CHAPTER-4

OBJECT AND SCOPE OF THE PRESENT WORK

4.1 Object and Scope of the Present Work

An exhaustive critical review of the available literatures as given in chapter 3 indicates that although some work is available on the effect of welding variables on bead geometry but an integrated approach on studying the effects of various welding process variables on bead geometric descriptors using full factorial technique and predicting the weld bead geometry using Artificial Neural Networks (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) is hardly found in the literature on Submerged Arc Welding. Based on this literature review the objectives for the present work have been outlined. That the effects of various welding parameters on bead geometry, Application of Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) in Submerged Arc Welding in optimization of process parameters and application of MRR to develop mathematical relationship between the welding process parameters and the output variables viz. Penetration depth, reinforcement height and weld width of the welded joint using full factorial design technique is not available and thus some work is needed in this direction to make more accurate predictions. The motivation was provided by the desire to explore the potential of SAW process. For exploiting the potential of the process to greatest possible extent, a basic understanding of the process is mandatory. The main objective of this project was to study the effects of SAW process parameters such as Arc
voltage, current, travelling speed, wire feed rate and nozzle-to-plate distance on weld bead geometry and to develop a mathematical model using multiple regression analysis for evaluating the effects of welding process parameters on the weld bead geometry. Further prediction of bead geometry using Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) and a comparison of above developed models.

Full factorial technique has been used for the analysis and modelling of bead geometry of SAW and using MRA, ANN and ANFIS. This research work describes the development of mathematical models based on practical observations, made during SAW of mild steel using bead-on-plate technique to measure accurately the weld bead geometrical dimensions as affected by welding process variables and predicting the bead geometry using MRA, ANN and Adaptive Neuro-Fuzzy Inference System (ANFIS). A mean of three observations was considered for better accuracy of the data used. Design of experiment using 2-level full factorial technique has been used to conduct experiments and to develop relationships & mathematical models for predicting the weld bead geometry in single wire Submerged Arc Welding of 12 mm thick mild steel plates. The response factor, namely penetration depth, bead width and bead reinforcement as affected by Arc voltage, current, welding speed, wire feed rate and nozzle-to-plate distance have been investigated, analyzed models developed. The models thus developed have been checked for their adequacy and significance by using the F-test and the t-test respectively. The values of $R$, $R^2$, t-test, F-test and value of VIF indicate that the models developed are valid. The results obtained from above said techniques have further been cross validated. Main and Interaction effects of the process variables on weld bead geometry have also been presented in graphical form. The developed models could be used for the prediction of weld bead dimensions and control of the weld bead quality by selecting
appropriate process parameter values and the model predicted weld bead
dimensions have been compared with their respective experimental values.
The present research initiative has been conducted in a phased manner
towards the accomplishment of objectives and the different phases have been
described in the following paragraphs. The details of these steps are given at
appropriate places in the text.

**Phase-1**

Step-1
Identification of all the important possible SAW processes control parameters
which influence the quality of the weld bead and investigating the behaviour
of these process parameters by conducting the experiments

Step-2
Selection of the acceptable working limits or levels of the SAW process
parameters,
Viz. Arc voltage (V), welding current (A), welding Speed (S), and Nozzle-to-
Plate distance (N) and Wire-feed-rate (F).

Step-3
Identification of the Output responses which truly reflected the performance
measures of the SAW process viz. Penetration depth (P), bead width (w) and
reinforcement height (H).

**Phase-2**

Step-1
Full Factorial Design Approach has been adopted for the design of matrix for
the present study and the experiments have been performed in accordance
with $2^5=32$ depending upon the selected parameters, their levels, and
interaction effects of interest.
Step-2
The experiments have then been performed in accordance with full factorial technique and a mean of three experimental observations (or responses) have been recorded for each of the 32 experiments viz. Penetration depth (P), bead width (W) and reinforcement height (H).

Step-3
Statistical Analysis of the experimental design to investigate the effects of SAW process parameters viz. voltage (V), current (A), travelling speed (S) and Nozzle to plate distance (N), wire feed rate (F) on weld bead quality viz. penetration (P), bead width (w) and reinforcement height (H).

Step-4
Optimization of SAW process parameters for enhanced weld bead quality. Prediction of optimal setting of SAW process parameters, prediction of optimal values of weld bead quality and to see these predictions are within ±5% accuracy and a confidence level of 95%. When predicted weld bead geometry is compared with the confirmation experiments performed.

Phase-3
Step-1
Development of mathematical models of weld bead quality viz. Penetration (P), Bead Width (w) and reinforcement height (H) using multiple regression analysis and calculate the co-efficient of multiple linear equations using SPSS-17 Software.

Step-2
Validation of significant effects of process parameters results obtained from Full Factorial Analysis for SAW.

Step-3
Further cross-validate the models using Stein’s Equation.

Step-4
To further develop and validate an Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) for weld bead quality viz. penetration (P), Bead width (w) and reinforcement height (H).

**Phase-4**

Step-1

Determination of optimal setting of SAW Process parameters for enhanced quality via the prediction made by Multiple Regression Analysis, Artificial Neural Network (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) model and performed conformational experiments.

Step-2

Experimental verification of weld bead quality at optimal setting of parameters obtained by Multiple Regression Analysis, ANN and ANFIS.