Transport Property of Gases from Acoustic Techniques: Recent Results

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We have developed two acoustic techniques, one for accurate measurement of the viscosity of gases and a second for accurate measurement of the Prandtl number of gases. With these techniques, the gas' properties are deduced from measurements of the frequency response of one or more acoustic modes of gas-filled acoustic resonators. A detailed acoustic model is required for each resonator. Absolute viscosity measurements with the Greenspan acoustic viscometer have an uncertainty less than 0.5% for argon and helium, and less than 1% for propane (see "Greenspan acoustic viscometer: Progress towards a standard for gases", Gillis, Mehl, and Moldover, 13th Symposium on Thermophysical Properties, 1997). Our second device is a modified cylindrical resonator in which the damping of the odd-numbered longitudinal modes is most sensitive to the gas' viscous diffusivity D_v, and the damping of the even-numbered modes is most sensitive to the gas' thermal diffusivity D_t. From measurements of both types of modes, we can accurately determine the gas' Prandtl number ($Pr = D_v / D_t = \eta C_p / \lambda$). The viscosity and Prandtl number of several gases have been measured with these techniques for temperatures between 250 and 400 K and pressures from 0.1 to 3 MPa. Gases studied include noble gas mixtures and semiconductor process gases. The results from these measurements and comparisons with values from the literature will be presented.