ABSTRACT

The quality of the weld joint is highly influenced by the welding parameters. Hence accurate prediction of weld bead parameters is highly essential to achieve good quality joint. This paper presents development of neural network models for predicting bead parameters such as depth of penetration, bead width and depth to width ratio for AISI 202 grade stainless steel GTAW plates. The use of this series in certain applications ended in failure of the product as there is no adequate level of user knowledge. Hence it becomes imperative to go for detailed investigations on this grade before recommending it for any application. The process parameters chosen for the study are welding current, welding speed, gas flow rate and welding gun angle. The chosen output parameters were depth of penetration, bead width and depth to width ratio. The experiments were conducted based on design of experiments using fractional factorial with 125 runs. Using the experimental data feed forward back propagation neural network models were developed and trained using Levenberg Marquardt algorithm. The training, learning, performance and transfer functions used are trainlm, learningdm, MSE and tansig respectively. Four networks were developed with four neurons for the input layer, 3 neurons for the output layer and different nodes for the hidden layer. They are 4 – 2 – 3, 4 – 4 – 3, 4 – 8 – 3 and 4 – 9 – 3. It was found that ANN model based on network 4 – 9 – 3 predicted the bead dimensions more accurately than the other networks. The prediction of weld bead geometry parameters helps in identifying the recommended combination of process parameters to achieve good quality joint.

Keywords: Artificial Neural Networks, Gas Tungsten Arc Welding (GTAW), Genetic Algorithm, Weld Bead Geometry, Weld Joint

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1. INTRODUCTION

Gas tungsten arc welding (GTAW) is used for welding hard to weld metals like aluminium, stainless steel, magnesium and titanium (Kumar & Sundarrajan, 2008). With the increased use of mechanized welding, the selection of welding process parameters and welding procedure must be more specific to ensure that the weld bead parameters of good quality are obtained at minimum cost with high repeatability (Gridharan and Murugan, 2008). GTAW quality is strongly characterized by the weld bead geometry. This is because weld bead geometry plays an important role in determining the mechanical properties of the weld (Tarang and Yang, 1998). Hence the input welding variables which influence the bead width must therefore be properly selected to obtain an acceptable bead width and hence a high quality joint. It is difficult to obtain analytical solution to predict depth of penetration and weld bead width. Costly and time consuming experiments are required to determine the optimum welding process parameters due to complex and non linear nature of the welding process. Therefore, a more efficient method is needed to determine the optimum welding process parameters. The technique of neural networks offers potential as an alternative to standard computer techniques in control technology and has attracted a widening interest in their development and application (Manikya Kanti et al., 2008). The advantage of neural networks is that the network can be updated continuously with new data to optimize its performance. The network has the ability to handle large number of input variables rapidly, filter noisy data and interpolate incomplete data (Manikya Kanti et al., 2008). Li et al. (2000) has proposed a neural network for on-line prediction of quality in GMAW. Kim et al. (2003) compared multiple regression and back propagation neural network approaches in modeling top bead height of multi pass GMAW. They reported that back propagation neural network was considerably more accurate than multiple regression techniques. Nagesh and Datta (2002) applied a back propagation neural network to predict weld bead geometry and penetration in Shielded Metal Arc Welding (SMAW). They reported that artificial neural networks are powerful tool for the analysis and modeling of weld bead geometry and penetration. The prediction of laser butt joint parameters using back propagation and learning vector quantization networks was done by (Jeng et al., 2000). The work piece thickness and welding gap were used as input parameters. The optimal focused position, acceptable welding parameters of laser power and welding speed, and welding quality were used as output parameters. They concluded that both networks are very useful in selecting welding parameters. Siva et al. (2009) optimized the weld bead parameters of nickel based over lay deposited by plasma transferred arc surfacing. The results showed that penetration is increased when the welding current is increased and decreased when travel speed is increased. Tarang et al. (1998) optimized the weld bead geometry in GTAW. They employed Taguchi method to formulate the experimental lay out and analyzed the effect of process parameters on weld bead geometry. Ghazvinloo et al. (2010) studied the effect of electrode to work angle, filler diameter and shielding gas type on weld penetration of HQ 130 steel joints produced by gas metal arc welding. They showed that increasing of electrode to work angle increased the depth of penetration and increase in filler diameter resulted in decrease in weld penetration. Gridharan and Murugan (2008) have investigated the pulse GTA welding process parameters for the welding of AISI 304L stainless steel sheets. They developed mathematical models by regression analysis to predict penetration, bead width and bead area. They concluded that weld bead parameters predicted by the models were found to confirm observed values with high accuracy. Rayes et al. (2004) studied the influence of various hybrid welding parameters on bead geometry. They conducted experiments on 316 L austenitic stainless steel work piece. They varied arc and laser power to study their influence on various bead dimensions. They found that arc power has a great influence on bead width. Ugur Esme et
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