

# A Review on Parameter Optimization of GMAW to Improve Weld Penetration by Using Taguchi Method

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**Abstract-** In heavy fabrication industry, GMA Welding is a very useful & important welding process and E250 & E350 is common material used for manufacturing of various parts. This research gives the detail influence of welding process parameters such as welding current, welding voltage, welding speed on the penetration in E250 & E350 mild steel materials. The experimentation of this research has been carried out by using three factors, three level Taguchi method. To analyze & optimize the welding parameters & characteristics, analysis of variance, nine runs orthogonal array & signal to noise ratio are used. Penetration is a major concern in fillet welded joints, as the penetration decides the strength of the welded joint. After analysis of penetration in all 9 welded samples, optimize parameters readings verified & found probability value within 0.05. From this research it is come to know that welding current & welding voltage is major parameters which affects the penetration in welded joints.

**Keywords-** GMA Welding, Welding Current, Voltage, Welding speed Penetration, Taguchi Method, Optimization.

## I. INTRODUCTION

Gas metal arc welding is a welding process which has various industrial applications. In GMAW an electric arc produced between electrode & work piece metals, this causes electrode & work piece metal to melt & join. The joining area is called as weld (Rajesh Ranjan et al.2015). GMAW process parameters affecting the quality of welding & productivity. In heavy fabrication industry penetration is one of the most important factor which should achieve during welding. The input parameters which are mainly responsible for welding penetration is welding current, welding voltage, welding speed & this parameters plays an important role in achieving the desired penetration in welded joints. In this research work, E250 & E350 mild steel materials has been used with sample size of 125 X 150X10mm. Design of experiments based on Taguchi technique is used to evaluate the data. An orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) has been used to find the best welding penetration in mild steel materials by using different range of input parameters.

In Gas Metal Arc Welding an electric arc produced between electrode & work piece metals, this causes electrode & work piece metal to melt & join. The joining area is called as weld. Gas Metal Arc welding process parameters affects the quality of welding & productivity. Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from contaminants in the air. The process can be semi-automatic or automatic. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations. GMAW is one of the most popular welding methods, especially in industrial environments. It is used extensively by the sheet metal industry and, by extension, the automobile industry. There, the method is often used for arc spot welding, thereby replacing riveting or resistance spot welding.

## II. OBJECTIVE OF PRESENT STUDY

Previous research on welding penetration has found that all researchers has done study on welding defects & its counter measures. Most of the research has done on weld bead geometry by using automated welding process. In this research we have done study on the best welding penetration by using three most influencing factors on penetration by using GMAW process. The controllable process parameters were selected conduct the experiments are Current, Voltage & Wire speed. The objective of this study as discussed earlier is to optimize the welding process parameters for enhancing weld penetration. A total of the three welding process parameters were chosen as the controlling factors.

## III. LITERATURE REVIEW

S. D. Ambekar & S. R. Wadhokar: Parametric optimization GMAW on SS AISI 410 material- they have used same base material (AISI 410) for the research & used input parameters as welding speed, wire diameter, welding current. The research had been done by using the plate thickness of 6 mm & used L16 orthogonal array to find out optimize

parameters & they have get the optimize parameters as welding speed – 60 cm/min, welding current – 110amp & wire diameter is 1.2 mm. To study the effect of Welding Process parameter on weld Penetration in Gas Metal Arc Welding a heat source is required. Heat source produce an electric arc to generate heat to melt the metal and form a weld for this purpose continuous supply of either direct or alternating electric current.

Rajesh Ranjan: The study has been done on multivariate data analysis methods such as hierarchical clustering analysis, partial least squares are used to develop classification models to and predict the weld quality based on various parameters. The models obtained using these methods are useful in classification and prediction of weld quality and can be uses in weld run monitoring. Conventionally, testing of the weld quality is performed off-line, with either destructive testing techniques (used on as few samples as possible) and non-destructive testing (NDT) techniques. The most common NDT is a visual inspection of the GMAW runs, which involves obtaining the penetration depth and the aspect ratio of the welds.

