Characterization of plasma arc piercing process for STS304

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1. Introduction

Plasma arc cutting is a cutting method in which the material to be cut is melted and removed by intensively projecting the arc heat source to the cutting part. In the case of cutting a thick plate, cutting efficiency increases when the molten pool blow out at the beginning of cutting. Therefore, it is good for cutting quality to start cutting at the end of the material to be cut. However, there are cases in which cutting cannot be started at the edge due to the complicated shape, and in this case, a plasma arc piercing process must be accompanied.

This research conducted the process characteristics analysis for plasma arc piercing process with different conditions

2. Research background and experiment setup

2.1 Double arcing phenomenon

Double arcing is an essential phenomenon that occurs during plasma arc cutting. In the case of a normal arc, an arc occurs in the arc path(A-C) connecting the electrode and the material as shown in Fig 1(a). In the case of an abnormal arc(double arcing), as shown if Fig 1(b), an arc is divided into an arc path(A-C) connecting the electrode and the material and the other arc path(A-B-C) connecting the electrode, the nozzle and the material. If a double arcing occurs, it not only adversely affects the cutting quality, but also damages the nozzle and electrode, preventing further cutting work [1].

The causes of double arcing are as follows. In plasma arc cutting, if the current value is higher than a certain limit, the shielding gas layer covering the arc in the nozzle confinement part is destroyed, resulting in a double arcing. Factors that cause double arcing include: increasing in the orifice, decreasing in the orifice diameter and increasing in the pressure inside the nozzle

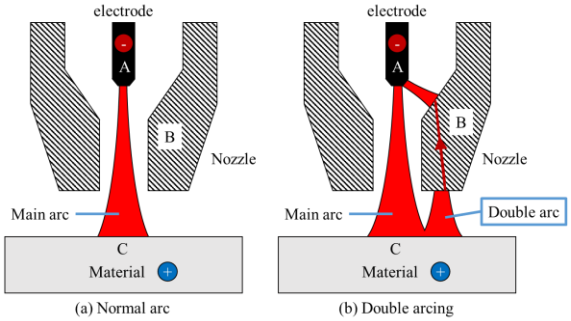


Fig. 1. Schematics of Normal arc (a) and Double arcing (b)

[2]. On the other hand, the dielectric film deposited on the nozzle orifice plays an important role in suppressing the occurrence of double arcing [3]. If double arcing occur, it not only adversely affects the cutting quality, but also damages the nozzle and electrode, making it impossible to perform further cutting work.

2.2 Experimental setup

As for the experiment method, as shown in Fig. 1, a high-speed camera, plasma arc cutting power source and data acquisition (current, voltage) measuring equipment were used. Plasma arc power source connected with a cathode and anode material (STS304 5mm, 10mm). Argon (Ar) and Nitrogen (N_2) gases are used in the piercing process. This research considered the experimental variables for nozzle distance between nozzle and materials (ND) and current value. The cutting signals (current, voltage) are synchronized with a high speed camera (1000 fps) to analyze the piercing process in detail.

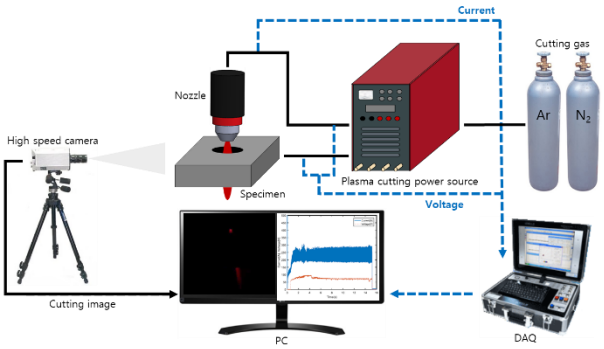


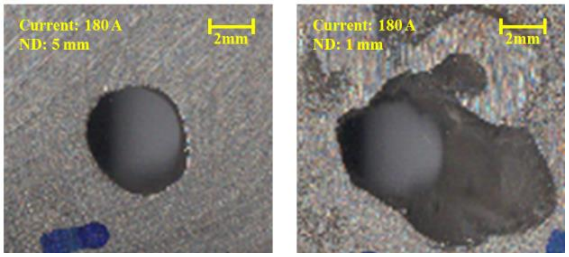
Fig. 2. Schematic of experimental method

3. Results and discussion

3.1 Results

In this study, the output variable according to the experimental variable is the piercing area of top and bottom surfaces and double arcing ratio (double arcing time/total piercing time). Fig. 3(a) and (b) shows the shape of piercing area for top surface. While 5mm ND brings smooth circle shape of piercing area in Fig. 3(a), 5mm ND bring the irregular shape of piercing in Fig. 3(b); therefore, it is found that small ND brings the bad quality.

Fig. 4 shows the measured voltage waveforms for different ND. It is found that small ND brings voltage drop and noise signals which is closely related with double arcing phenomenon.



(a) 5mm ND (b) 1mm ND

Fig. 3. Result of top surface plasma arc piercing

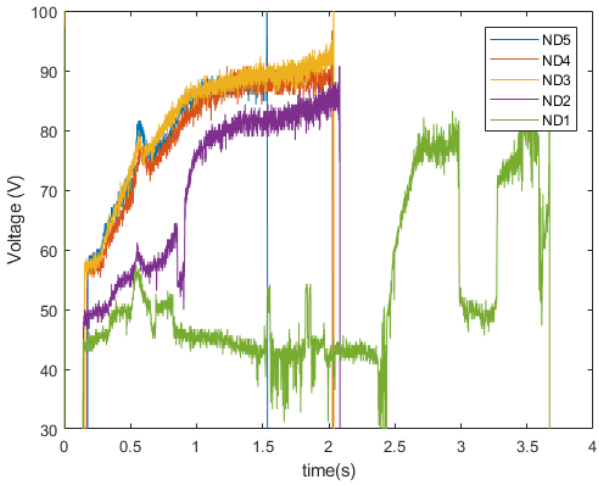


Fig. 4. Voltage waveforms for different ND

3.2 Discussion

This study tested the properties of plasma arc piercing. It was confirmed that when the ND was reduced, the double arc incidence increased and the piercing quality become bad.

Acknowledgement

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