

Modelling of electric arc helium flow inside a profiling channel

Citation for published version (APA):

Lelevkin, V. M., Kulumbaev, E. B., Semenov, V. F., & Schram, D. C. (1996). Modelling of electric arc helium flow inside a profiling channel. In Lukac, Kslnar, & Skalny (Eds.), *ESCAMPIG 13 : 13th European Sectional Conference on the Atomic and Molecular Physics of Ionized Gases, Poprad, Slovakia, August 27-30, 1996 : Abstracts of invited lectures and contributed papers* (pp. 211-212). European Physical Society (EPS).

Document status and date:

Published: 01/01/1996

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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MODELLING OF ELECTRIC ARC HELIUM FLOW INSIDE A PROFILING CHANNEL

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Numerical calculation of acceleration and heating of a gas in profiling channel of electric arc plasma generator [2] (volume gas flow rate is $1000 \text{ cm}^3/\text{s}$, current of the arc is 100 A и 500 A , pressure on an output is 10 mbar) with account of dependence the transport coefficients on temperature and pressure was carried out on the basis of MHD equations [1].

The results have shown (Fig. 1-2) that in a narrow cylindrical part of a channel a fast heating and acceleration of a gas occurs. On initial section the temperature of plasma is $\sim 100 \text{ kK}$, the velocity of a flow is close to velocity of sound. A large role in acceleration of a gas plays the electromagnetic forces which, similarly to electromagnetic pump, suck up the flow of a cold gas inside the arc column heats up it and pumps it in axial direction.

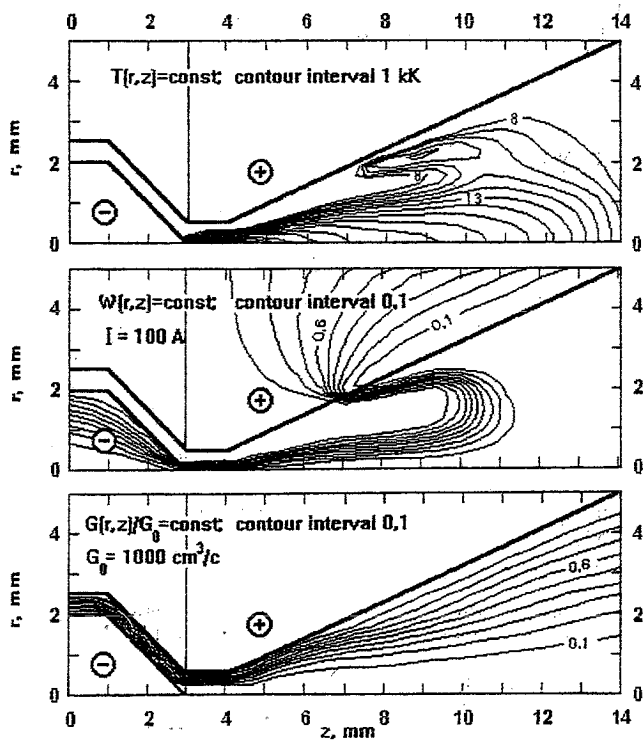


Fig. 1. Isotherm fields, electric current lines and gas flow lines on $I=100 \text{ A}$.

Expansion of the arc from a surface of the cathode leads to reduction of density of electrical current, intensity of electromagnetic field strength, pressure and temperature of plasma near axis region. The change of characteristics of the flow in axial direction is most strong displayed with increase of the current.

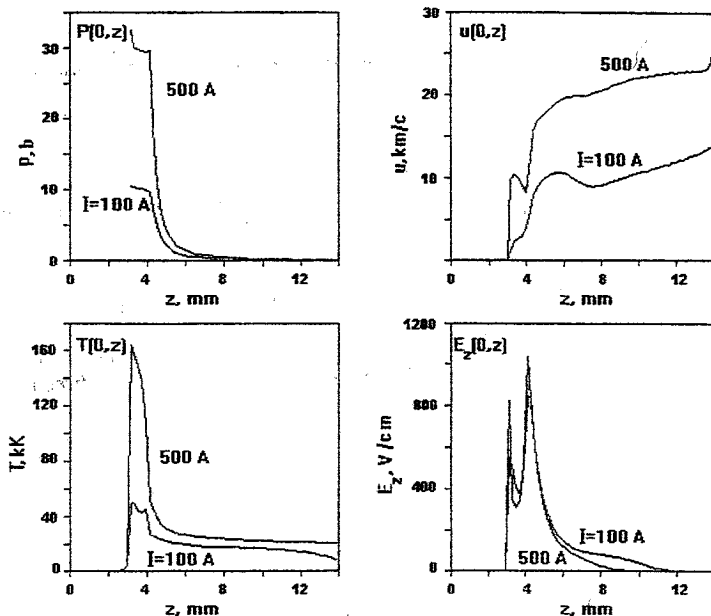


Fig. 2. Axial changes of pressure, velocity, temperature and an electric field strength on the axis of arc.

With approach to diffusor part of the channel, the arc column is narrowed, the density of electrical current, electromagnetic field strength and pressure near axis are increased. In diffusor anode, a further acceleration of plasma occurs, in result the flow with supersonic speed generates, the area of increased pressure is disappeared, temperature of plasma and intensity of axial flow decreases. The conductive area is carried out behind the cylindrical channel in diffusor of the anode, the stream lines of electrical current are distorted and closed on a conic surface of the anode. This causes the electromagnetic interaction of antiparallel currents. The position of binding of the arc to the anode at a change of the current from 100 A up to 500 A has not practically changed. Main mass of a gas flow along a surface of diffusor.

Acknowledgements. This work was partially supported under grant No. 94-2922 of INTAS, and partially supported under grant LG. HTECH. 951514 of NATO.

1. Lelevkin V.M., Otorbaev D.K., Schram D.C. Physics of Non - Equilibrium Plasmas Elsevier Science: North - Holland. - 1992. 418 p.
2. Pockl M., Stori H., Aumayr F. // J. Appl. Phys., 1995. Vol. 77, No. 7 P. 3575-3577.