UNIVERSITY OF MARYLAND

THE BURGERS PROGRAM FOR FLUID DYNAMICS
THE FLUID DYNAMICS REVIEWS SEMINAR SERIES

NEW DYNAMIC STANDARDS FOR GAS FLOW USING ACOUSTIC RESONANCES AND RATE-OF-RISE TECHNIQUES

Thursday, November 14, 2024 | 3 pm

DeWalt Seminar Room
2164 Glenn L. Martin Hall

Speaker

DR. KEITH A. GILLIS

Physicist
Fluid Metrology Group, Sensor Science Division
National Institute of Standards and Technology

ABSTRACT

The Fluid Metrology Group at NIST is developing two new dynamic methods to measure gas flow as potential flow standards. One method measures gas flow exiting a large, unthermostated pressure vessel by tracking the time-dependent pressure and acoustic resonance frequency of an acoustic mode of the gas remaining in the vessel. The instantaneous pressure and resonance frequency, combined with the gas's equation of state and the known volume determine the mass of gas remaining in the vessel. The time rate-of-change of the mass is the mass flow. The expanded uncertainty (95 % confidence level) is 0.51 % of the flow. The other method measures the rate-of-rise of the pressure as gas flows into a thermostated collection vessel. This new system is designed for process gases used by the semiconductor industry and covers low flows from 1000 SCCM (standard cm3 per minute) down to 0.01 SCCM. We call this standard SLowFlowS (Semiconductor Low Flow Standard). Because many semiconductor process gases react with water, we locate the collection vessel, which consists of several long tubes welded together, in a thermostated air bath. We developed a thermodynamic model of the flow work and heat transfer to the environment to help determine the gas temperature in the collection vessel. The expanded uncertainty (95 % confidence level) of SLowFlowS is between 0.056 % and 0.098 % of the flow. Details of both methods and limitations will be discussed.

BIO

Dr. Gillis is a physicist in the Fluid Metrology Group of the Sensor Science Division at the National Institute of Standards and Technology in Gaithersburg, MD. He earned his PhD in Physics from the University of Illinois in Urbana-Champaign under Professor J.M. Mochel in 1987. His thesis work was studying third sound in thin superfluid helium films. He was awarded an IBM Postdoctoral Fellowship position at Penn State University in State College under Professor M.H.W. Chan, where he studied the heat capacity anomaly at the superfluid transition of helium in porous media. In 1989, Dr. Gillis joined the Fluid Science Group in the Thermophysics Division at NIST under Dr. Michael R. Moldover. Dr. Gillis measured the speed of sound in gaseous halogenated hydrocarbons to determine their thermodynamic properties. During his 35 years at NIST, Dr. Gillis learned how to use acoustic resonance techniques as a tool to measure thermophysical properties as well as flow of gases. Dr. Gillis developed acoustic viscometers to measure shear viscosity of gases as well as the bulk viscosity of xenon near its liquid-vapor critical point. In 2011, Dr. Gillis was made a Fellow of the Acoustical Society of America. He was awarded the Dept of Commerce Bronze Medal in 2003 and 2015, and he has two patents.

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