Comparison of Three Methods for Oscillating Flow Measurements in Cryocoolers

R. Snodgrass, V. Kotsubo, and J. Ullom, NIST, Boulder, CO and Univ. of Colorado, Boulder, CO

Determining acoustic power flows is critical for the experimental study of cryocoolers and requires measurements of both pressure and volume flow rate oscillations. Pressure is easily obtained using piezoresistive transducers, but measurement of flow rate requires more effort. One common method to measure oscillating flow in cryocoolers is by monitoring the pressure in a dead volume of known compliance. Unfortunately, this dead-volume method has multiple drawbacks: it can only measure flow at the entrance of terminating volumes, and it also assumes that the gas enters the volume at a constant temperature and then compresses and expands completely adiabatically. These assumptions are not usually checked and are sometimes violated. In this work we quantify the accuracy of the dead-volume method by comparing it to other flow-rate measurements. We have built two devices capable of measuring oscillating flows: a constant temperature anemometer (CTA) and a packed-screen device. The CTA measures flow by regulating a thin wire to a fixed temperature, and the packed-screen device measures the pressure difference generated across a screen bed. These two devices are calibrated against a high-accuracy, commercial Coriolis flow meter under steady flow conditions. Our goal with this work is to quantify the accuracy of the dead-volume flow measurement and to deliver practical advice for the cryocooler experimentalist on the pros and cons of several flow rate measurement techniques.