TITLE: A Study of the Characteristics of the Plasma Air Arc Used for Cutting Metals

A STUDY OF THE CHARACTERISTICS OF THE PLASMA AIR ARC USED FOR CUTTING METALS

Tudor Stanciu
Technical University of Moldova, Power Engineering Faculty
168, bd. Stefan cel Mare, Chisinău, 2004, Moldova
tel.(3732) 237617, FAX (3732) 234187,
e-mail : stanciu@mail.md

The plasma air arc used for cutting metals must ensure an important heat transfer efficiency to metal during the cutting. More important parameter that ensure a great efficiency of cutting metals is the integral pressure of the outgoing plasma arc. In this paper are given the results of the experimental study of the influence of parameters of plasma torch with the antivortex generator on the integral pressure.

1. Introduction

In the plasma arc torch with the copper electrode with the cavity for cutting metals the vortex transport of the gas is used to ensure the decreasing of the electric erosion of the copper electrode and the space stabilisation of the electric arc, particularly in the nozzle channel [1]. This is necessary to prevent the appearance of a double arc that is very dangerous for the nozzle.

But the integral pressure of the plasma flux, in which the tangential component of the velocity predominates over the axial velocity, quickly decreases from the exit of the nozzle [1]. At the same time the diameter of this flux significantly increases. As a result the velocity and the deep of cutting diminish but the width of cut increases.

To increase the integral pressure of the outgoing plasma flux, to decrease his diameter, as well as to increase a capacity of cut it is necessary to increase the axial component of the velocity.

To eliminate these disadvantages a new plasma arc torch with the antivortex generator was elaborated, the principle of the work and its application for cutting metals is given below.

2. Experimental set-up and method of study of the gas dynamic characteristics

The principle scheme of the plasma arc torch is shown in the figure 1. The particularity of this torch in comparison with the other torch [1] is the utilization of a metallic antivortex generator (4) installed between the vortex generator (3) and the nozzle (2). On the both sides of the antivortex generator the chambers (5) and (6) are created in which the gas arrives via the tangential channels (7). The channels on the both sides are in opposite directions. This is necessary to create two opposite vortices.

The vortex created in the chamber (6), having the opposite direction, will compensate partially or totally the gas vortex issues from the chamber (5) to the nozzle.

Consequently the tangential component of the velocity of the plasma flux decreases but the axial component increases on the issue of the nozzle. The vortex generator ensures the insulation between the cooper electrode with the cavity (1) and the nozzle (2).

The diagnostic includes the capacitor transducer (8) with a Pitot tube for measurement of the integral pressure, the camera with filters (9) to take pictures and the microphotometer (10) to study the radiation capacity and the radial distribution of the temperature of the outgoing plasma arc (11).

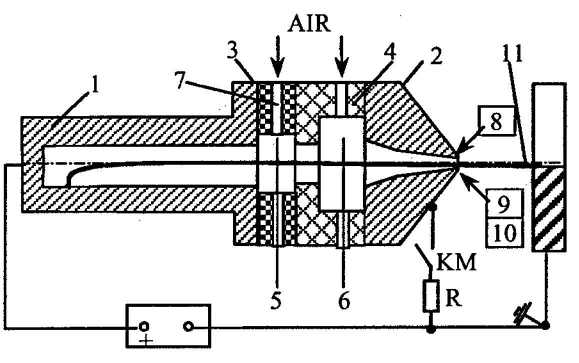

Figure 1. Experimental set-up.

3. Experimental results

The integral pressure of the outgoing plasma arc was measured at 3 to 35 mm from the outside of the nozzle for the values of the arcing current between 200 and 300 A and the values of the flow rate from 0.75 to 1.5 $g \cdot s^{-1}$. The diameters of the nozzle channel and the cavity of copper electrode were respectively 4 and 12 mm. The length of the nozzle channel and the cavity of the electrode were respectively 6 and 30 mm.

The distribution of integral pressure of the outgoing plasma arc for different values of the arcing current is shown in fig.2.

The integral pressure increases when increasing the arcing current. At the distance 3 mm from the nozzle the integral pressure increases from $3 \cdot 10^4$ to $6 \cdot 10^4$ $N \cdot m^{-2}$ when increasing the arcing current from 200 to 300 A (fig.3, curves 1 and 3).

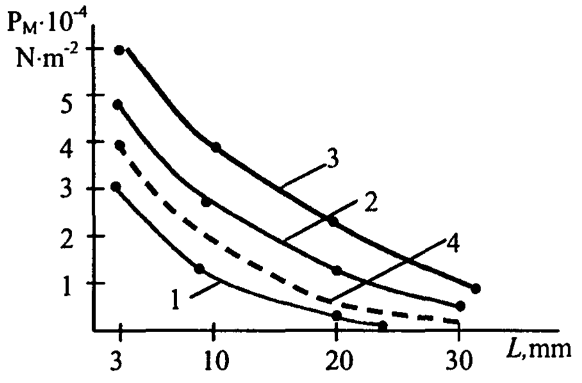

Fig.2. Distribution of integral pressure of the plasma arc torch with the antivortex generator for arcing current, A: 1 -200; 2 -250; 3 -300; 4 -250 (without antivortex generator).

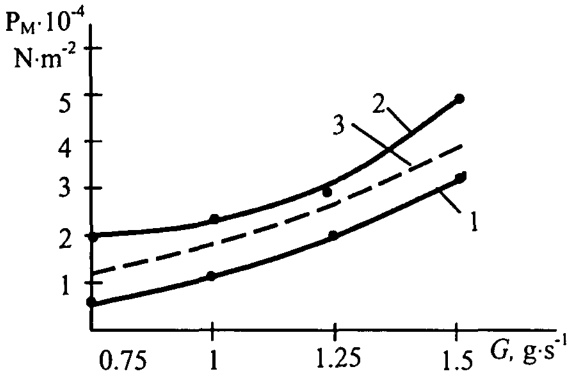

Fig.3. Correlation between the integral pressure and the flow rate for the plasma arc torch with the antivortex generator for arcing current, A: 1-200; 2-300; 3 –300 (without antivortex generator).

For the same parameters the integral pressure, for the arcing current 250 A, is approximately 40% greater than for the plasma arc torch without antivortex generator (curves 2 and 4 respectively).

The integral pressure increases about 1.4 ...1.6 times when increasing the flow rate G of the air from 0.75 to 1.5 $g \cdot s^{-1}$ (fig.3, curves 1,2).

4. Conclusions

The utilisation of the antivortex generator ensures the increasing of the integral pressure of the outgoing plasma arc approximately from 1.4 to 1.6 times. The diameter of the plasma flux at the distance 3 mm from the nozzle, for the same values of the current and the flow rate, is 1.15 time less than without antivortex generator. As a result a deep of cutting increases up to about 40% but a width of cut decreases to 15%.

5.Acknowledgements

The author would like to thank the Moldavian Ministry of Education for the financial support.

6.References

1. V. Pogora, I. Protsouc, T. Stanchou. Etude et optimisation de l'Installation de Coupage des Métaux par la Torche à plasma d'air. UIE Congress on electricity Applications, 1, Birmingham, UK (1996).