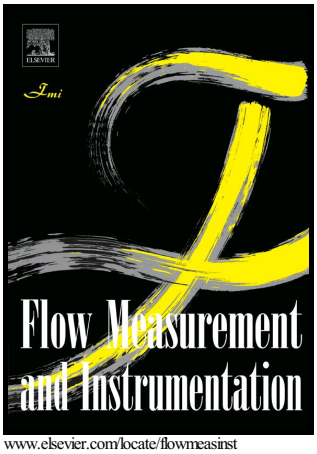
Uncertainty Estimates of Tracer Gas Dilution Flow Measurements in Large-Scale Exhaust Ducts

Rodney A. Bryant



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Rodney A. Bryant

National Institute of Standards and Technology, 100 Bureau Drive, MS 8662, Gaithersburg, MD 20899

rodney.bryant@nist.gov

Abstract

Accurate measurements of volume or mass flow in large conduits can be difficult to achieve due to non-ideal flow characteristics such as asymmetry of the velocity profile and off-axis flow components due to swirl. The tracer gas dilution method is independent of these and other non-ideal flow characteristics, but relies on the conservation and uniform mixing of the tracer. This study demonstrates the application of the tracer gas dilution method to measure the volume flow in a large-scale exhaust duct used for flue gas venting. The estimated measurement uncertainty was less than ±3.5% and considered contributions from instrumentation, degree of mixing, and repeatability of the method. This level of uncertainty demonstrates that the method can be applied as an independent comparison or quality check for other flow measurement methods in large exhaust ducts or flow conduits.

Keywords: *tracer gas dilution; volumetric flow; measurement uncertainty; constant-injection; photoacoustic gas detection; flow mixing; duct flow*

1. Introduction

Many methods exist to measure flow in ducts. Examples include pitot tube traverses, averaging pitot tubes, hot-wire anemometers, ultra-sonic flow meters, and critical flow orifices. The accuracy of these methods is limited when less-than-ideal flow characteristics exist, such as: asymmetric velocity distribution, off-axis flow components due to swirl, turbulence, very low flow, and flow reversal due to wakes or buoyancy. These methods also require the measurement of the cross-sectional area which can be a significant source of error if the shape and dimensions of the sampling section cannot be determined with sufficient accuracy. Tracer gas dilution is a