

Abstract:

J-STAR[®] Welding is a new method for stabilizing the arc in CO₂ gas shielded arc welding. In the welding current under 200A, with that of conventional CO₂

method.

1. Introduction

Broadly speaking, there are three types of gas-shielded arc welding (MAG process): a mixed gas of Ar and CO₂, and CO₂ gas-shielded arc welding (C₂Gas). The type of CO₂ gas-shielded arc welding, a process developed in the 1960s, has been widely used in the world.

As the improvement of the welding work by arc stabilization is now regarded as the important task, "J-STAR Welding," a method developed to meet the requirements, has been successfully realized.

Table 1 Evaluation of effect of polarity/wire combinations on arc stability

Polarity	Welding wire	
	Si-Mn/Si-Mn-Ti	Si-Mn-Ti-REM
Electrode positive (EP)	Normal	Poor
Electrode negative (EN)	Poor	Excellent

Table 2 Chemical composition of steel welding wire

Table 3 Chemical composition and mechanical properties of deposited metal

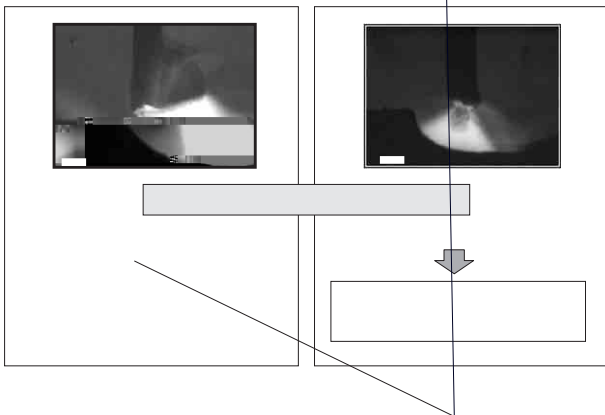


Fig. 1 Arc phenomena in CO₂ gas shielded arc welding

the droplet, which in turn causes spattering. Concretely, the spatter can be attributed to the scattering of the molten metal during the re-arc after the droplet and molten pool are short-circuited, or after the droplet itself is scattered under the arc force. The coarsening of the droplets compounds the spattering effect. Table 1 shows an evaluation of the stability of CO₂ gas-shielded arc welding when applying different combinations of polarity and wire. Figure 1 shows arc phenomena during two processes: first, in the conventional welding process in EP mode; second, in the JFE-developed welding process in EN mode. In each case, the welding is performed at a welding current of 300A with or without a REM-added wire. In the conventional EP welding, CO₂ gas-shielded arc welding with an Si-Mn/Si-Mn-Ti-based wire is less stable when no REM is added to the wire, compared to the case when REM is added. In the EN welding plus the use of REM-added wire, the arc generation point is substantially displaced and a coarser droplet is formed, resulting in an unstable arc and increased spatter. In EN welding, an ideal conical arc terminating in the wire tip is formed with the use of an Si-Mn/Si-Mn-Ti-based wire treated with an appropriate amount of REM, and the micro-droplets in the spray are smoothly transferred onto the base-metal sheet side without shaking from the tip.

2.2 J-STAR Welding Wire "KC-500"

Table 2 shows the chemical composition of the KC-500 wire for J-STAR Welding. KC-500, the same

material as YGW11 in JIS Z 3312, contains a trace amount of added REM.

Table 3 shows the results of a total deposited metal test of CO₂ gas-shielded arc welding with KC-500. The deposited metal obtained from KC-500 as a welding wire for 490N/mm² class steels has sufficient strength and toughness. Tests have proved that the addition of a trace amount of REM into the welding wire leads to good welding characteristics with J-STAR Welding Wire regardless of the strength level, and the ready development of welding wires for application to 540N/mm² class and 590N/mm² steels.

2.3 Welding Characteristics of J-STAR Welding

Tests have proved for the very first time that J-STAR Welding, a technique characterized by the formation of a stable conical arc terminating with the wire tip at its apex, realized a spray transfer optimal for droplet transfer in CO₂ gas-shielded arc welding. The advantages of this technique over conventional CO₂ gas-shielded arc welding are enumerated below.

- (1) The generated spatter is reduced to 1/10 that generated by the conventional technique.
- (2) No spatter adheres near the weld bead.
- (3) The generated fumes are reduced to 1/2 the level generated by the conventional technique.
- (4) The sound of the Arc is soft, with sound pressure reduced to 1/2 that of the conventional technique.

These advantages of J-STAR Welding are expected to improve working environments for welding lines and beautify the appearance of welded structures.

3. Welding of Steel Sheets

J-STAR Welding is capable of ultra-low-spatter welding through a process of spray transfer. A relatively

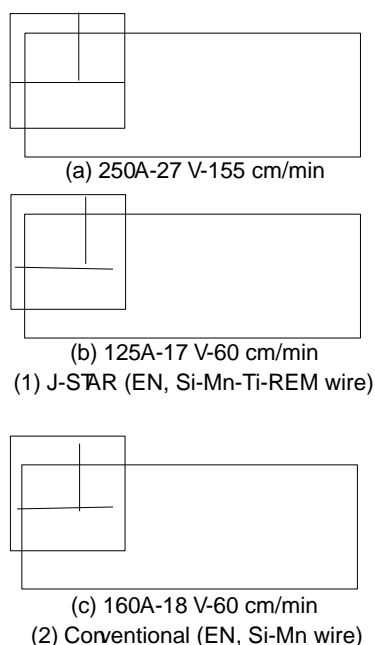


Fig. 2 Welding bead appearance and cross-sectional macroscopic organization

high current (250A or more) is required to obtain this effect. Figure 2 (a) shows the weld appearance and cross-sectional macrostructure of a T-joint welded joint with a plate thickness of 2mm. In spite of favorable performance features (a smooth weld bead shape with no spatter adherence) during high-speed welding at 155cm/min, the penetration exceeds 80% of the thickness and there appears to be a risk of burning with thicknesses of 1.6mm or less. Arc stabilization in a lower current region is required for the stable welding of steel sheets of lower thicknesses.

5 shows the relationship between welding current and the amount of generated spatter. The

3.1 Spatter Reduction by Waveform Control of the Welding Current

Figure 3 shows the waveform control of current in

49n0.235 0641.3750 6.5 10 499.5307 562 Tw 50.5 [25()]TJ he durbe of transfers was approximately doubled, as the current decreased gradually in the arc period.

Figure 4 shows variations in the waveform of current and voltage and the short-circuit transfer cycle. In conventional EP welding, no great difference is observed in the variations in the short-circuit transfer cycle ascribable to the difference in welding wire composition. In EN welding, however, the use of a wire with a trace amount of added REM reduced the variations in the short-circuit transfer cycle twofold and the application of optimum waveform control reduced the variations six-fold.

Figure

Fig. 3 Waveform control of welding current

