Simulation of transient behavior of the free plasma jet

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The main purpose of this work was to develop a numerical model and to create a computation code for prediction of the transient regimes arising in the plasma jet due to various causes: wear of the cathode, instabilities in the powder supply, powder inconsistency, etc. We use an approach in which molecules, atoms, ions and electrons are represented as separate chemical species in the mixture. Interactions between the multiple species due to individual species diffusion fluxes and dissociation and ionization reactions are taken into account. Thermodynamic properties of the separate mixture fractions used in this study were calculated according to the collisional radiative equilibrium model. The thermodynamic and transport properties of the gas and plasma mixture are determined using the Wilke mixing rules. The non-MUSCL type TVD scheme is applied to solve the conservation equations of mass, momentum and energy for a compressible plasma flow. The positivity preserving FCT algorithm is used to solve the time-dependent continuity equations of chemical species and to predict the mixing of the plasma jet with the surrounding atmosphere. A numerical simulation of the Ar-H_2 plasma jet in cold N_2-O_2-Ar mixture at atmospheric pressure has been performed. The effect of short-term changes in velocity and temperature at the nozzle exit on the behavior of gasdynamic fields in the free plasma jet was investigated. The inlet fluctuations of these characteristics of $\pm 5\%$, $\pm 10\%$, and $\pm 20\%$ were considered. Results of numerical simulation demonstrate the origination and development of the transient flow. The important features of the dynamics of flow fields in axi-symmetrical geometry and transient times into the stationary regime are discussed. Simulations allow to perform a detailed investigation of the structure of transient flows in interaction with the plasma jet.