# "A REVIEW ON OPTIMIZATION OF DESIGN PARAMETERS FOR HYBRID WELDING JOINTS BY TOPSIS METHOD"

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**ABSTRACT**

Welding joint is possible to make good strength in same material but it is difficult to suggest the joint parameter design for dissimilar material. Different chemical composition of material it is very difficult to suggest the welding joint for dissimilar material for this type of joint presents a study on the strength of welding joining of stainless steel with different grade material, the joint are in between Inconel 601 and carbon steel AISI 1040 has to prepare with variation of electrode, voltage, current and type of cooling. MIG welding process parameters were optimized for joining Inconel 601 and carbon steel AISI 1040 plates. Taking the combination of Welding pressure, welding speed and welding temperature were carefully selected with the objective of producing weld joint with maximum impact strength and hardness, these temperature and pressure are made by the perfect combination of voltage and current. Optimization procedurefollowed for optimized the selected input parameters. The factors used in this study consisted of voltage, current, electrode and type of cooling, each of which had three levels in the study. By orthogonal array was selected according to the aforementioned factors and levels and experimental tests were Performed. The objective is to analyze the effect of welding on dissimilar plate of alloy steel and carbon steel. In this case variation of voltage and type of electrode will give the strength variation.

**Key Words**:- Welding, Strength, Voltage, TOPSIS.

## INTRODUCTION

MIG welding is a process that produces a weld at the surfaces of two similar metals. MIG is a multi-objective, multi-factor metal fabrication technique [1, 3]. Complex manner resulting in direct or indirect influence on bead geometry and hence on the mechanical behavior of the welds prepared by this process and several process parameters interact to find an optimal process condition in terms of welding parameters such as, Wire feed rate, Arc Voltage, Welding Speed, Nozzle to Plate Distance, Gas flow rate to obtain the optimum bead geometry.The material passes between themelectrodes to stay in constant contact with the material to make longcontinuous welds. MIG welding is a continuous joining process using electrode wheels on generally overlapping work piecesassist the movement of the material. MIG is an arc welding process where in coalescence is obtained by heating the job with an electric arc produced between work piece and metal electrode feed continuously. Parameters consisting of welding are heating, melting and solidification of parent metals and a filler material in localized fusion zone by a transient heat source to form a joint between the parent metals. metal inert gas (MIG) welding process gas shielded process that can be effectively used in all positions which selected of proper process parameters is important to obtain the desired weld bead profile and quality. In this work carried out work on numerical and graphical optimization techniques of the MIG welding. Increase the productivity and minimize the total operation cost by considering the welding parameters range of laser power, welding speed and focus position established to improve the weld quality. The flexibility of the assembled structures and contributes adequately to the damping properties,although most of the inherent damping occurring in real structures arises in the joints, but little effort has been made to study this source of damping because of complex mechanism occurring at the interfaces due to coefficient of friction, relative slip and pressure distribution characteristics. Accurate assessment of damping capacity of structures is therefore important to focus the attention on these parameters for the role of friction is of paramount importance in controlling the dynamic characteristics of engineering structures. In applications where relative motion between surfaces in contact occurs, the effect of frictional forces, whether desirable or not, cannot be ignored.

## WORKING PRINCIPLE OF MIG WELDING

The electrode in this process is in the form of coil and continuously fed towards the work during the process and MIG schematic diagram is shown in fig 1.1. At the same time inert gas (e.g. argon, helium, Co2) is passed around electrode from the same torch. Inert gas usually argon, helium, or a suitable mixture of these is used to prevent the atmosphere from contacting the molten metal and HAZ. When gas is supplied, it gets ionized and an arc is initiated in between electrode and work piece. Heat is therefore produced. Electrode melts due to the heat and molten filler metal falls on the heated joint. Continuous welding with coiled wire helps high metal depositions rate and high welding speed. The filler wire is generally connected to the positive polarity of DC source forming one of the electrodes. The work piece is connected to the negative polarity. The power source could be constant voltage DC power source, with electrode positive and it yields a stable arc and smooth metal transfer with least spatter for the entire current range.

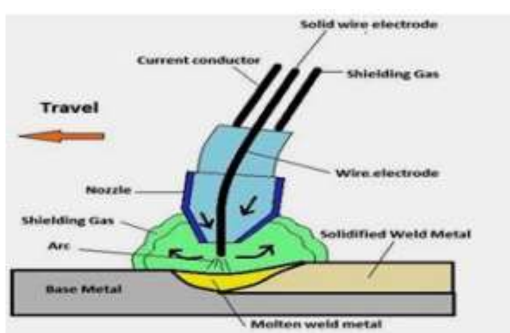


Fig 1.1 MIG Welding Nomenclature

## CHARACTERISTIC OF MIG WELDING

During the MIG welding process, the electrode melts within the arc and becomes deposited as filler material. The shielding gas that is used prevents atmospheric contamination from atmospheric contamination and protects the weld during solidification. The shielding gas also assists with stabilizing the arc which provides a smooth transfer of metal from the weld wire to the molten weld pool. The illustration that follows provides a look at a typical MIG welding process showing an arc that is formed between the wire electrode and the work piece.

