ABSTRACT

The present trend in the fabrication industry is to use automatic and automated welding processes to obtain high production rates and high precision. To make effective and efficient use of the fully mechanized system, it is essential that a high degree of confidence be achieved predicting weld bead parameters to get the desired quality. So, it is essential to develop a mathematical model to predict accurately the weld bead dimensions which can be fed to the automated welding system through computer.

While comparing the secondary forming processes, the welding has several merits like flexibility in design, productivity and economy. The American Welding Society has recognized and recommended various processes to suit different applications. However the Shielded Metal Arc Welding (SMAW) is the most widely used welding process because of its low cost, flexibility, portability and versatility. The SMAW process is very flexible in terms of metal thickness to be welded at different welding positions. The SMAW has been used to weld almost any metal or alloy including Cast iron, Aluminum, Stainless Steel and Nickel.

The quality of welded components can be evaluated by many characteristics like strength of weld joints, bead geometric parameters, defect free bead and by pressure testing. The welding process variables are categorized into two groups, one is controlled variables and the other is uncontrolled variables. The controlled
variables are current, voltage, root gap, electrode metal deposition rate, welding speed, surface cleanliness, arc length and preheating temperature. The uncontrolled variables are weld bead dimensions, Heat Affected Zone (HAZ), weld penetration, distortion, strength and leakage. The controlled variables are the welding process parameters and the uncontrolled variables are quality characteristics.

These characteristics vary in wide range for given set of normal operational conditions. This makes welding process inconsistent and falls under the category of special processes. These welding output variations become more critical for applications like pressure vessels, pipe lines, automobiles, hydraulics and in process industries.

As per the available literature the mechanism connecting these two variables is not known accurately and scientifically. Therefore experimental optimization of any welding process is often a very costly and time consuming task.

In the light of above, the researcher wants to make an attempt to investigate variations in welding quality by standardizing and optimizing process parameters. For this, SMAW process has been selected to weld commercially available pipes. To optimize SMAW process parameters for welding of pipe joints, most widely accepted Taguchi techniques are adopted. The parameters significantly affecting mechanical properties and leakage are selected by consulting experts in the field of pipe line fabrication and their suggestions are verified by literature survey and tested scientifically.
Welding current, welding speed, angle of electrode and root gap are considered as important process parameters. The research work is planned in two phases. In first phase pipes namely Ø48x3, Ø48x4, Ø60x3 and Ø60x4mm are welded as per L₉ OA. The results are studied and analyzed by ANOVA and Minitab software. ANOVA computes the percentage contribution and statistical significance of process parameters. Minitab software enables study of each factor (main effects plot) and interaction between factors (interaction plot) and also assist in discovering of optimum process parameters. Based on the outcome of first the phase for each case, OA in second phase has decided. Welding of Ø48x3, Ø48x4, Ø60x3 and Ø60x4mm are carried out as per L₃₁ OA, L₁₆ OA, L₁₂ OA and L₃₂ OA respectively. These OA’s have facilitated to consider other process parameters like electrode diameter, electrode specification, number of tacks and interaction between factors. Analysis of results similar to first phase has revealed that results are improvised.

The work is divided into five parts, in which first part deal with the introduction, in the second part a detailed study of literature survey pertaining to optimization techniques has been carried out, third part concentrates on Taguchi method implementation, experimental work with Minitab modeling, forth part gives analysis and results, finally last and fifth part concentrates on summary and contribution of the work.