NUMERICAL IMPLEMENTATION OF LANGMUIR AND MAXWELL SLIP MODELS IN A MODAL DISCONTINUOUS GALERKIN METHOD

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ABSTRACT

Accurate numerical simulation of rarefied gases involves incorporation of robust algorithms and methods to study their flow characteristics. It is generally accepted that these gases deviate from the continuum descriptions at high Knudsen (Kn) numbers under the conditions: (1) if the mean free path between the collision of gas atoms increases to few orders of magnitude; or, (2) if the characteristics length of the domain reduces to few microns. To account for these deviations, various numerical methods have been developed, amongst which the extended Navier-Stokes-Fourier equations with slip and jump models are popular in the slip and transition regimes due to its computational efficiency.

In this work, we studied the Dirichlet type Langmuir and Neumann type Maxwell slip and jump models by implementing them into the in-house modal discontinuous Galerkin method code in multi-dimensional problems. The Langmuir model based on the physical adsorption isotherm considers the interfacial gas-surface molecule interaction. On the other hand, the Maxwell model based on the momentum accommodation considers the incidence and reflection processes for the gas-surface molecular interaction. The effects of these slip and jump models on the flow characteristics are investigated in detail using different test cases. Results clearly show that both these slip and jump models improve prediction of flow characteristics under slip and transition regimes in comparison with the conventional no-slip wall condition.

Figure 1. (a) Contour plot of the tangential velocity field, and (b) velocity profile plot measured along the radial distance for cylindrical Couette flow at Kn = 0.1 and Mach = 0.2.
REFERENCES


