Database construction of fundamental flows of a rarefied gas between two parallel plates

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Abstract

A binary mixture of rarefied gases between two parallel plates is considered. The Poiseuille flow, thermal transpiration (flow caused by a temperature gradient of the plates) and concentration-driven flow (flow caused by a gradient of concentration of the component species) are analyzed on the basis of the linearized model Boltzmann equation with the diffuse reflection boundary condition. The analyses are first performed for mixtures of virtual gases composed of the hard-sphere or Maxwell molecules and the results are compared with those of the original Boltzmann equation. Then, the analyses for noble gases (He e, He r and Ne r) are performed assuming more realistic molecular models (the inverse power-law potential and Lennard-Jones 12,6 models). By use of the results, flux databases covering the entire ranges of the Knudsen number and of the concentration and a wide range of the temperature are constructed. The databases are prepared for the use in the fluid-dynamic model for mixtures in a stationary nonisothermal microchannel derived in [S. Takata, H. Sugimoto, S. Kosuge, Eur. J. Mech. B/Fluids 26 (2007) 155], but can also be incorporated in the generalized Reynolds equation [S. Fukui, R. Kaneko, J. Tribol. 110 (1988) 253] in the gas film lubrication theory.