Improvement of bead formation in plasma MIG welding process in pure argon atmosphere†

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KEY WORDS: (Plasma MIG welding) (Bead formation) (Pure argon atmosphere)

1. Introduction

In the plasma MIG welding process, because shielding gas is ionized in advance by a plasma electrode before supply, the shape of arc is easily controlled through electromagnetic force. Therefore the controllability of the arc is remarkably enhanced compared with that in a conventional MIG welding process. Because of this advantage, it can be employed for MIG welding in pure inert gas atmosphere. Although experimental results on plasma MIG welding in pure argon atmosphere were reported, further improvement of the welding process is required because it is difficult to form a bead stably due to lack of the wettability [1]. We have developed a new torch for plasma MIG welding which has a shorter distance between a contact tip and the top of a nozzle than that of the conventional torch. In this study, experimental results on welding of steel plates with V groove in pure argon atmosphere employing the new torch are discussed compared with those for the conventional torch.

2. Experimental procedure

The plasma torch for plasma MIG welding was improved to shorten the distance between a contact tip and the top of a nozzle than that of the conventional torch in order to increase heat flux to base metal for increasing wettability in pure argon atmosphere. **Figure 1** shows a schematic illustration of plasma MIG welding and **Fig. 2** shows a schematic illustration of the new torch. The distance between a contact tip and the top of a nozzle is shorter than that of the conventional torch by 5mm. **Figure 3** shows configuration of a V groove in the base metal. **Table 1** shows the experimental conditions of plasma MIG welding. Furthermore, a surface temperature of weld pool was also measured by a two color pyrometry method utilizing a measurement system consisting of a high speed video camera and a spectroscope as shown in **Fig. 4**.

Table 1 Experimental condition of plasma MIG welding

Flow rate of center gas [L/min]	Flow rate of plasma gas [L/min]	Flow rate of shielding gas [L/min]	Plasma current [A]	Wire feed speed [m/min]	Welding speed [cm/min]
5	10	10	50	12	40

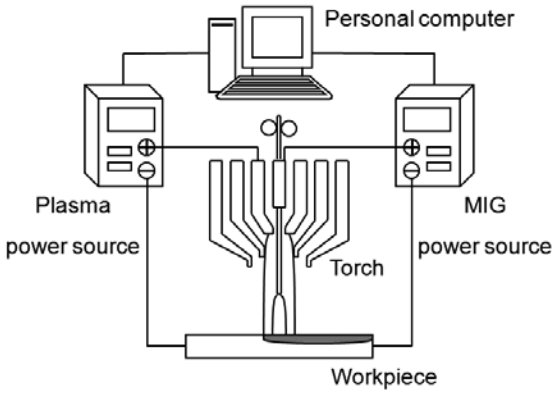

Fig. 1 Schematic illustration of Plasma MIG welding

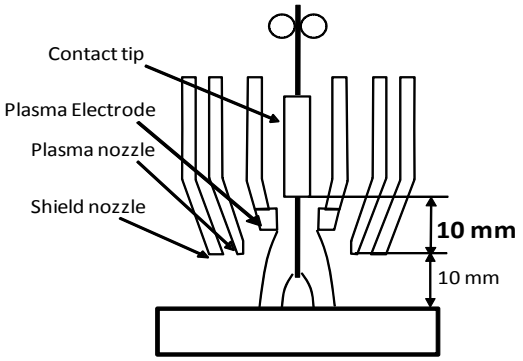

Fig. 2 Schematic illustration of anew torch

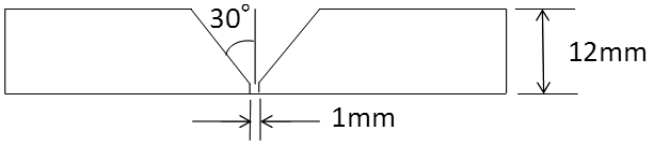

Fig. 3 Configuration of V groove

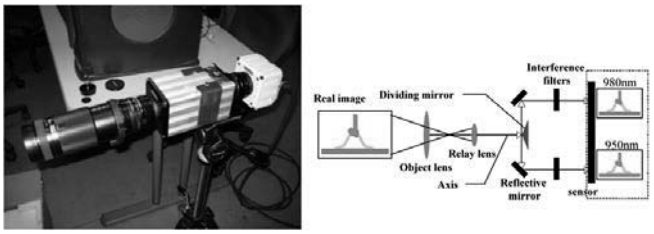

Fig. 4 Temperature measurement system by two color pyromety method

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3. Results and discussion

Figure 5 and **6** show bead appearance and cross section in the case of conventional torch and new torch, respectively. It was seen that bead formation was improved due to high wettability in the case of new torch. On the other hand, incomplete fusion occurred due to the small melting volume of the base metal and the bead surface became convex in the case of the conventional torch. It is considered that melting volume of the base metal increased because of the increased heat flux caused by high averaged MIG current.

