RESEARCH ARTICLE OPEN ACCESS

Study and Parameter Optimization of Dissimilar Materials Using Mig Welding Process

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Abstract:

Welding input parameters play a very significant role in determining the quality of a weld joint. The quality of the joint can be defined in terms of mechanical properties, distortion and weld-bead geometry. Generally, all welding processes are employed with the aim of obtaining a welded joint with the desired characteristics. However efficient welding of dissimilar metals has posed a major challenge due to difference in thermal, mechanical and chemical properties of the materials to be joined under a common welding condition. This causes a steep gradient of the 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 stresses, stress corrosion cracking, etc. To overcome this causes there are required to study the effect of welding process parameter on mechanical property. The aim of this research is to predict and optimize MIG welding of some economically important dissimilar materials in industry through applying a full factorial design as a DOE approach to design the experiments, develop mathematical models and optimize the welding operation.

KEYWORDS: MIG welding, dissimilar materials, micro structures

1.0 Introduction:

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. The materials to be joined may be similar or dissimilar to each other. The heat required for the fusion of the material may be obtained by burning of gas or by an electric arc. The latter method is more extensively used because of greater welding speed.

MIG welding is an arc welding process where the heat for welding is generated by an arc between a consumable electrode and the work material. The electrode, a solid wire that is continuously fed to the weld area, becomes the filler metal as it is consumed. The electrode, weld puddle, arc and adjacent areas of the base metal are protected from atmospheric contamination by a gaseous shield provided by a stream of gas, or mixture of gases, fed through the electrode holder

2.0 Literature review:

Vikas Chauhan et al. (2017) have optimized process parameters of MIG welding for Stainless Steel (SS-304) and low carbon steel using Taguchi design method. Three parameters of MIG welding viz. current, voltage and travel speed were taken for the analysis. The analysis for signalto-noise ratio was done for higher-the-better quality characteristics. The significance of each parameter was studied by using the ANOVA (Analysis Of Variance). Finally the confirmation tests were performed to compare the predicted values with the experimental values which confirm its effectiveness.

Balasubramaniam (2016) has used regression analysis to optimize the welding current and weld time setting to achieve a minimum nugget diameter and a maximum tensile shear force. The work was carried out on the SPRC35 steel sheet. Subramaniam concluded the increase in welding current will lead to increase in nugget diameter and tensile shear strength.

Abdul wahab H. Khuder et al. (2014), have studied the effect of welding process parameter in welding joint of dissimilar metal by using MIG spot welding. In this research the base material selected for welding are austenitic stainless steel-type AISI 316L and carbon steel. The filler metal use for welding this dissimilar metal is E80S-G and CO2 is used as shielding gas. The experiment was carried out by considering feed of wire, time of feed and weld current as input parameter. The effect of these parameters on diameter of the spot and shear force was predicted by doing the experiment. From the result they conclude that the size of spot weld and shear force is increase with increasing welding current while the shear force is decrease with increase of welding time. Also they found that the increasing welding current and time of welding will also increase diameter of weld zone and decreases the shear force.

C. N. Patel et al. (2012) evaluated the parameters; welding current, wire diameter and wire feed rate to investigate their influence on weld bead hardness for MIG welding and TIG welding by Taguchi's method and Grey Relational Analysis (GRA). From the study it was concluded that the welding current was most significant parameter for MIG and TIG welding. By use of GRA optimization technique the optimal parameter combination was found to be welding current, 100 Amp; wire diameter 1.2 mm and wire feed rate, 3 m/min for MIG welding.

Monika K. et al. (2011) analyzed the Mechanical Properties of MIG Welded Dissimilar Joints under the effect of heat input. Welding current, voltage and speed of wire determines the heat input. The IS 2062, IS 45 C8, IS 103Cr1 were used as a base material. 1.2mm diameter copper coated mild steel was used as a filler wire. The both joints (IS 2062 & IS 45 C8) and (IS2062 & IS 103 Cr1) increased the tensile strength when increased with the heat input and also increased the hardness value when decreased with the heat input.

Pradip D. Chaudhari et al. (2010) have investigated the effects of welding process parameters of Gas Metal Arc Welding (GMAW) on tensile strengths of SS 3Cr12 steel material specimen. In this research work the welding voltage, wire feed rate, welding seed and gas flow rate were considered as inflating input parameter. The experiment was designed by central composite design matrix and the analysis was done by using Minitab software. From the analysis they found that the tensile strength was increasing with increasing with increase the value of welding speed and gas flow rate whereas the increasing with decrease the value of wire feed rate and welding voltage.

Tewari et al. (2009) studied the effect of parameters on weld ability of Mild Steel plates. The effect of current, voltage, welding speed and heat input rate on depth of penetration was studied. They concluded that increasing the speed of travel and maintaining constant arc voltage and current will increase penetration until an optimum speed is reached at which penetration will be maximum. Increasing the speed beyond this optimum value will result in decreasing penetration.

3.0 Methodology:

1mm thick Low carbon steel and 2mm thick AA1050 aluminium alloy were used. The dimensions of the work piece, length 300 mm, width 150mm. The heat generated by the electric arc is used to melt and join the base metal. In this study an MIG welding machine is used to weld the base plates of AA1050 and Low Carbon Steel. The chemical composition of Stainless steel and Low carbon steel are given in Table. Two plates of size 125 mm x 100 mm x 4 mm are tacked together to form a weld pad of 250 mm x 100 mm. Welding is carried out in the down hand position and beads are laid along the weld pad center line to form a butt joint. The plates are allowed to cool to room temperature, after the completion of welding.

