High Temperature Gas Flow Meter

Real-Time Measurement of Vehicle Exhaust Gas Flow

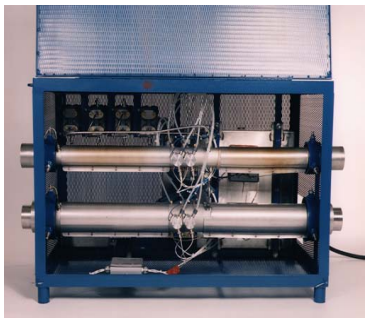
Total Vehicle Exhaust Gas Flow Measurement Was Not Available

To meet new, lower exhaust emissions standards, the auto industry needed a flow meter to measure the total volumetric exhaust gas flow from a vehicle. The industry testing methodology required small samples to be extracted from the exhaust at known flow rates. The emission constituents were measured in the small flow rates. To obtain the total constituents the plan was to ratio the values in the small samples to the total exhaust flow; thus, the need for the total gas flow. This flow design criteria posed significant measurement challenges. The most critical ones were a very wide flow range (150 to 1), high accuracy, fast time response (0.1 second), low pressure drop (<1.2 kPa), and function in an harsh environment (up to 650^{0}C, corrosives, and pulsating flow).

Development of gas flow meter

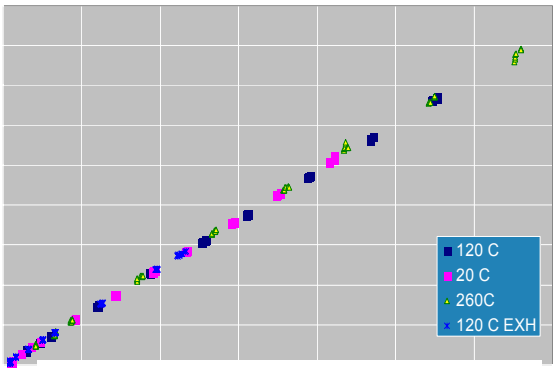
Several flow measurement technologies were considered before selecting the vortex shedding method. This method had proven functionality in similar fields, had no moving parts that enhanced reliability, caused minimal flow obstruction and pressure drop, had the potential to meet accuracy and rangeability requirements, and could be fabricated to address the high temperature constraint. A partnership was formed with an instrumentation manufacturer, an automobile company, and ORNL to develop, test, and eventually commercialize an exhaust gas flow meter. Ultrasonic transceivers were used to detect vortex shedding frequencies which are proportional to flow rate. The transceivers were offset from the high temperature gas by waveguides and air cooled. Advanced signal processing techniques were employed to extend the range of the flow meter and increase its accuracy. A prototype was completed, tested and calibrated by NIST, and commercialized.

Vehicle Exhaust Flow



Features

- Very wide flow range of > 150 to 1
- High accuracy, <2% of reading over entire flow range
- Very low pressure drop, < 1 kPa at highest flows
- Reliable, over two years of operation in exhaust gas
- Response time is less than 100 millisecond
- Capable of reading bi-directional flow
- Operates in pulsating conditions



NIST Calibration (1 to 130 lps) at Several Temperatures

Point of Contact:
James E. Hardy
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6004
Phone: 865-576-8670
FAX: 865-574-1249
E-mail: hardyje@ornl.gov