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Distribution of Dynamical and Energy Parameters in Axisymmetric Air Plasma Jet

Authors : Vitas Valinčius, Rolandas Uscila, Viktorija Grigaitienė, Žydrūnas Kavaliauskas, Romualdas Kėželis

Abstract : Determination of integral dynamical and energy characteristics of high-temperature gas flows is a very important task of gas-dynamic for hazardous substances destruction systems. They are also always necessary for the investigation of high-temperature turbulent flow dynamics, heat and mass transfer. It is well known that distribution of dynamical and thermal characteristics of high-temperature flows and jets is strongly related to heat flux variation over an imposed area of heating. As is visible from numerous experiments and theoretical considerations, the fundamental properties of an isothermal jet are well investigated. However, the establishment of regularities in high-temperature conditions meets certain specific behavior comparing with moderate-temperature jets and flows. Their structures have not been thoroughly studied yet, especially in the cases of plasma ambient. It is well known that the distribution of local plasma jet parameters in high temperature and isothermal jets and flows may significantly differ. High temperature axisymmetric air jet generated by atmospheric pressure DC arc plasma torch was investigated employing enthalpy probe 3.8•10-3 m of diameter. Distribution of velocities and temperatures were established in different cross-sections of the plasma jet outflowing from 42•10-3 m diameter pipe at the average mean velocity of 700 m•s-1, and averaged temperature of 4000 K. It has been found that gas heating fractionally influences shape and values of a dimensionless profile of velocity and temperature in the main zone of plasma jet and has a significant influence in the initial zone of the plasma jet. The width of the initial zone of the plasma jet has been found to be lesser than in the case of isothermal flow. The relation between dynamical thickness and turbulent number of Prandtl has been established along jet axis. Experimental results were generalized in dimensionless form. The presence of convective heating shows that heat transfer in a moving high-temperature jet also occurs due to heat transfer by moving particles of the jet. In this case, the intensity of convective heat transfer is proportional to the instantaneous value of the flow velocity at a given point in space. Consequently, the configuration of the temperature field in moving jets and flows essentially depends on the configuration of the velocity field.

Keywords : plasma jet, plasma torch, heat transfer, enthalpy probe, turbulent number of Prandtl
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