CALCULATION OF TRANSPORT PROPERTIES OF HELIUM BASED GAS MIXTURES IN APPLICATION TO EXPERIMENTAL DETERMINATION OF THE TEMPERATURE RECOVERY FACTOR

Kochurov D.S.,* Eletskiy I.A., Kotova E.S.

BMSTU, Moscow, Russia
**kochurov_ds@yahoo.com*

A great amount of experimental data for temperature recovery factor r [1] values is available for compressible air flows (Prandtl number $Pr \approx 0.7$), however, there is no such data in open sources for the cases of flows of binary helium He based gas mixtures with lower Pr values (from 0.2 up to 0.7). To carry out the experiments on determination of the r values, it is necessary to select or establish a reliable methodology for calculation of thermophysical and transport properties (and the Pr values) of the binary gas mixtures, and to verify this methodology against available experimental data for wide ranges of pressures and temperatures. The methodology can also be used in designing processes of gas-dynamic temperature stratification devices [2] as parts of space gas turbine energy systems [3], as well as other parts of such systems.

In this paper an analysis is being conducted of the known techniques of transport properties calculation (based on the intermolecular interaction potential parameters, quantum-mechanical ab initio calculations with known intermolecular interaction potentials, law of corresponding states, and empirical polynomials) of He based binary gas mixtures. The calculation results obtained with the techniques are compared against experimental data available in open sources for binary mixtures $He - Ar$, $He - N_2$, $He - Kr$, $He - Xe$ in the complete range of their composition and at pressures up to 10 MPa and temperatures up to 2000 K. Based on the results of the analysis a modified law-of-corresponding-states methodology is proposed with recent available quantum-mechanical calculations included. This work was financially supported by the Russian Science Foundation (RSF) under grant no. 14-19-00699.

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