Effect of Shear Work on the Heat Transfer Characteristics of Gaseous Flows in Microchannels

The heat transfer and fluid flow characteristics of gaseous fluids through microdevices play an important role in various engineering and scientific applications including micro-pumps, cooling of electronic equipments, bio-chemical devices and micro-sensors. In microdevices, the micro length scale plays a vital role and affects the fluid flow and heat transfer characteristics significantly. In such cases, the hydraulic dimension of the device is of the same order compared to the mean free path of the molecules of flowing fluid. The fluid flow and heat transfer characteristics at microscale is different compared to the macro-scale because of the velocity slip and temperature jump at the wall and does not obey the classical continuum approach in the slip regime. Various parameters, namely, rarefaction, viscous dissipation, compressibility, property variation, thermal creep, shear work and axial conduction can affect either separately or simultaneously the fluid flow and heat transfer characteristics. Here, the effect of shear work at the solid boundaries is considered to analyze the heat transfer characteristics in the slip flow region for gaseous flow. Results show that neglecting shear work under predicts the Nusselt number.

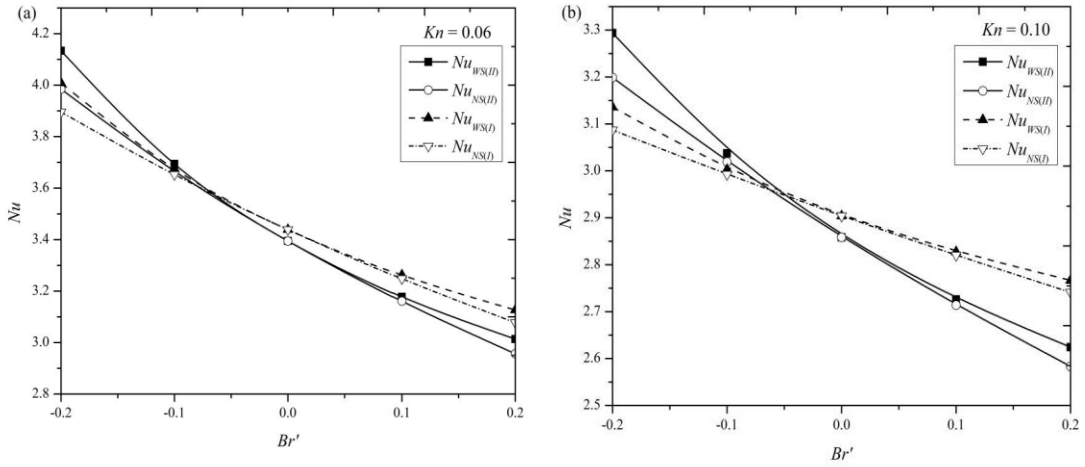

Fig.1: Variation of Nusselt number with Brinkman number for various Knudesn number for micro-pipe