Computational Investigation on the Effects of Arc Location in Vacuum Arc Remelting

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Abstract

Vacuum arc remelting (VAR) is a secondary melting process for exotic alloys. The main purpose of this process is to increase the input ingot's physical and chemical homogeneity. This is accomplished through the application of a high current that melts the material through the emergence of electrical arcs that induce joule heating. Arc behavior drives quality of the end product, but no methodology is currently used in VAR furnaces at large scale to track arcs in real time. An arc position sensing (APS) technology was recently developed as a methodology to predict arc locations using magnetic field values measured by sensors. This system couples finite element analysis of VAR furnace magnetostatics with direct magnetic field measurements to predict arc locations. Vertical position of the sensor relative to the electrode-ingot gap, a varying electrode-ingot gap size, ingot shrink-age, and the use of multiple sensors rather than a single sensor were studied to analyze potential changes of previous made assumptions and their effects on arc location prediction accuracy. Among the parameters studied, only vertical distance between arc and sensor locations causes large sources of error, and should be considered further when applying an APS system. However, averaging the predicted locations from four evenly spaced sensors helps reduce this error. In addition, the effects of the arc position on the solidification of the ingot was also studied. Where the arc is located alters the heat transfer and fluid dynamics of the liquid melt pool. Being able to both locate and conclude how exactly arc position effects the final product could aid in the development of arc position sensing technology and the industry as a whole.

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