# Simulation of gas flows in micro/nano systems using the Burnett equations

**Fubing Bao[1], Xia Yu[1], Jianzhong Lin[1,2]**

[1]Institute of Flow Measurement and Simulation, China Jiliang University, Hangzhou 310018 China

[2] Department of Mechanics, State Key Laboratory of Fluid Power Transmission and Control, Zhejiang University, Hangzhou 310027 China

E-mail: dingobao@zju.edu.cn

**Abstract**

The gaseous flow characteristics in micro/nano systems are studied using the Burnett equations. The Burnett equations are the second-order approximation of the Chapman–Enskog solution to the Boltzmann equation. This set of equation is appropriate to describe the rarefied gas flows. Velocity slip and temperature jump boundary conditions are applied on solid surface. Several techniques, including the usage of relaxation method on slip values and Burnett terms, are introduced to increase the stability of the Burnett equations. Hence, convergent results at Knudsen number up to 0.5 are achieved for the first time. The results of the Burnett equations are first verified using the corresponding experimental and the DSMC data. The Navier-Stokes and the Burnett equations give almost the same result when the flow is in slip regime ($Kn<0.01$). But when the flow is in transition regime ($0.1<Kn<0.5$), the results of Navier-Stokes equations deviate from DSMC data while those of Burnett equations still agree very well. The Burnett equations are then used to study the gaseous flows in micro/nano systems. The pressure driven plane Poiseuille and the backward-facing step flows, the flows through micro filters are then studied. Different inlet to outlet pressure ratios, size effects, shape effects and boundary conditions are analyzed. The competitive relations of rarefied and compressible effects in micro gas flows are discussed.