Unsteady State Gaseous Flow past a Square Confined in a Micro-channel

K. S. Shterev and S. K. Stefanov

Institute of Mechanics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Micro mechanical devices are rapidly emerging technology, where new potential applications are continuously being found. A simulation of internal and external gas flows in or around these devices is important for their design. The gas flows are characterized with areas of low speed flows (low Reynolds numbers). The flows can go from high speed supersonic to very low speed regimes down to the incompressible limit. This made the pressure based numerical methods very suitable to be used for calculation of this kind of gas flows. In this paper we present a short review of a finite volume method, developed by the authors, and demonstrate its application for calculation of some unsteady state gaseous flows. We study a flow past square-shaped particle confined in a micro-channel filled with a hard-sphere monatomic gas. The problem is solved using the finite volume method SIMPLE-TS (a modification of SIMPLE created by the authors). The flow motion is described on the basis of the Navier-Stokes-Fourier compressible equations with diffusion coefficients determined by the first approximation of the Chapman-Enskog theory for the low Knudsen numbers. First order velocity slip and temperature jump boundary conditions are used. The target of the research is to find the Knudsen number (corresponding Reynolds number) for which the microflow becomes unstable and some effects of flow separation and Karman vortices appear. The investigation is accomplished for subsonic (Mach number M=0.1) and supersonic (M=2.43) speeds, leading to different regimes of the gas microflow.

$\rightarrow \infty \diamond \infty \leftarrow$