Chemical composition of Low carbon steel in wt%

Mtrl	C	Mn	S	P	Fe
%	0.15	0.6	0.055	0.055	99.14

Chemical composition of AA1050 in wt%

Mtrl	Cu	Mg	Si	Fe	Mn	Zn	Ti	Al
%	0.05	0.05	0.25	0.4	0.05	0.07	0.05	Balance

Design of Experiments (DOE), is one of the most important statistical tools of TQM for designing high quality systems at reduced cost. Design of Experiments (DOE) methods provides an efficient and systematic way to optimize designs for performance, quality, and cost. Design of Experiments (DOE) is a systematic, rigorous approach to engineering problem-solving that applies principles and techniques at the data collection stage so as to ensure the generation of valid, defensible, and supportable engineering conclusions. In addition, all of this is carried out under the constraint of a minimal expenditure of engineering runs, time, and money

Modeling:

Here, the engineer is interested in functionally modeling the process with the output being a good-fitting mathematical function and to have maximal accuracy of the co-efficient in that function.

Optimization:

In this case, the engineer is interested in determining optimal settings of the process factors, that is, to determine foe each factor the level of the factor that optimizes the process response. For example, you may want to maximize process yield or reduce product variability

Input parameter level and value

Parameter level	Gas Pressure (Psi)	Current (Amp)	Voltage (Volt)
	A	B	C
1	12	150	15
2	15	170	20
3	18	190	25

4.0 Results:

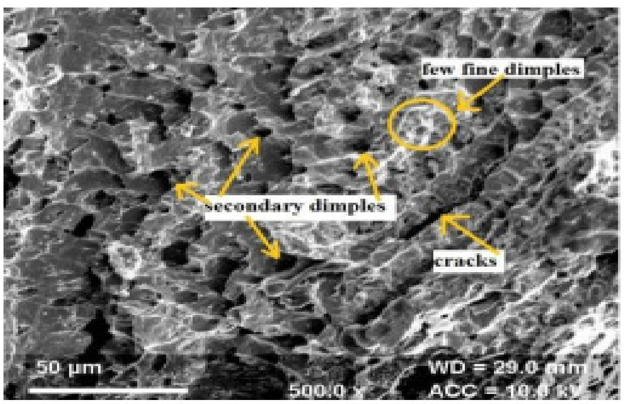
The tensile strength of the dissimilar welded plates is measured in the Universal Testing Machine (UTM) and the Result. The center portions of the welded specimens are cut down with a width of 20 mm in order to hold it in the UTM

Experimental observations

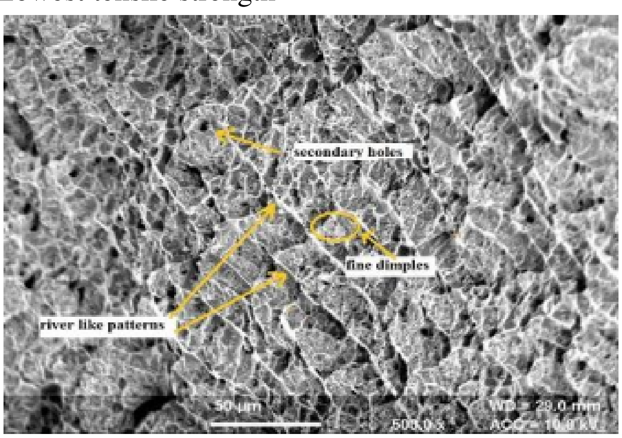
Expt. Number	Tensile strength (N/mm2)
1	115.5
2	98.5
3	68.5
4	105.5
5	115.5
6	125
7	112.5
8	98.5

The corresponding S/N ratio for the nine experiments

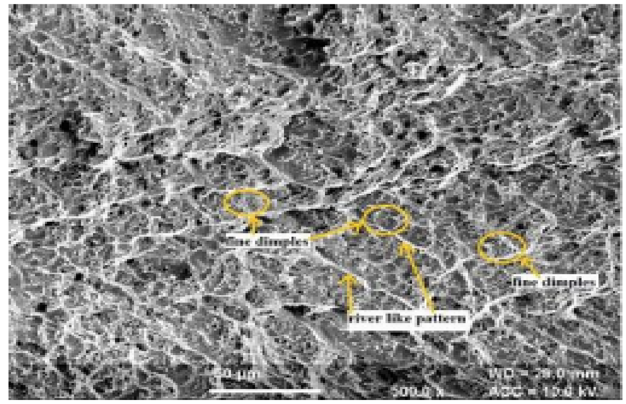
Experiment Number	S/N ratio(db)
1	41.25164
2	39.86872
3	36.71381
4	40.46505
5	41.25164
6	41.9382
7	41.02305
8	39.86872



Lowest tensile strength



Average tensile strength



Highest tensile strength

5.0 Conclusions:

In this paper, the optimization of the process parameters for MIG welding of AA1050 and low carbon steel with greater weld strength has been reported. If the dimple size is fine, the strength and ductility of the respective joint are higher. The size variation of dimples and the presence of micro-pores and secondary cracks might be the reason for the drop of impact energy absorption. The higher-the-better quality characteristic is considered in the weld strength prediction. The experimental result shows that the weld strength is greatly improved by using this approach.

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