Oxygen content in the base metal was also measured. It was found that although oxygen content in the case of the conventional torch was 58.1ppm, that of the new torch decreased to 41.3ppm. It is considered that the shielding effect from the surrounding air was enhanced due to stabilization of the arc in the case of new torch.

Furthermore, the surface temperature of the weld pool was measured by a two color pyrometry method. Consequently, it was found that the surface temperatures in both cases were approximately the same, which is the melting point of the base metal. For this reason, it was considered that the input powers in both cases were at nearly the same level. Although the averaged MIG current increased in the case of the new torch, MIG voltage and plasma voltage decreased due to the short distance between a contact tip and the top of a nozzle. In the case of the new torch, heat transport in the weld pool was enhanced because of strong convective flow in the weld pool caused by increased electromagnetic force. It is considered that this factor also contributed to high wettability and increase in the melting volume.

As a result, it was found that bead formation in the case of the new torch was improved preventing increase in heat input to the base metal.

4. Conclusions

It was found that by utilizing the new torch with shorter distance between a contact tip and the top of a nozzle comparing to that of the conventional torch, the bead formation was improved due to high wettability, because melting volume of the base metal increased due to increase in averaged MIG current and heat flux.

Acknowledgement

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References

[1] T. Kozuru et al: Preprints of the national meeting of J.W.S., 83 (2008) pp.330-331.

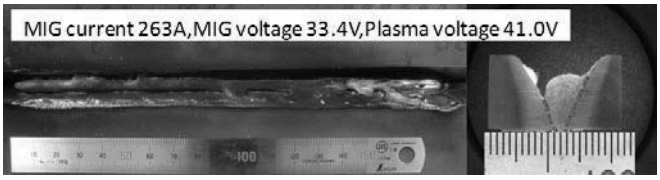

Fig. 5 Bead appearance and cross section in case of conventional torch

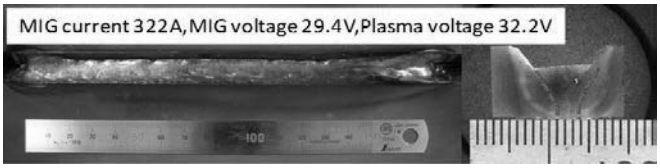

Fig. 6 Bead appearance and cross section in case of new torch

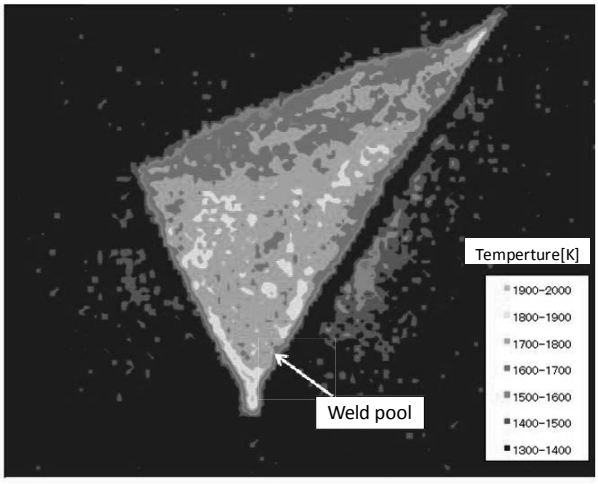

Fig. 7 Surface temperature distribution of weld pool in case of conventional torch

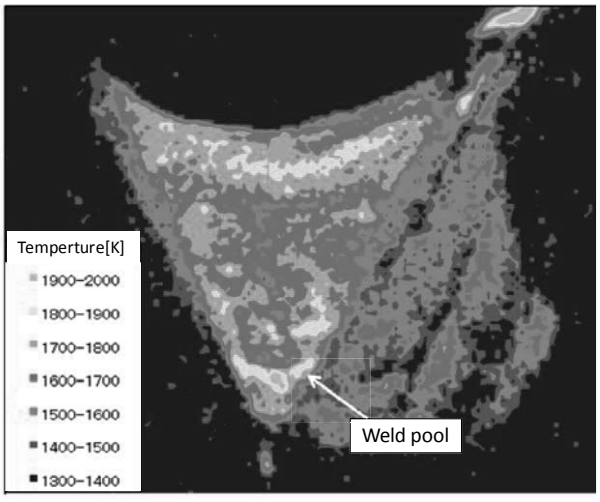

Fig. 8 Surface temperature distribution of weld pool in case of new torch