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Multi-variable measurements and optimization of GMAW parameters for API-X42 steel alloy using a hybrid BPNN-PSO approach

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Abstract This research addresses multi criteria modeling and optimization procedure for Gas Metal Arc Welding (GMAW) process of API-X42 alloy. Experimental data needed for modeling are gathered as per L_{36} Taguchi matrix. Model inputs include work piece groove angle as well as the five main GMAW process parameters. The proposed back propagation neural network (BPNN) simultaneously predicts weld bead geometry (WBG) and heat affected zone (HAZ). Image processing technique along with Bridge Cam and AWS gauges are used to take accurate measurements of WBGs and HAZs. The adequacy of the developed BPNN is established through comparisons against measured process outputs. Measurements indicate that the BPNN model simulates GMAW process with average errors of 0.33% to 0.82%. Next, the BPNN model is implanted into a particle swarm optimization (PSO) algorithm to simultaneously optimize HAZ and WBG characteristics. The hybrid BPNN-PSO determines process parameters values and groove angle so as a desired WBG is achieved while HAZ is minimized. Verification tests demonstrate that the proposed BPNN-PSO is quite efficient for in multi-criteria modeling and optimization of GMAW.

Keywords: Gas Metal Arc Welding (GMAW), Design of Experiments (DOE), Multi-criteria Optimization, Back Propagation Neural Network (BPNN), Particle Swarm optimization (PSO).

1. Introduction

Nowadays, Gas Metal Arc Welding (GMAW) process is widely used in various industries including gas pipelines, petrochemical plants, automotive and ship buildings. High productivity rate due to the continuous feed of wire electrode, low weld discontinuity, no slag inclusion and low thermal hazard on base metal are the main merits of this process [1].

In welding processes the quality of the joint is usually determined by such process quality measures as weld bead geometry (WBG) and heat affected zone (HAZ) [2]. Weld bead geometry is a significant factor as it strongly affects the mechanical properties of the joint [3]. Another key quality indicator of the joint is HAZ that determines the

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