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An Expression for the Gas Mass Flow Rate through a Tube from Free-Molecular to Continuum Conditions J.R. TORCZYNSKI, M.A. GALLIS, Sandia National Laboratories — An expression for the steady isothermal gas mass flow rate through a long thin tube from free-molecular to continuum conditions with arbitrary accommodation is developed. This expression is based on the Navier-Stokes equations and a slip boundary condition developed with the philosophy that the mass flow rate is more important than the velocity field. Its form permits integration along the tube to obtain a closed-form expression. This expression contains three coefficients. The first and the second are known from free-molecular and near-continuum flow. The third is determined from Direct Simulation Monte Carlo (DSMC) simulations for flows in the transitional regime. A similar expression is developed for rectangular channels. These expressions agree well with recent experiments measuring mass flow rates through microscale tubes and channels. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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