

Abstract

Welding is a key technology in the manufacture of engineering components and is of particular importance in the context of steels. The complexity of welding alloys has in the past prevented the development of generalised models capable of giving quantitative estimates of anything other than the most simple mechanical properties.

The development of new welding alloys for Ferritic Steel Welds has in the past been achieved by trial and experience. The purpose of this work was to enable a significant proportion of the development procedure to be done by computation. A variety of methods have been used towards this end, ranging from Neural Network methods to Genetic Algorithms methods which rely heavily on patterns in experimental data.

The thesis begins with an introduction and literature review covering both a description of the essential features of types of Ferritic Steels, Welding Metallurgy, Physical Metallurgy, Neural Network Methods and Genetic Algorithms. The reliability expected from the steels over a period of some years of service is quite remarkable, and sets similarly stringent requirements on any model used for design purposes.

A ferritic steel weld typically might contain more than fifteen important solute additions. Its properties also depend on the welding conditions and post weld heat treatment. It is a formidable task, therefore, to attempt to predict the yield and ultimate tensile strengths, elongation and Charpy toughness, all of which are elementary design parameters. A massive dataset was compiled using detailed data from the published literature and industries, and subjected to various neural network analysis as well as Genetic Algorithms. The Neural Networks is a highly flexible and powerful empirical method, but it is demonstrated that with care the network can be trained to recognise metallurgically sound relationships. The resulting models have been validated in a variety of ways with emphasis on data previously unseen by the models. Having done this, the models have been used to successfully design a new welding alloy.

The Genetic Algorithms method has been tested for the prediction of the Input Variables for the Targeted Mechanical Property value within the data and beyond the data.

The trends are confirmed in the present analysis as illustrated in all the types of the Graphs as results. They are impossible to reproduce in practice. They give a clear understanding of the

relationship between the Input variables and the Mechanical properties of Ferritic Steel Welds. These pieces of information are very valuable for design, as well as understanding the existing theory and also guiding about new research and new finding for the Ferritic steel Welds.

The design of the ferritic weld alloys becomes easier, accurate, economical and time-saving with the help of the Neural Networks and Genetic Algorithms modeling Tools. The control of the effective input variables gives the desired Mechanical Properties of weld alloys for real applications in industries.