Design of micro distribution systems consisting of long channels with arbitrary cross sections

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Abstract

Gas flows through long micro-channels of various cross sections have been extensively investigated over the years both numerically and experimentally. In various technological applications including microfluidics, these micro-channels are combined together in order to form a micro-channel network. Computational algorithms for solving gas pipe networks in the hydrodynamic regime are well developed. However, corresponding tools for solving networks consisting of micro-channels under any degree of gas rarefaction is very limited. Recently a kinetic algorithm has been developed to simulate gas distribution systems consisting of long circular channels under any vacuum conditions. In the present work this algorithm is generalized and extended into micro-channels of arbitrary cross-section etched by KOH in silicon (triangular and trapezoidal channels with acute angle of 54.74^o). Since a kinetic approach is implemented, the analysis is valid and the results are accurate in the whole range of the Knudsen number, while the involved computational effort is very small. This is achieved by successfully integrating the kinetic results for the corresponding single channels into the general solver for designing the gas pipe network. To demonstrate the feasibility of the approach two typical systems consisting of long rectangular and trapezoidal micro-channels are solved.