The Influence of Arc Length Correction on Welding in CMT Welding

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Abstract. The influence of arc length correction welding in CMT welding is studied through a single variable experiment, and it is found that the influence of arc length correction on welding process is nonlinear. The change of arc length correction not only affects the transition frequency and size of the melt during welding, but also affects the weld forming.

1. Introduction
The CMT technology is widely used in various welding fields [1]. A characteristic of CMT welding technology is that the droplet transfer is stable and has a good ability to bypass the bridge. The minimum thickness that can be welded is 0.3mm [2]. Welding heat input is lower than MIG / MAG [3]. Compared with the traditional MIG / MAG welding, the CMT welding method can precisely control the welding heat input through the rectification of the current and voltage waveforms and the welding wire retraction movement, and is suitable for welding between thin plates and dissimilar metals [4].

The CMT welding technology makes a single adjustment of the current and voltage through the wire feeding speed, so the wire feeding speed is equivalent to the current and voltage in the MAG welding. After adjusting the wire feeding speed, adjust the adjustment of arc length and advance the adjustment. In this paper, the effects of CMT welding arc length correction on welding have not been studied. In this paper, the influence of arc length correction on welding is analyzed through a single variable experiment.

2. The Experiment to Prepare
2.1. Laboratory Equipment
This experiment uses CMT welder, welding robot and high speed camera equipment.
2.2. The Experimental Materials
In this paper, the test plates for the welding experiment are 2mm and 301L austenitic stainless steel plates with a thickness of 350mm x 150mm. The wire used for welding is 1.0mm and 1.2mm. The specific chemical components are shown in Table 1.

| composition | C   | Si  | Mn  | P   | S   | Cr  | Ni  | N   | Cu  | Mo  | Fe  |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 301L        | 0.02| 0.43| 1.08| 0.04| 0.003| 17.7| 7.10| 0.2 | -   | -   | other |
| 308LSi      | 0.016| 0.85| 1.89| 0.017| 0.006| 19.5| 9.98| 0.01| 0.01| other |

3. The Effect of Arc Length Correction on Welding
The CMT welding machine can be controlled by the closed loop control circuit mechanical wire feed and arc ignition moment, thereby change the arc ignition wire when the distance between the end and plank, obtained for the arc length. In order to explore the correction of arc length on the welding process and weld forming and the effect of parameters on the remaining under the condition of constant change, in arc length revised order - 20%, 15%, 10%, 0, 5%, 10%, 15%, 10%. In this parameter, the welding process and the transverse section of the weld are observed to investigate the effect of arc length correction on the surface morphology and weld forming. Specific parameters are shown in Table 2.

| No. | Arc length correction | Welding speed | Wire feeding speed | Stem elongation |
|-----|-----------------------|---------------|-------------------|----------------|
| 1   | -20%                  | 20%           | 15%               | 10%            |
| 2   | -15%                  | 10%           | 5%                | 5%             |
| 3   | -10%                  | 0%            | 5%                | 10%            |
| 4   | -5%                   | 10%           | 0%                | 15%            |
| 5   | 0%                    | 5%            | 10%               | 20%            |
| 6   | 5%                    | 10%           | 15%               | 20%            |
| 7   | 10%                   | 15%           | 20%               | 20%            |
| 8   | 15%                   | 20%           | 20%               | 20%            |

3.1. The Effect of Arc Length Correction on Weld Molding
As shown in Fig. 3, in the wire feed speed, welding speed, the other parameters such as thrust modification, change the arc length correction parameters in the order: -20%, -15%, -10%, 5%, 0, 5%, 10%, 15%, 10%, 20%, get the weld cross section figure. From the depth of melting, the weld depth gradually decreases with the increase of the length of arc length. From the general appearance of the section, the weld section is changed from high to flat to high.
Figure 3. Different arc length correction parameters of the weld cross section

The weld depth and width of weld are quantitatively measured by the change of arc length correction parameter. The results are shown in the figure.

Figure 4. The effect of arc length repair on weld forming

It can be seen from Fig. 4 that the arc length is in the range of -20%~20%. With the increase of the positive arc length, the weld width and depth of weld will decrease after the increase of the arc length, and reach the maximum when the arc length is at -5%. At the same time the weld is almost constant.

The weld width and depth of the weld directly reflect the thermal input of the arc to the welds, and it increases within -20%~5% range, and decreases in the range of -5%~20%. Arc length fixed at 15%, the arc length is too short, lead to welding wire ends with distance is too short, in the case of the same wire feed speed arc duration is shorter, resulting in a loss of the heat input; When the arc length is
fixed at -10%~ 5%, the length of the solder end and the plate is longer than that at -15%, and the arc time is also longer, resulting in relatively high heat input. Arc length fixed at 10%, although the wire ends with distance longer arcing time is longer, but the arc of conical structure led to the longer the arc heat source function is scattered, the arc of weld heat input rather than arc length correction about 10% less.

3.2. The Effect of Arc Length Correction on Welding Process
Using high-speed camera to shoot the arc and molten pool in the welding process, the influence of the change of arc length on the welding process is observed. Frame rate is 1703 frames per second. Each group took 20 cycles, and the conversion of the transition period through the photo tensor was shown in Fig. 5.

It can be seen from the figure that, with the increase of the length of arc length, the transition frequency of molten drops first increases slightly and then decreases, reaching the maximum 77HZ at -10%, reaching the minimum of 52HZ at 20%. As the arc length increases, the arc gradually grows, so the distance between the end of the electrode and the substrate is larger, and the extended wire is longer. The time required for the same redraw and forward delivery speed is longer, resulting in the above phenomenon.

By observing the high-speed camera, the droplet size of the transition of each droplet transition is unchanged as shown in Fig. 6.
4. Analysis and Conclusion

When the arc length is fixed to -15%, the length of the wire end and the plate is short, and the time of arc is shorter and the heat input is lower. When the arc length is fixed at -10%~5%, the length of the wire end and the plate is longer than that of -15%, and the arc is longer and the heat input is relatively high. Arc length fixed at 10%, although the wire ends with distance is longer, arcing time longer, but as a result of arc inverted conical structure led to the longer the arc heat source function is scattered, the arc of weld heat input rather than arc length correction about 10% less. With the increase of arc length correction, the weld section is changed from flat to high, the depth of penetration and the melting width are increased first and then decreased, reaching the maximum at -5%. The transition frequency of molten drop is also increased first and then decreased, reaching the maximum at -10%, while the droplet size is basically unchanged.

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