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Improved Models for Predicting Ferrite Content in Stainless Steel Welds

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As-welded ferrite content has a strong influence on stainless steel weld properties. In addition, it is used as an indicator of the solidification mode during welding. In the last 60 years, constitution diagrams have been used to predict ferrite content as a function of weld composition. Over the years these constitution diagrams have been improved but the basic approach used in the diagrams has not changed. Ferrite is predicted as a function of chromium and nickel equivalent factors, which are determined by taking a weighted sum of alloying additions. More recently, a new approach using artificial neural networks for predicting ferrite content in welds has been examined. This approach has the advantage that complex interactions among alloying additions can easily be taken into account. This paper describes two such models that have been developed. The first predicts Ferrite Number (FN) as a function of composition only. This model was developed using the same data as the most recent constitution diagram (WRC-1992) but it is far more accurate in predicting FN over a wide composition range. A second neural network model has been developed more recently. This model considers FN as a function of composition and cooling rate. The fact that cooling rate affects FN has been known for years and yet it has never been incorporated into ferrite prediction models up to now. For example, the cooling rates prevalent during laser welding can alter the solidification mode of austenitic stainless steel welds. In the case of duplex stainless steel welds, less extreme cooling rates still have a strong influence on the amount of residual ferrite after cooling. These effects are now included in the latest predictive model.

Conclusion

New models that utilize artificial neural networks when predicting FN in stainless steel welds are more robust and accurate than earlier constitution diagrams. The most recent neural network model includes the effect of cooling rate as well as composition for the first time. This latest model predicts changes as a function of cooling rate that are expected theoretically and observed experimentally.

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