Flow and heat transfer characteristics of turbulent gas flow in microtube with constant heat flux

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Abstract
Local friction factors for turbulent gas flows in circular microtubes with constant wall heat flux were obtained numerically. The numerical methodology is based on arbitrary - Lagrangian-Eulerian method to solve two-dimensional compressible momentum and energy equations. The Lam-Bremhorst's Low-Reynolds number turbulence model was employed to calculate eddy viscosity coefficient and turbulence energy. The simulations were performed for a wide flow range of Reynolds numbers and Mach numbers with different constant wall heat fluxes. The stagnation pressure was chosen in such a way that the outlet Mach number ranged from 0.07 to 1.0. Both Darcy friction factor and Fanning friction factor were locally obtained. The result shows that the obtained both friction factors were evaluated as a function of Reynolds number on the Moody chart. The values of Darcy friction factor differ from Blasius correlation due to the compressibility effects but the values of Fanning friction factor almost coincide with Blasius correlation. The wall heat flux varied from 100 to 10000 W/m2. The wall and bulk temperatures with positive heat flux are compared with those of incompressible flow. The result shows that the Nusselt number of turbulent gas flow is different from that of incompressible flow.