STUDIES OF CHARACTERISTICS OF THE LOW-TEMPERATURE DC PLASMA GENERATOR WITH DIRECT ARC

Gadzhiev M.Kh., Tyuftyaev A.S., Sargsyan M.A., Ilyichev M.V., Demirov N.A.

Joint Institute for High Temperatures, Russian Academy of Sciences, Moscow, Russia*,* [makhach@mail.ru](mailto:makhach@mail.ru)

In technological processes where temperatures of up to tens of thousands degrees are needed: welding, cutting, hardening, spraying, surfacing and remelting, alloying steel with nitrogen from arc plasma, producing steels with extremely low carbon content, cleaning metal from non-metallic inclusions, desulfurization and other refining processes , low-temperature plasma generators (LTPGs) are becoming more widely used. In recent years, there has been an interest in direct arc LTPG for efficiently doping steel with nitrogen during plasma arc remelting, which makes it possible to produce steel with a higher and more uniform nitrogen content [1] due to active absorption of nitrogen in the excited and atomic state by the liquid metal. All this contributes to the grinding of grains, increasing the strength properties, plasticity, total fracture work, wear resistance under dry friction conditions and reducing the corrosion rate [2]. To ensure such technology, it is necessary to have a reliable LTPG operating in a wide range of variations in the arc current and plasma-gas flow rate. In contrast to the LTPG with an indirect arc, the direct-arc plasma torch allows (taking into account thermal loads and erosion of the main parts of the LTPG) to obtain a much greater thermal power [2]. The basis of such a device was taken LTPG with an expanding channel of the output electrode, providing arc burning in a laminar flow at high gas velocity at the inlet, increasing efficiency, increasing stability and service life of the device in a wide range of variations in arc current and plasma gas flow rate [3]. The optimal parameters for the developed plasma torch were determined: the current strength is 100 ÷ 150 A, the plasma-forming nitrogen flow rate is ~0.23 g/s, the distance of steady arc burning is 60 ÷ 63 mm. The current-voltage characteristic study showed that with an increase in current in the range of 100 ÷ 200 A, there is a slight voltage drop from 105 to 98 V. To determine the plasma-chemical composition and parameters of the high-enthalpy plasma flow, spectral methods were used using an AvaSpec 2048 three-channel optical fiber spectrometer. The electron temperature Te was determined using the method of relative intensities of NI lines with differing excitation energies of the upper levels. The electron concentration ne can be obtained from the Stark half-width of the Balmer lines of hydrogen Hα and Hβ or using the lines with large Stark-effect constants [4]. Thus, the plasma flow of nitrogen with a flow rate of 0.23 g/s at an arc current strength of 100 A affects the surface of the melt with an electron temperature and concentration of Te ~ 0.6 eV (7000 K), ne ~ 1016 cm–3, respectively.

References

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