An Experimental Study on the Effect of MIG Welding parameters on the Weld-Bead Shape Characteristics

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Abstract

In this study the effect of MIG welding parameters on the weld bead and shape factor characteristic of bright drawn mild steel specimen of dimensions 144×31×10 mm has been investigated. The welding current, arc voltage, welding speed, heat input rate are chosen as welding parameters. The depth of penetration and weld width were measured for each specimen after the welding operation and effect of welding speed and heat input rate parameters on depth of penetration and weld width were investigated.

The present paper aims at the evaluation of depth of penetration and weld width by employing different MIG welding parameters.

Key wards: welding current, Arc Voltage, Welding Speed, penetration depth, weld width, shape factor.

1 INTRODUCTION

Welding is a process of joining two materials. It is more economical and is much faster process compared to both casting and riveting [2]. Various welding methods are: Shielded Metal Arc Welding (SMAW), Tungsten Inert Gas (TIG) Welding, Plasma Arc Welding (PAW), Gas Metal Arc Welding (GMAW), Flux Cored Arc Welding (FCAW), Electro Slag Welding (ESW), Oxy-acetylene (OA) Welding and Friction Welding [3].Submerged Arc Welding (SAW)[5] .The two most commonly used types of Gas Metal Arc Welding (GMAW) processes are tungsten inert gas (TIG) and metal inert gas (MIG) [8]. TIG welding (Tungsten inert gas welding) is also called as gas Tungsten Arc Welding (GTAW) uses a non consumable electrode and a separate filler metal with an inert shielding gas. GTAW process welding set utilizes a suitable power source, A cylinder of Argon gas, torch with connections for current supply, tubing for shielding gas supply and water tubing for cooling for the torch [11]. In the present work MIG process has been used.

The metal inert gas welding process consists of heating, melting and solidification of parent metal and a filler material in localized fusion zone by a transient heat source to form a joint. MIG welding parameters are the most important factors affecting the quality, productivity and cost of welded joint [1]. Metal transfer in MIG welding refers to the process of transferring material of the welding wire in the form of molten liquid droplets to the work-piece [9].

Mild steel is most commonly used form of steel, because it is relatively low in cost, but it provides good material properties, which required for many engineering applications. The input variables directly affect the shape factor. The input variables consider for investigation are as follows:

Welding current

It is the most important variable for welding, because it controls the burn off rate of electrode, fusion depth and weld geometry.

Welding voltage

It determines the shape of fusion zone and weld reinforcement height.

Welding speed

It is defined as the rate of travel work piece under electrode [7].

Heat Input

Speed of welding(s) = Travel of electrode/ arc time mm/min.

Heat input rate = (V×A×60) /S joules per mm

Where, V is arc voltage in volts,
A is welding current in ampere,
S is speed of welding in mm/min [12].

Shape Factor

It is the ratio of Penetration Depth to Weld Width.

Shape factor = Penetration Depth/Weld Width

The above factor i.e. arc current, arc voltage and welding speed and their interactions play a significant role in determining the weld bead shape characteristics [4,10].

2 PLAN OF INVESTIGATION

The research work was carried out in the following steps:

(i) Identifying the important process variables;
(ii) Conducting the experiments.
(iii) Recording the response, viz. penetration depth and weld width.
(iv) Presenting the effects the significant interactions between the different parameters in graphical form and;
(v) Analyzing the results to draw specific conclusions.

3 EXPERIMENTAL DETAILS

In this investigation, MIG welding has been used. Specimen of dimensions 144×31×10 mm were prepared. The shielding gases employed were mixture of Argon + 8%CO_2. The Welding Voltage and Welding current were 16 V and 165 amp.

Table 1: MIG welding variables and their responses

SN	Arc Time (Sec)	Welding Speed (mm/min)	Heat input (J/mm)	Weld Width (mm)	Penetration (mm)	Shape Factor
1	2.01	900	176.00	1.27	1.01	1.25
2	1.86	1000	158.40	1.35	1.08	1.28
3	1.69	1100	144.00	1.43	1.10	1.3
4	1.43	1300	121.84	1.63	1.24	1.32
5	1.43	1350	117.33	1.86	1.40	1.33
6	1.32	1400	113.32	2.06	1.53	1.35
7	1.32	1450	109.14	2.62	1.875	1.4
8	1.24	1500	105.6	2.17	1.61	1.35
9	1.2	1550	102.19	1.90	1.43	1.32
10	1.16	1600	99	1.49	1.15	1.30

4 RESULTS AND DISCUSSION:

Total 10 experiments were performed with constant welding current and arc voltage. Welding speed was varied. The results as a function of welding parameters and their response have been summarized in Table 1.

