Rarefied Gas Flow in Microtubes

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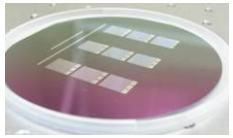
Objective

Develop a model that can predict mass flowrate and streamwise pressure distribution of rarefied gas flows in microtubes

Impact



Rarefied gas flow is important for:

- Gas dynamics in high vacuum environments – orbital science, vacuum pump, etc.
- Compressible gas flow in micro/nano-structures

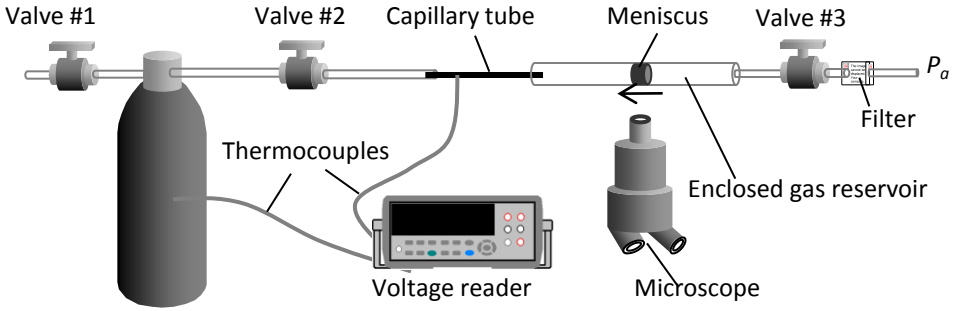
Approach

Mass flow rate

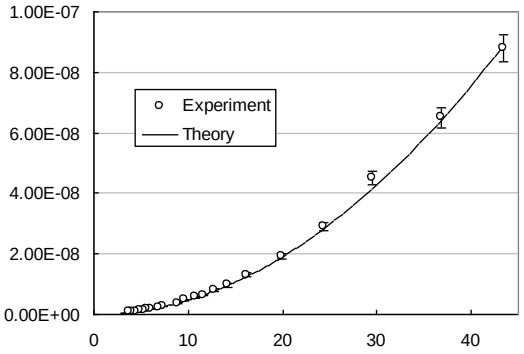
$$Q = \frac{\pi r_0^4 p_o^2}{2\mu_0 RTL}\left[\frac{P^2-1}{8} + \frac{Kn_o(4+\bar{\alpha})}{4}(P-1) + (b+\bar{\alpha})Kn_o^2 \ln\left(\frac{P-bKn_o}{1-bKn_o}\right)\right]$$

Pressure distribution

$$1-\bar{x} = \frac{\bar{p}^2 - 1 + 2Kn_o(4+\bar{\alpha}(\bar{p}))(\bar{p}-1) + 8(b+\bar{\alpha}(\bar{p}))Kn_o^2 \ln\left(\frac{\bar{p}-bKn_o}{1-bKn_o}\right)}{P^2 - 1 + 2Kn_o(4+\bar{\alpha}(P))(P-1) + 8(b+\bar{\alpha}(P))Kn_o^2 \ln\left(\frac{P-bKn_o}{1-bKn_o}\right)}$$



Results & Comparisons



Publications

Z. Yang and S. V. Garimella, "Rarefied Gas Flow in Microtubes at Different Inlet-Outlet Pressure Ratios," Physics of Fluids Vol. 21, 052005 (15 pp), 2009.