A Review On Parametric Optimization By Factorial Design Approach Of Mag-Co_2 Welding Process

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ABSTRACT

The main objective of this review paper is optimizing various Gas Metal Arc welding parameters including welding voltage, and nozzle to plate distance (NPD) by developing a mathematical model for weld deposit area of a mild steel specimen. And this mathematical model is developed with the help of the design of Matrix. MAG-CO_2 is a process in which the source of heat is an arc format between consumable metal electrode and the work piece with an externally supplied gaseous shield of gas either inert such as CO_2. This experimental study aims at Factorial design approach has been applied for finding the relationship between the various process parameters and weld deposit area. And after that we can easily find out that which parameter will be more affect OR which parameter will be more influence variable to WDA (Welding Deposition area) in the MAG-CO_2 welding Process.

Keywords - **MAG-CO_2 Process; Factorial Design Approach; Weld Deposit Area.**

I. INTRODUCTION

MAG-CO_2 is a process in which the source of heat is an arc format between consumable metal electrode and the work piece, and the arc and the molten puddle are protected from contamination by the atmosphere (i.e. oxygen and nitrogen) with an externally supplied gaseous shield of gas either inert such as argon, helium or an argon-helium mixture or active such as carbon dioxide, argon-carbon dioxide mixture, which is chemically active or not inert.

Initially GMAW was called as MIG Welding because only inert gasses were used to protect the molten puddle. The application of this process was restricted to aluminum, deoxidized copper and silicon bronze. Later it was used to weld ferrite and austenitic steels, and mild steel successfully by using active gasses in place of inert gasses and hence was term MAG (Metal Active Gas) welding. The American Welding Society refers to the process Gas Metal Arc Welding process to cover inert as well as active shield gasses. GMAW is basically a semi automatic process, in which the arc lengths of electrode and the feeding of the wire are automatically controlled. The welding operator's job is reduced to positioning the gun at a correct angle and moving it along the seam at a controlled travel speed. Yet basic training is required in the setting up of the equipment and manipulation of the gun must be provided to the operator to ensure quality GMAW welding. GMAW welding process overcome the restriction of using small lengths of electrodes and overcome the inability of the submerged-arc process to weld in various positions. By suitable adjusting the process parameters, it is possible to weld joints in the thickness range of 1-13 mm in all welding position. All the major commercial metals can be welded by GMAW (MAG/CO2) process, including carbon steels, low alloy and high alloy steels, stainless, aluminum, and copper titanium, zirconium and nickel alloys. GMAW (MAG/CO2) is also used in mechanized and automatic forms to eliminate the operator factor and to increase the productivity and consistency of quality.

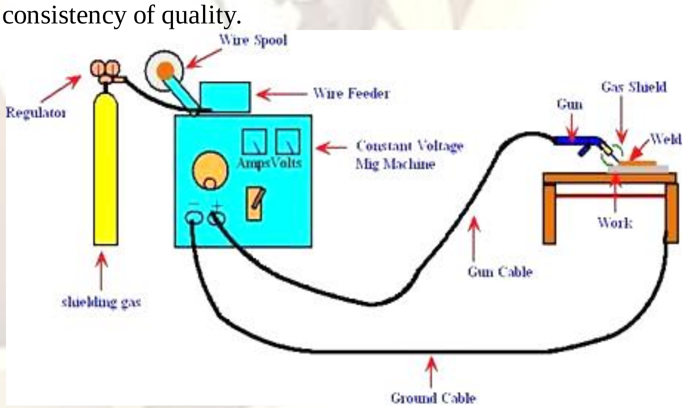

Fig. 1 – Schematic diagram of the MAG-CO_2 Welding Process.

The schematic diagram of MAG-CO_2 Welding process is shown in Fig. 1. MAG stands for metal-active-gas arc welding. This is a variation of MAG welding, in which identical equipment is used but the inert gas is replaced by carbon dioxide, which is chemically active The American Welding Society refers to the process as Gas Metal Arc welding and has given it the letter designation GMAW.

All the major commercial metals can be welded by the MAG- CO2 process, including carbon steels, stainless steels, aluminum, copper, titanium, zirconium and nickel alloys. Gas metal arc welding (GMAW or MIG welding) is an electric arc welding process which joins metals by heating them with an arc established between a continuous filler metal (consumable) electrode and the work. Shielding of the arc and molten weld pool is obtained entirely from an externally supplied gas or gas mixture.

II. INTRODUCTION TO ARC WELDING

This is a group of processes in which the heat required for fusion is generated by electric arc formed between a metallic electrode and the base metal. The electric arc is an ideal source of welding heat.