(a) The effect of welding speed on penetration depth:

After welding all the welded specimens were cut perpendicular to the direction of welding to measure the penetration depth. It has been found that as the welding speed increases; penetration depth also increases up to speed of 1450 mm/min, which is the optimum value to obtain maximum penetration; beyond which the penetration decreases as shown in fig.1

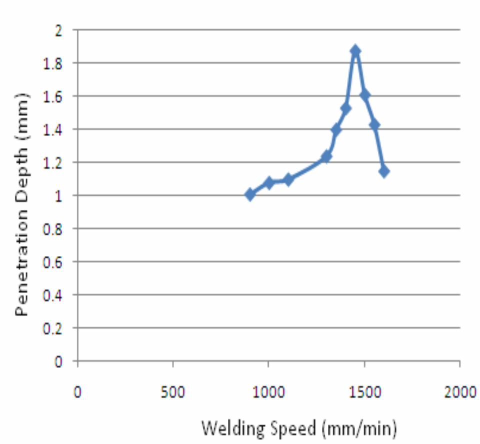

Fig.1 Penetration depth as a function of welding speed

(b)The effect of heat input on penetration depth:

Penetration depth increases with increase in heat input. Maximum penetration occurs at heat input rate of 109.14 J/min., beyond which penetration depth starts decreasing. Therefore optimum results were obtained at a heat input of 109 J/min as shown in fig 2.

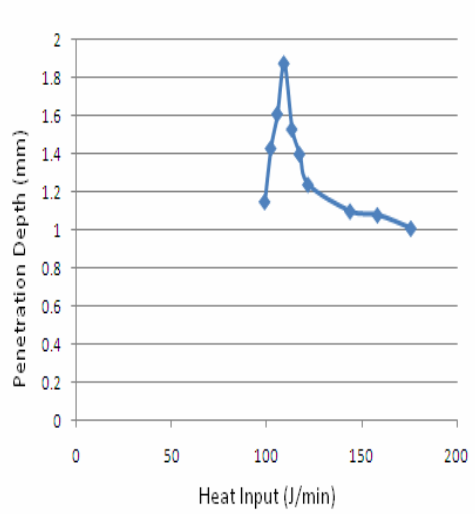

Fig. 2 Penetration depth as a function of heat input

(c)The effect of welding speed on shape factor:

Shape factor increases with increase in welding speed. Maximum shape factor was observed at a welding speed of 1450 mm/min., beyond that the shape factor starts decreasing. Thus the optimum shape factor was obtained at a welding speed of 1450 mm/min as shown in fig. 3.

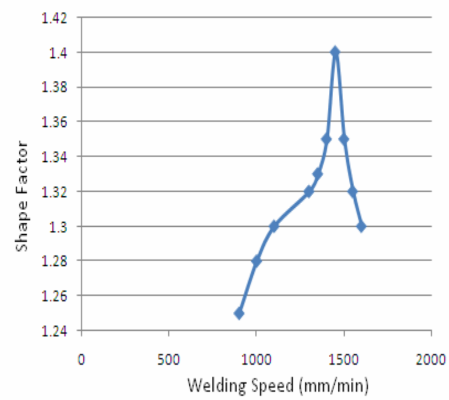

Fig. 3 Shape factor as a function of welding speed

5 CONCLUSIONS

From the above investigation on bright drawn mild steel of dimensions 144✕31✕10 mm, and using a current of 165 amp and arc voltage of 16 V the following conclusions have been drawn:

1. When speed is taken as variable parameters, penetration depth increases with increase in speed upto an optimum value of 1450 mm/min, beyond that speed penetration starts decreasing.
2. When the heat input is taken into consideration the depth of penetration increases with increase in heat input upto a rate 109 J/min, beyond which the penetration depth starts decreasing.
3. Shape factor increases with increase in welding speed. An optimum shape factor was observed at a welding speed of 1450 mm/min., beyond which shape factor starts decreasing. Therefore optimum shape factor was observed at welding speed of 1450 mm/min.

It can, therefore, be concluded that at a given current of 165 amp and arc voltage of

16 V as the welding speed increases the penetration depth increases until optimum value is reached, at which penetration depth and shape factor are optimum. Beyond that speed penetration depth and shape factor start decreasing.

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