- Uses a consumable wire electrode during the welding process that is fed from a spool,
- Provides a uniform weld bead,
- Produces a slag-free weld bead,
- Uses a shielding gas, usually – argon, argon - 1 to 5% oxygen, argon - 3 to 25% CO2 and a combination argon/helium gas,
- Is considered a semi-automatic welding process,
- Allows welding in all positions,
- Requires less operator skill than TIG welding,
- Allows long welds to be made without starts or stops,
- Needs little cleanup.

## DISSIMILAR WELDING JOINT

The properties of the welded joints and the feasibility of the welding processes are influenced by many factors: for example, welding electrode, Voltage Power, carbon migration from the low-alloy side, the microstructure gradient and residual stress situations across different region of the weld metal. The process is efficient, economical and dependable as a means of joining metals. The input parameters are travel speed, current, nozzle plate distance. The output parameters are bead penetration and tensile load [5].The problem that has faced the manufacturer is the control of the process input parameters to obtain a good welded joint with the required weld quality. Traditionally, it has been necessary to study the weld input parameters for welded product to obtain a welded joint with the required quality. To do so, requires a time-consuming trial and error development method. Then welds are examined whether they meet the requirement or not. Finally the weld parameters can be chosen to produce a welded joint that closely meets the joint qualities. Also, what is not achieved or often considered is an optimized welding parameters combination, since welds can often be formed with very different parameters. In other words, there is often a more ideal welding input parameters combination, which can be used. In order to overcome this problem, various optimization methods can be useful to define the desired output variables through developing.

Joining of dissimilar metals has found its use extensively in power generation, electronic, nuclear reactors, petrochemical and chemical industries mainly to get tailormade properties in a component and reduction in weight. However efficient welding of dissimilar metals has posed a major challenge due to difference in thermo-mechanical and chemical properties of the materials to be joined under a common welding condition. This causes a steep gradient of the thermo-mechanical properties along the weld. A variety of problems come up in dissimilar welding like cracking, large weld residual stresses, migration of atoms during welding causing stress concentration on one side of the weld, compressive and tensile thermal stresses, stress corrosion cracking, etc. Now before discussing these problems coming up during dissimilar welding, the passages coming below throw some light on some of the causes of these problems. In dissimilar welds, weldability is determined by crystal structure, atomic diameter and compositional solubility of the parent metals in the solid and liquid states. Diffusion in the weld pool often results in the formation of intermetallic phases, the majority of which are hard and brittle and are thus detrimental to the mechanical strength and ductility of the joint. The thermal expansion coefficient and thermal conductivity of the materials being joined are different, which causes large misfit strains and consequently the residual stresses results in cracking during solidification.

## II LITERATURE REVIEW

Abbasi. K et al. investigated the effect of increased pressure on MIG welding arc using automatic robotic welding machine and a mixture of Argon and Carbon Dioxide as shielding gas. The variation of welding parameters like feed rate, arc voltage and arc current were observed on penetration. Variation of penetration with pressure at different wire feed speeds has also been studied. They observed that increased pressure has remarkable effect on the welding arc, weld penetration and bead geometry.[1]

Haragopalet al. presented a method to design process parameters that optimize the mechanical properties of weld specimen for aluminium alloy (Al-65032), used for construction of aerospace wings. The process parameters considered for the study were gas pressure, current, groove angle and pre-heat temperature. Process parameters were assigned for each experiment. The experiments were conducted using the L9 orthogonal array. Optimal process parameter combination was obtained. Along with this, identification of the parameters which were influencing the most was also done. This was accomplished using the S/N analysis, mean response analysis and ANOVA. Mechanical properties obtained for three samples of each run were obtained. Signal to noise ratio for each quality (S/N) ratio for each quality characteristic was calculated, significant parameters were identified and optimum input parameter for each quality characteristic were predicted from S/N values and mean response. Analysis of variance (ANOVA) ascertained significant parameters identified through S/N analysis.[2]

Mishra et al. presented the effect of welding parameters like welding current, welding voltage, welding speed on penetration depth of AISI 1020 steel during welding. A plan of experiments based on Taguchi technique has been used to plan the experiment, acquire the data and to optimize the welding parameters as well as the process. Finally the conformations tests have been carried out to get the difference between the predicated values with the experimental values to find the effectiveness in the analysis of penetration. [3]

Balasubramanian V. et al. studied the high strength aluminium alloy joints produced by gas metal arc welding and gas tungsten arc welding under the effect of continuous current and pulsed current technique. Pure argon used as a shielding gas. The pulsed current gas metal arc weld joints produced high strength values and high joint efficiency than other welded joints. Due to that of fine grains the Base metal and heat affected zone regions produced high hardness values than weld metal. Pulsed current gas tungsten arc weld joints produced high highness values and continuous current gas metal arc weld joints produced low hardness values. A very fine grain in the welded region was produced by the pulsated current gas metal arc welding.[4]

