Monte Carlo analysis of thermal transpiration effects in capacitance diaphragm gauges with helicoidal baffle system

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Abstract
The Capacitance Diaphragm Gauge (CDG) is one of the most widely used vacuum gauges in low and middle vacuum ranges. This device consists basically of a very thin ceramic or metal diaphragm which forms one of the electrodes of a capacitor. The pressure is determined by measuring the variation in the capacitance due to the deflection of the diaphragm caused by the pressure difference established across the membrane. In order to minimize zero drift, some CDGs are operated keeping the sensor at a higher temperature. This difference in the temperature between the sensor and the vacuum chamber makes the behaviour of the gauge non-linear due to thermal transpiration effects. This effect becomes more significant when we move from the transitional flow to the free molecular regime. Besides, CDGs may incorporate different baffle systems to avoid the condensation on the membrane or its contamination. In this work, the thermal transpiration effect on the behaviour of a rarefied gas and on the measurements in a CDG with a helicoidal baffle system is investigated by using the Direct Simulation Monte Carlo method (DSMC). The study covers the behaviour of the system under the whole range of rarefaction, from the continuum up to the free molecular limit and the results are compared with empirical results. Moreover, the influence of the boundary conditions on the thermal transpiration effects is investigated by using Maxwell boundary conditions.