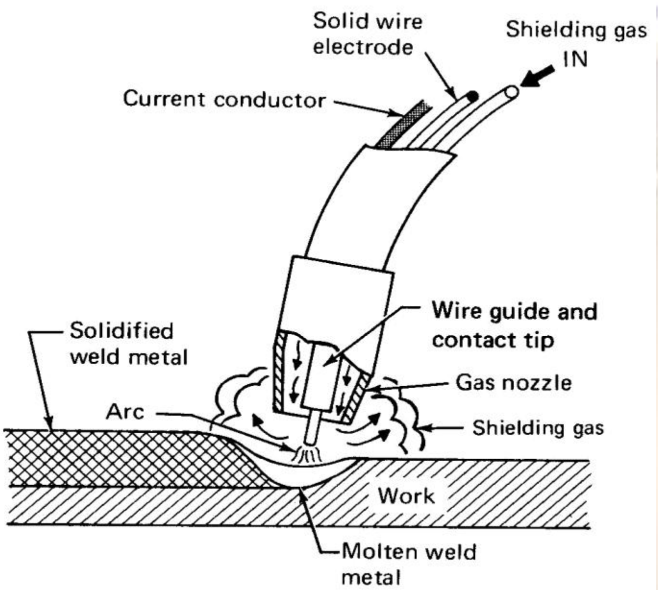

Fig.2 Schematic diagram of Principle of GMAW process

The extremely high arc temperature of over 5000 C permits it to supply a large amount of heat to a small area.

III. FACTORIAL DESIGN APPROACH AND TERMINOLOGY

Factorial experiments permits to evaluate the combined effect of two or more experiments variables when evaluated simultaneously. Information obtained from factorial experiments is more complete than those obtained from a series of single factor experiments, in the sense that factorial experiments permit the evaluation of interaction effects. An interaction effect is an effect attributable to the combination of variables above and beyond that which can be predicted from the variables considered separately. For the need of factorial experiments, the information gathered could be used to make decisions, which have a board range of applicability. In addition to information about how the experiments variables operate in relative isolation, it can be predicted, what will happen when two or more variables are used in combination. Apart from the information about interactions, the estimate of the effects of the individual variables is a more practical use. In the case of factorial experiments, the population to which inferences can be made is more inclusive than the corresponding population for a single factor experiments.

Factorial experiments are concerned with answering the following questions:

• What factors should be included?
• How many levels of each factor should be included?
• How should the levels of the factors be spaced?
• How many experimental units should be selected for each treatment conditions?

A factor is a series of related treatments or related classifications. The related treatments making a factor constitute the levels of that factor. The number of levels within a factor is determined largely by the thoroughness with which an experimental desires to investigate the factor
Components.

NOTATION

The levels for each factor were the highest value and the lowest value of the factors in between and at which the outcome was acceptable. These values were outcomes of trials runs. Highest value has been represented by "+" and the lowest value has been represented by "-"

WHEN TO USE

Factorial experiments can be used when there are more than two levels of each factor. However, the number of experimental runs required for three-level (or more) factorial designs will be considerably greater than for their two-level counterparts. Factorial designs are therefore less attractive if a researcher wishes to consider more than two levels.

IMPLEMENTATION

For more than two factors, a 2^k factorial experiment can be usually recursively designed from a 2^{k-1} factorial experiment by replicating the 2^{k-1} experiment, assigning the first replicate to the first (or low) level of the new factor, and the second replicate to the second (or high) level. When the number of factors is large (typically more than about 5 factors, but this does vary by application), replication of the design can become operationally difficult. In these cases, it is common to only run a single replicate of the design. When there are many factors, many experimental runs will be necessary, even without replication. For example, experimenting with 10 factors at two levels each produces 2^{10}=1024 combinations. At some point this becomes infeasible due to high cost or insufficient resources.

IV. LITERATURE SURVEY

There are many articles are published on parametric optimization. Not all the articles are directly related to our work, especially, those articles which were focused on computational work. Many articles addressed experimental findings and remaining discussed various theories explaining energy separation phenomenon. In this subsection, we are going to discuss only those articles (experimental and/or theoretical work) which are directly related to current work.

