AC electric arcs burning in and outside of the discharge channels of high voltage three-phase plasma torches

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Characteristics of AC electric arcs, burning in the experimental three-phase generators of thermal plasma are investigated. Part of the arc column is burning outside the device discharge channel. Arc currents were up to 85 A (rms), voltage drops were up to 3.3 kV. Average temperature of working gas exceeded 3000 K and in discharge zone temperature was above 8000 K.

1. Introduction

High-efficiency thermal plasma generators having a long life time of operation are required for plasma-chemical applications [1-3]. Electric arc plasma torches allow energy transfer to the working gas with high efficiency. Direct current (DC) plasma torches have been used for a wide range of applications [2]. However, the thermal efficiency of DC plasma torches as a rule does not exceed 80%. The operating cost is an important parameter for industrial applications, so achieving of a high efficiency is an urgent task. Industrial application of alternating current (AC) plasma systems is considered in [3]. IEE RAS conducts research on physics of gas discharge aimed at obtaining of the new data required for the development of high-efficiency thermal plasma generators. Experimental models of high-voltage plasma generators have been created. The thermal efficiency of plasma torches reaches 95%, the resource of continuous operation is up to 2000 hours [4]. The work is devoted to investigation of electric arcs in a variety of environments, burning in the split cylindrical channels and closes outside of the housing.

2. Experimental setup, methods and results

Experiments were conducted at the work of arc systems in the open space at atmospheric pressure and when working on the plasma chemical reactor. In figure 1 shows the schematic of experimental devices and photo of the torch with arc, burning outside of the discharge channels. The form of the arc quickly changes due to surrounding conditions where flows from channels are mixing. Video recording was conducted at speed 4000 fps. Measurements of the arc current and voltage drop on various parts of the arc column were carried out using the high voltage measuring system and multi-channel signal acquisition. To conduct extensive experimentation with halogen-containing gases and vapors under atmospheric and elevated pressure (upto 5 bar) a diagnostic chamber with windows was developed.

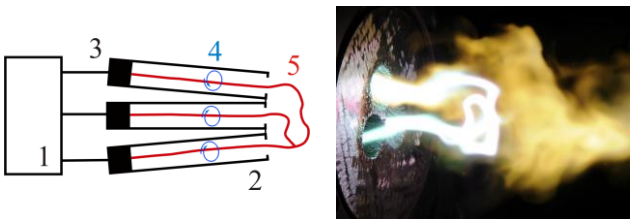

Fig. 1. Schematic of three-phase AC electric arc plasma system and photo of outside part of arc. 1 – power supply, 2 – cases, 3 – electrode, 4 – swirling gas flow, 5- arc.

Experimental studies of the high-voltage AC arcs, depending on the composition of the plasma-forming gas (air, CO_2, CH_4, steam and mixtures) and flowrate, parameters of the power source, influence of external conditions were carried out. Measurements of parameters of electric arcs with currents of 85 A (rms), the voltage drops to 3.3 kV (rms) are performed, dynamic characteristics are obtained. Average temperature of working gas exceeded 3000 K and in discharge zone temperature was above 8000 K.

3. Acknowledgements

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4. References

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