P.Sreeraj : They have studied optimization of weld bead geometry by using test. plates of size  $300 \times 200 \times 20$  mm mild steel plates. They have used five level five factor full factorial design matrix method for optimization. The parameters used for the study is welding gun angle, contact tip to work distance, pinch, welding speed. From this research study it is observed that the developed model can be used to predict clad bead geometry within the applied limits of process parameters.

Cladding is a surface modification process in which a specially designed alloy is surface welded in order to enhance corrosion resistant properties. Common cladding techniques include Gas Tungsten Arc Welding (GTAW), submerged arc welding (SAW) and gas metal arc welding (GMAW). Because of high reliability, easiness in operation, high penetration good surface finish and high productivity gas metal arc welding became a natural choice for fabrication industries. This paper presents central composite rotatable design with full replication techniques to predict four critical dimensions of bead geometry. The second order regression method was developed to study the correlations. The developed models have been checked for adequacy and significance. The main and interaction effects of process variables and bead geometry were presented in graphical form.

Anoop C A, Pawan Kumar : used taguchi method to design process parameters that optimize mechanical properties

of weld specimen Aluminium alloy 7039 used in aircraft, automobiles, infantry combat vehicles and high speed trains. Process parameters of Pulsed GTAW setup considered are Pulse Current, Base current and Pulse Frequency Assigning process parameters to L-9 orthogonal array, experiments were conducted and optimization condition was obtained along with the identification of most influencing parameters using S/N analysis, mean response analysis and ANOVA.

#### IV. ANALYSIS OF LITERATURE

A review of literature shows that most of the experimental studies has been done on Wide research had done on parametric optimization by using Taguchi method Many researchers are adopted different techniques viz. surface response methodology, grey analysis, regression analysis etc. Many researcher studied different response parameters like bead width, height, micro-hardness, microstructure of heat affected zone (HAZ). For future scope researchers may adopt genetic algorithm, ant colony optimization techniques. There are many other process in which researcher can optimize parameters b different optimization techniques & it seems that there is huge scope for research in welding technology to find out & modify weldng variables to acieve better strength in welding with optimized process set up.

#### V. SELECTION OF BASE METAL

There are many materials that are available for manufacturing process but there is certain limitation of material use in various application. In fabrication industry the first requirement is material should be weld able if material is not weld able it will not able fabricate the parts. The material E250 & E350 has good mechanical, chemical properties the important factor is the materials has very good weld ability & formability as formability is also important factor that should consider while selection material for fabrication purpose. The two materials which selected for experimentation is E250 & E350 mild steels.

#### VI. SPECIMEN SIZE OF MATERIAL

The size of specimen decided from the EN standard in which the size is widely used in welder qualification of welder by which it confirms that welder is capable to do the welding as per requirement. The size as per EN standard is 125 X150 X10 mm. The specimen samples prepared according to the size given in standard. To maintain proper size & accuracy in size the samples were cut by using plasma cutting machine in the accuracy level is +- 0.5 mm. After cutting of

sample that has been checked with vernier caliper & all samples found within 0.5 mm accuracy.

## VII. METHODOLOGY

Methodology used for determination of optimized process parameters is Taguchi Design method. With the help of Taguchi design three level three factors orthogonal array developed for sampling plan & according to sampling plan different trials has been conducted with desired set of parameters. Taguchi design method is less time consuming, has greater accuracy. The method was selected for the experimentation because the method is cost effective, less time consuming, greater accuracy, and robust design for large scale application. By using Taguchi method for process parameters optimization Design of Experiments were selected

## VIII. EXPERIMENTAL DETERMINATION

By this experimentation we are calculating & checking the penetration level in the specimen as per different welding process parameters which has selected as per sampling plan in Taguchi method. The main aim of this determination is to achieve better penetration with the help of desired welding parameters. The three process parameter has been considered for this experimentation i.e. welding current, welding voltage, welding speed. All parameters can be controlled as per the variables in the process.

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