Erdal Karadeniz, Ugur Ozsarac, Ceyhan Yildiz study the effects of various welding parameters on welding penetration in Erdemir 6842 steel having 2.5 mm thickness welded by robotic gas metal arc welding were investigated. The welding current, arc voltage and welding speed were chosen as variable parameters. The depths of penetration were measured for each specimen after the welding operations and the effects of these parameters on penetration were researched. They found the result which is shown below. [1]

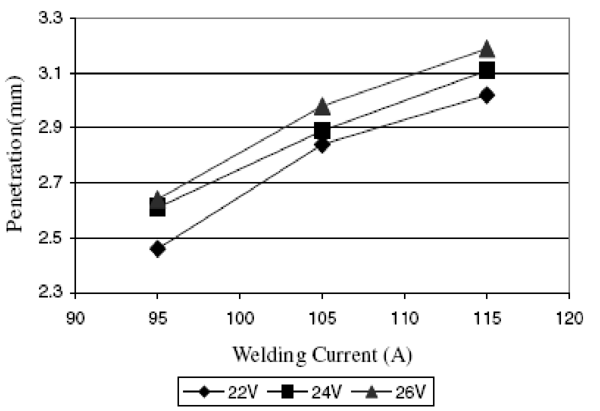

Fig.1 Penetration vs. welding current diagram for 40 cm/min welding speed.

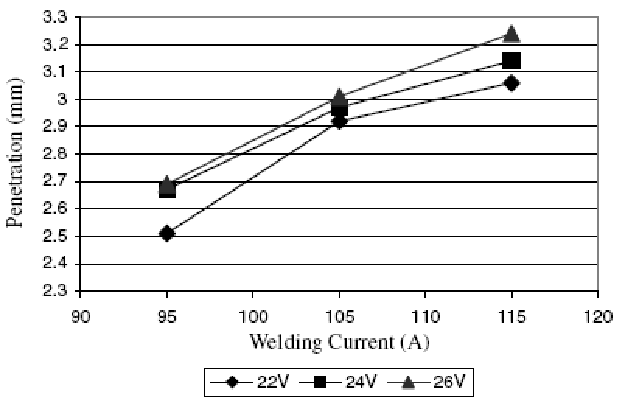

Fig.2 Penetration vs. welding current diagram for 60 cm/min welding speed.

Shuangyu Liu n, FengdeLiu, Hong Zhang,YanShi, has found that CO2 laser-metal active gas (MAG) hybrid welding technique is used to weld high strength steel and the optimized process parameters are obtained. Using LD Pumped laser with an emission wavelength of 532 nm to overcome the strong interference from the welding arc, a computer-based system is developed to collect and visualize the waveforms of the electrical welding parameters and metal transfer processes in laser-MAG. The welding electric signals of hybrid welding processes are quantitatively described and analyzed using the ANALYSATOR HANNOVER. The effect of distance between laser and arc (forming process of weld shape, electric signals, arc characteristic and droplet transfer behavior is investigated. It is found that arc characteristic, droplet transfer mode and final weld bead geometry are strongly affected by the distance between laser and arc [2]

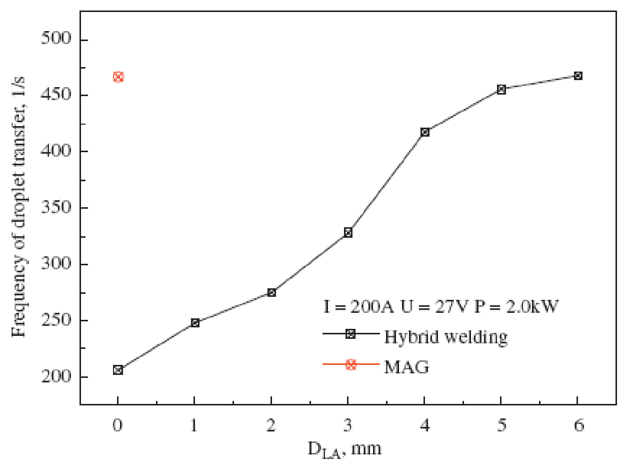

Fig. 1 Effects of the DLA on the frequency of droplet transfer

Marjan Suban, Janez Tusek describes several methods for the determination of arc stability in MAG/MIG welding. The stability of the welding process is affected by numerous parameters. The most unfavourable results of poor arc stability are spatters which are problematic in terms of material losses, extension of production times due to cleaning, as well as unaesthetic appearance. The methods described in the paper are based on measurement of time-varying welding current and welding voltage. [3]

Marco A. Ramirez a, Gerardo Trapaga b, John McKelliget was developed mathematical model to simulate gas tungsten arc welding (GTAW) in order to compare two distinct numerical formulations to represent the electromagnetic problem in arc welding operations, i.e. the "potential" and the "magnetic" approaches. Both formulations, representing the same physics but mathematically and numerically different, are tested against each other and against experimental measurements [4]

