Application of Orifice Plates for Flow Calibrations at ATI Filter Test Facility

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ABSTRACT

Calibration plates consisting of multi-orifices are used in the U.S. DOE Filter Test Station to set the flow rates for HEPA filter certification testing. These plates were calibrated at the Colorado Engineering Experiment Station, Inc (CEESI) using NIST traceable measurements and ASME flow equations. The critical parameter in these calibration flow equations is the function used to approximate the discharge coefficient C_d. Graphs of C_d versus the air flow are approximated by straight lines and parabolas. The scatter of data about the C_d lines and curves represent the relative error (or precision) of the CESSI measurements and the use of the ASME flow equation. The relative error (precision) in the CEESI calibration data is obtained by comparing the measured ΔP values against the calculated ΔP values derived from the fitting equations. The calibration data for the two calibration plates used for the Q-76 filter tester and the high flow calibration plate (with 77 holes) for the Q-107 filter tester have maximum errors (uncertainties) of +/- 1.5%. The smaller flow calibration plates for the Q-107, (24 holes) and (12 holes), have maximum errors of +/- 2% and +/-4% respectively. Thus the flows at the DOE filter test station can at best be within this error margin.

The new calibration curves for the orifice plates were compared with the flow calibration curves used in the filter test station. The Q-76 plates with 24 holes and 8 holes had 4-7% and 2-6% higher flows respectively for the FTS calibration than with the values obtained with new flow calibration equations based on the CESSI data. Correction tables were prepared for these two plates to have agreement between the FTS values and the flow equations. Comparisons of the three plates for the Q-107 filter tester showed the FTS calibrations had 0.2-0.5% higher flows for the 77 hole plate and 1-2% lower flows for the 24 and 12 hole plates. Since the agreement between FTS calibrations and the new flow equations is less than the variability in the flow equations, no corrections are required for these plates.

Although the flow equations can be used to conduct filter tests under standard temperature and pressure conditions (SCFM), this was not done. Other studies show that filter tests conducted under actual flow conditions (ACFM) have less variability in pressure drop measurements than tests conducted under standard flow conditions (SCFM).