STUDY ON HIGH SPEED WELDING IN GTA WELDING PROCESS

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ABSTRACT

A study of noticeable improvement in welding speed in thin–plate Type 304 stainless steels gas tungsten arc (GTA) welding was investigated. The welding speeds were increased to more than 3m/min, up to 8m/min. During the welding, Direct Current Straight Polarity (DCSP) and pulsed current GTA welding processes were carried out, respectively. The appropriate high speed welding parameters were established while achieving a high quality weld. After this, Erichsen test and tensile test were performed. The results obtained were summarized as following: ultra high speed welding for thin-plate Type 304 could be satisfactorily welded with high speed from 3m/min to 8m/min in both DCSP and pulsed GTA welding; Increasing welding speed was found to decrease the ductility, tensile strength and elongation of welded joint; The optimal frequency would be 200Hz –500Hz for high speed welding in pulsed current welding; DCSP welding could obtain the better results of Erichsen test and tensile test than those of pulsed current welding obtained.

KEYWORDS

High speed, GTA welding, DCSP and pulsed welding, Erichsen test, tensile test

1. Introduction

High speed welding is preferred in production line of austenitic stainless steels, and it is one way to effectively improve the quality and productivity of the welding process while reducing the overall cost. Conventional fusion welding doesn't meet this requirement, robot welding and laser welding are considered the alternatives for this. However, a few problems in laser welding of thin sheet steel limit the applications of laser welding in industries [1] and robot welding also need to be considered the practical use, the optimal level of robot welding quality, reliability [3], and so on. On the point of these views, this study tried to find an economic high speed welding process to meet this requirement. High speed welding has been implemented in the past by controlling the weld current during short-circuiting [2]. Priority is given to the stability of the welding bead when short-circuiting occurs which decreases the occurrence of spatter. Using this method, researchers were able to weld 1m/min-2m/min. However, even though it was effective for the low current and were not transposed to the high current tests. Moreover, 1m/min-2m/min was not high enough in the real production. During the last decades the GTA welding process has become the major process for high quality welding [4]. It can be used for welding of almost all metals and alloys, and is particularly suited for single pass and autogeneous welding of thin material. On the basis of these, the new high speed welding control was expected to carry out by high speed GTA welding.

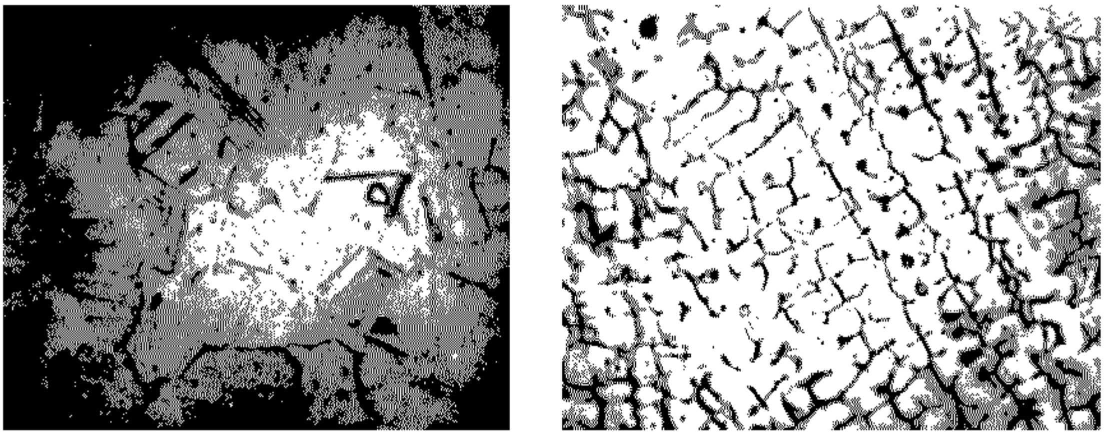
2. Experimental procedure

2.1 Materials and microstructures

The materials used in this investigation were plates (300×80×0.5mm) of Type 304 austenitic stainless steels; the chemical compositions are given in Table 1, and the microstructures of base materials and weld metal were given in Fig.1.