P.K. Ghosha, Lutz Dornb, Shrirang Kulkarnia, F. Hofmannb has found that the variation in arc characteristics, stability in shielding of arc environment and behavior of metal transfer with a change in pulse parameters have been studied by high speed videophotography during pulsed current gas metal arc (P-GMA) weld deposition using austenitic stainless steel filler wire. A comparative study of similar nature has also been carried out during gas metal arc (GMA) weld deposition in globular and spray transfer modes. The effect of pulse parameters has been studied by considering their hypothetically proposed summarized influence defined. [5]

Davi Sampaio Correia, Cristiene Vasconcelos Gonçalves, Sebastiao Simoes da Cunha, Valtair Antonio Ferraresi study on the response surface methodology (RSM) is a traditional technique for experimental process optimization. Recently, a new approach to this problem has been tried with the genetic algorithm (GA), which is most known in the numerical field. The present paper compares these two techniques in the optimization of a GMAW welding process application. The situation was to choose the best values of three control variables (reference voltage, wire feed rate and welding speed) based on four quality responses (deposition efficiency, bead width, depth of penetration and reinforcement), inside a previous delimited experimental region. For the RSM, an experimental design was chosen and tests were performed in order to generate the proper models. [6]

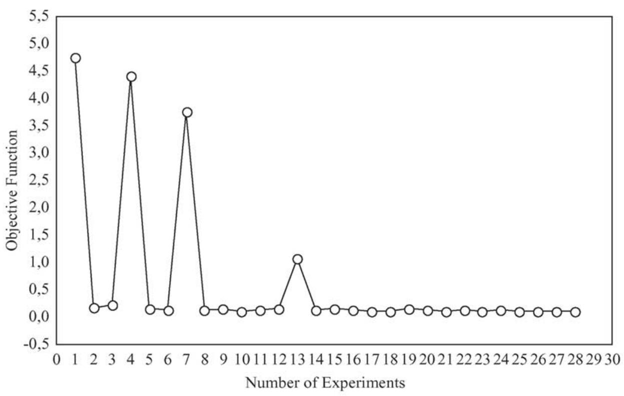

Fig 1. Convergence of the genetic algorithm.

Hakan Ates presents a novel technique based on artificial neural networks (ANNs) for prediction of gas metal arc welding parameters. Input parameters of the model consist of gas mixtures, whereas, outputs of the ANN model include mechanical properties such as tensile strength, impact strength, elongation and weld metal hardness, respectively. ANN controller was trained with the extended delta-bardelta learning algorithm. The measured and calculated data were simulated by a computer program. [7]

P. Praveen, P.K.D.V. Yarlagadda found the newer automobile designs aim at reducing vehicle weight. Driven by this need light metal industry is experiencing some exciting developments. One of the most widely used light metal is aluminum. As use of aluminum as an alternative material grows, manufacturers face newer challenges. These new challenges are development of new aluminum alloys, joining of different types of aluminium alloys and improvement in weld quality of welds and weld repairs. One of the technologies being explored by the fabricators of aluminum is pulse gas metal arc welding (GMAW-P). This paper explores difficulties in joining of newer varieties of aluminum alloys and how GMAW-P can help in meeting newer challenges of welding of aluminum. [8]

P. Praveen, P.K.D.V. Yarlagadda, M.J. Kang, study on modern welding has become complex due to need for setting up of combination of large number of welding parameters to achieve best quality of weld. Trial and error methods are impractical. In addition, there are many facets of disturbances and each has its own source and mitigation techniques. This need has resulted in several advancements in GMAW-P technology. This paper reviews progress in performance of GMAW-P technology. [9]

K.Y. Benyounis, A.G. Olabi classified according to the output features of the weld, i.e. bead geometry and mechanical properties of the welds. Because of Welding input parameters play a very significant role in determining the quality of a weld joint. The joint quality can be defined in
terms of properties such as weld-bead geometry, mechanical properties, and distortion [10]

V. CONCLUSION:-

The issue concerned in all explanations related to parametric optimization methods. But Factorial design has several important features.
First, it has great flexibility for exploring or enhancing the "signal" (treatment) in our studies. Whenever we are interested in examining treatment variations, factorial designs should be strong candidates as the designs of choice.
Second, factorial designs are efficient. Instead of conducting a series of independent studies we are effectively able to combine these studies into one.

Finally, factorial designs are the only effective way to examine interaction effects. From the above study I am much more interested to work on parametric optimization by factorial design approach of mag-co_2 welding process.

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