested at Lawrence Livermore National Laboratory (LLNL) to measure the size, shape, and power density distribution of electron beams. This tool is being used to transfer welding parameters between electron beam welders at LLNL and the BWXT Y-12 Plant. The results are presented here.

Technical Approach

The performance characteristics of three electron beam welders were determined using the E-MFC diagnostic tool. A Hamilton Standard welder was used at LLNL, and two different Leybold Heraeus welders were used at the Y-12 plant. As a result of differences in construction, each machine produced different power density distributions for nominally the same weld parameters. The effects of changes in focus settings on the electron beam characteristics at a constant power of 1 kW were determined for each machine. These results were used as the basis for developing equivalent beam parameters for each machine. Electron beam welds were then made with each machine on 304L stainless steel samples using these beam parameters. The weld depth, width, and cross sectional area for each weld produced by the three welders are then examined and compared.

Results and Discussion

Beam defocus studies were performed on each welder at the same power level of 1 kW but with different accelerating voltages, beam currents, and work distances. By performing a beam defocus study on each machine at different voltages and currents, parameter windows were established for each machine, allowing a range of parameters that would produce nominally the same beam, and thus nominally the same weld on each machine. A series of autogenous electron beam welds were then made on 304L stainless steel samples using the LLNL welder as the standard machine, and then these welds were duplicated on each of the Y-12 machines. It was determined that the welds could be duplicated by directly transferring the beam properties from welder to welder, however, it was not always possible to duplicate both the peak power density and the FWHM together on each machine. Additional work needs to be performed to determine which of these two beam properties is the most important when cases arise where only one of the two parameters can be matched.

Conclusions

Using the beam parameters measured by the E-MFC diagnostic device, a series of autogenous welds on 304L stainless steel have been replicated at both LLNL and Y-12. This study shows that welds of similar size and shape can be made on different electron beam welders with only knowledge of the beam parameters. It is thus shown that the transfer of beam parameters, rather than machine settings, provides the best means for the development of a state-of-the-art beam transfer procedure. The ability to easily transfer electron beam welds represents a major accomplishment in the development and more widespread use of this new electron beam diagnostic tool. This work also serves as a basis for the continuing development of procedures and equipment for characterizing electron beams and increasing the reliability of existing tools.