Table 1 **Chemical composition of Type 304 austenitic stainless steels**

Material	Element (wt%)						
Type 304	C	Si	Mn	P	S	Ni	Cr
	0.07	0.46	0.78	0.032	0.006	8.10	18.32



(a) Base material (b) Weld metal

Fig.1 Microstructure of Type304 stainless steel (×1000)

2.2 Welding

The appropriate welding parameters when full penetration occurred were studied first. All plates were cleaned prior to welding for removing grease, oil and contaminant by alcohol. Autogeneous welds were then carried out down the center of the plate with arc welding power supply. DCSP and pulsed current welding were carried out by varying the welding speed from 3m/min to 8m/min. The studied parameters were welding speed, welding current and pulse frequency. In DCSP welding, the currents were changed; in pulsed current welding, the welding was performed by altering the pulse frequency in accordance with the welding speed and welding current setting. Throughout the entire experimental, the electrode was a 2.38mm (3/32-in) diameter, tungsten electrode. Pure argon, at 15L/min, was the shielding gas throughout the study. Tip clearance was 2mm, and the base current was 60A when pulsed current welding was conducted. The weld bead outviews were given in Fig.2. After welding, sectioning, grinding, mounting, polishing and ethching were undertaken before observing the grain size by optical microscope.

2.3 Erichsen test and tensile test

After obtaining the optimum welding parameters, the specimens for Erichsen and tensile test were chosen from the ones of sound weld bead outviews and full penetration. Erichsen test was carried out according to KS B 0812-74 for measuring the ductility of weld joint. According to KS B 0802-83, tensile test was conducted to check the tensile strength and elongation of weld joint.

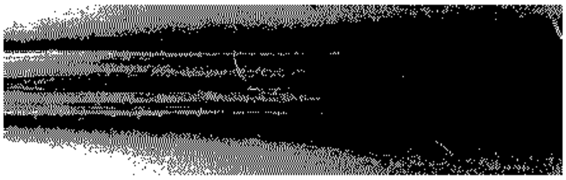
7 m /min, DCSP, 250A	7 m /min, Pulse, 240A, 500Hz
	
8 m /min, DCSP, 280A	8 m /min, Pulse, 270A, 500Hz
	

Fig.2 Weld bead outview of high speed GTA welding

3. Results and discussion

3.1 Establishing optimum welding parameters

The results of optimum welding parameters were presented in Table 2. The optimum welding current range and optimum frequency were obtained at each welding speed as seen from the table. This result shows us that autogeneous high speed GTA welding was welded satisfactorily for Type 304 stainless steels both in DCSP and pulsed GTA welding. It was also observed that at the lower speed of 3m/min and 4m/min, the welding could be carried out with lower frequency, such as 40Hz and 60Hz; however, as the welding speed increasing, the frequency must be increased to higher than 200Hz as seen in Table 2. Consequently, the optimum frequency existed in high speed pulsed current welding was found to be higher than 200Hz. Full penetration at the speed of 9 m/min and 10 m/min in DCSP welding was tried, but this trial couldn't get the full penetration weld due to limitations of the current controller, the maximum current obtained was 310A.

Table 2 Optimum welding parameters for high speed welding

Welding speed (m/min)	DCSP welding	Pulsed current welding	
	Welding current (A)	Welding current (A)	Pulse frequency (Hz)
3	110-130	115-125	60-500
4	140-150	140-150	40-500
5	160-180	160-175	100-500
6	210	200, 210	200-500
7	250,260	230,240	200-500
8	280,285	270	200-500

3.2Erichsen test

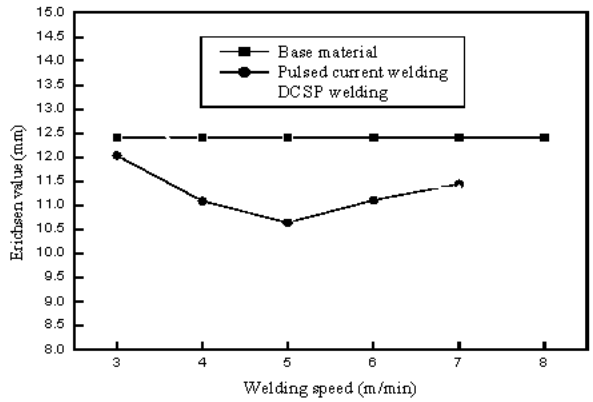
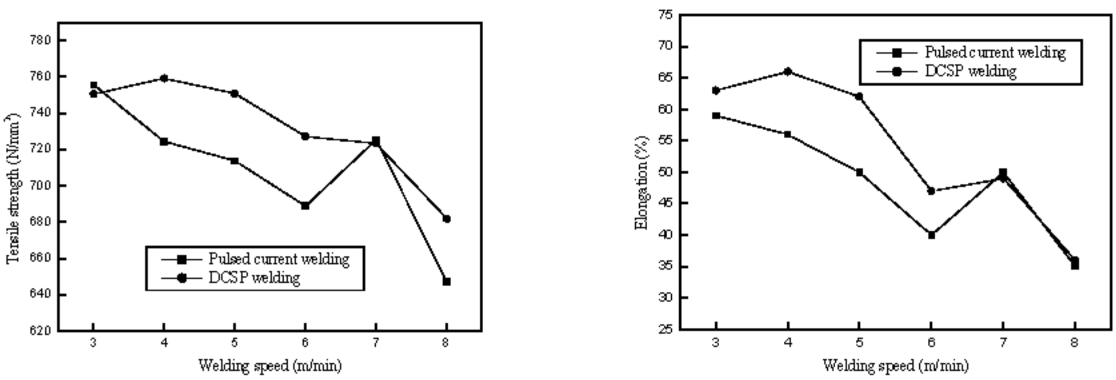