Chandresh& Patel used Full factorial method for Design of Experiment for optimization work. By use of the experimental data optimal process parameter combination was achieved by grey relational analysis (GRA) optimization technique. In this work, input parameters for MIG welding were welding current, wire diameter and wire feed rate and the output parameter is hardness. Also the input parameters for TIG welding are welding current, wire diameter and the output parameter was hardness. AISI 1020 or C20 material was used for welding. Experiments were performed on plates of thickness 5 mm and double V-groove joint is used. And input parameters for MIG welding were welding current, wire diameter and wire feed rate and the output parameter is hardness. Also the input parameters for TIG welding are welding current, wire diameter and the output parameter was hardness. For Experimental design full factorial method ($L=m^n$) was used to find out number of readings. To find out percentage contribution of each input parameter for obtaining optimal conditions, we were used analysis of variance (ANOVA) method. Grey relational analysis (GRA) optimization technique was used for optimization of different values. A grey relational grade obtained from the grey relational analysis is used to optimize the process parameters.[5]

Correia et al. presented the optimization of MIG welding parameter using Genetic algorithm (GAs). The search for the near-optimal was carried out step by step, with the GA predicting the next experiment based on the earlier and without information of the modelling equations between the inputs and outputs of the MIG welding process. The GA was able to establish near optimum conditions with a relatively small number of experiments. But, the optimization by GA technique requires a good setting of its own parameters, such as number of generations, population size, etc. Otherwise, there is a risk of an inadequate extensive of the search space.[6]

Bataineh&Barqawi was identified and optimized the main factors that have significant effect on weld joint strength through factorial design experiments. Welding experiments were carried out using MIG Welding process and An ER1100 filler wire with 1.2 mm in diameter was used as a consumable electrode. The factors that were studied are arc voltage, filler feed rate, gas flow rate, specimen edge angle and preheat temperature.

Results of factorial design experiments and the analysis of variance (ANOVA) showed that arc voltage and filler feed rate are the only significant factors of the five. Optimal settings of arc voltage and filler feed rate were reached using regression analysis at 24 V and 7 in/s, respectively, at which the mean weld strength is maximum.[7]

## III PROBLEM IDENTIIACTION

Dissimilar welding is used to fabricate the pressure vessels and piping in nuclear reactors, thermal power plants, vessels and heat exchangers but failures occurs frequently due to low tensile strength. This tensile strength of weld specimen is most commonly affected due to welding process parameters. Dependent of weld metal microstructure they might also be more sensitive to hot cracking and sensitive to intermetallic precipitations compared to mild steels. Ferrite grades are alloys for stainless applications commonly contain of their high chromium and nickel content, are the most corrosion resistant of the stainless group providing unusually fine mechanical properties. Significantly by cold-working cannot be hardened by heat treatment, but can be hardened material properties of stainless steels affect that the higher the alloy content of a stainless steel, the more difficult it is to obtain durable weld. The special properties that make stainless steels difficult to weld occur to a greater or lesser extent in all grades of Inconel alloy, but are most marked summarized someproblem.

- Stainless steels work-harden considerably weld with Inconel material.
- Inconel is lighter than Stainless steels
- Stainless steels have poor joining with other metal.

## IV PROPOSED METHODOLOGY

Objective of this work based on detailed study of MIG Welding and process parameters are made. Then problems in welding of Inconel 601 with stainless steel AISI 1040 using conventional Welding process are analyzed. In the next phase design of Experiment are done by conducting several Welding in the test specimens and the effect of each parameters and depth of penetration is analyzed. The aim of this work is to predict and optimize MIG welding of a selected economically important dissimilar material in industry through applying the design of experiments (DOE) technique, in terms of process input parameters. Engineers to achieve outstanding welding properties developed models could support designers the taguchi orthogonal array design as a DOE approach was applied to design the experiments, develop statistical models and optimize the welding operation through controlling selected welding parameters. Taguchi design of the experiment provides a straight evaluation of the influence of the investigated parameters on the MIG welding outcomes. Optimize the responses parameters through the settings of design parameters which also reduce the fluctuation of system performance to allow the source of variation to be identified. The mechanical properties such as tensile stress, impact strength, and hardness will be tested and discussed as responses of dissimilar welding processes. Following objective can be follow in this thesis

1. Design the experiment for following the welding process as per the parameter required by L9 orthogonal array.

2. Perform the experiment as per the design and find out their tensile, impact test and hardness to check their strength capability.
3. Apply the TOPSIS method to short out the multi-objective problem and for optimization of parameter.
4. Prediction of parameter which is most efficient in design of hybrid welding by ANOVA analysis.

## V EXPECTED RESULT

The DOE method has become influential welding for improving output during research and development, so that better quality products can be produced quickly and at minimum cost. Design of Experiments with optimization of control parameters to find best results are attained in the Taguchi Method. "Orthogonal Arrays" (OA) provides a set of well-balanced experiments which are log functions of desired output, serve as objective functions in optimization, help in data analysis.

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