Fig.3 Effects of welding speed on Erichsen values and comparison of results with those of basematerial

The effects of welding speed on Erichsen values were given in Fig.3, which were in DCSP and pulsed current welding, respectively, increasing welding speed was found to decrease Erichsen values in DCSP and pulsed current welding from 3m/min to 5m/min. But, from 5m/min to 8m/min, there was not a significant difference in the erichsen results with increasing the welding speed in DCSP welding; the erichsen value has been a little increased with increasing the speed from 5m/min to 7m/min in pulsed current welding.

It was also observed that the comparisons of base material's erichsen value with DCSP and pulsed welding erichsen results were shown clearly. At the speed of 3m/min, the results of DCSP was higher than that of base material, and the ones of pulsed current welding was a little lower than that of base material. This will show similar performance to that of base metals. However, from 4m/min to 8m/min, the erichsen values were found to be lower than that of base material, whether in DCSP or in pulsed welding, that is, austenitic stainless steel welds have lower ductility than the corresponding base metals.

3.3 Tensile test

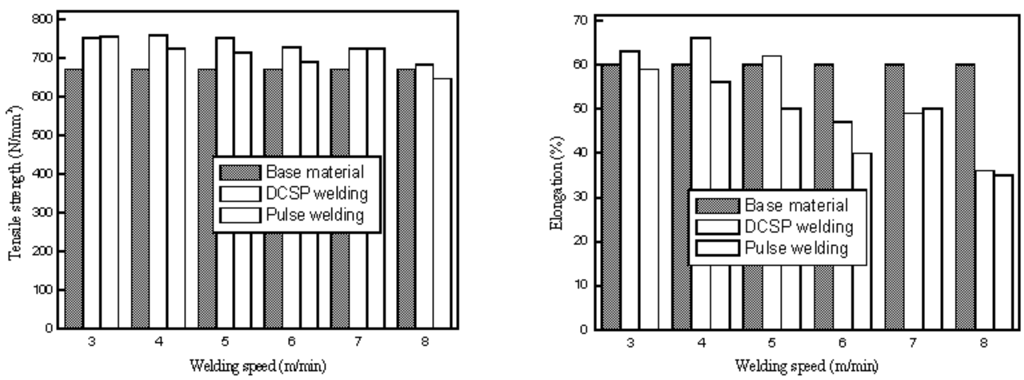


(a) Tensile strength (b) Elongation

Fig.4 Effects of welding speed on tensile test

Fig.4 were the effects of welding speed on tensile test, it was found that increasing the welding speed resulted in decreasing the tensile strengths and elongations both in DCSP and pulsed current welding. There was a liner relationship between the tensile strengths, elongations and welding speeds.

The comparison of tensile strength and elongation with that of base material was given in Fig.5 (a) and (b). Fig.5 (a) showed almost all of the tensile strengths were higher than that of base material from 3m/min to 7m/min except for 8m/min. In Fig.5 (b), at speed of 3m/min to 5 m/min, DCSP welding has higher values than that of base material; the results of other conditions were lower than that of base material. It was suggested that weld metals have excellent tensile strengths, and have good elongations in parts of high speed welding.



(a) Tensile strength (b) Elongation

Fig.5 Comparisons of tensile test result with that of base material

4. Conclusions

Based on the experimental results described in the foregoing, the following conclusions could be drawn:

1. High speed welding for thin-plate Type 304 had been satisfactorily welded using with autogenously GTA welding processes with the high speeds in both DCSP and pulse current welding. It was suggested that high speed GTA welding was possible with a noticeable improvement in welding speed up to 8m/min.
2. The tensile strengths and elongations were decreased with increasing the welding speeds.
3. The optimal frequency for sound weld would be 200Hz –500Hz in high speed pulsed current welding.
4. The weld joint has excellent tensile strength after high speed GTA welding.

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