AN ALTERNATE PROCEDURE FOR STACK GAS VOLUMETRIC FLOW RATE DETERMINATION (TRACER GAS)

GUIDELINE

INTRODUCTION

This procedure was developed from Method 5H which measures woodstove particulate emissions from a stack where gas velocities are often low and hard to measure and exhibit significant temporal variations. This procedure is applicable for stacks one foot or less in diameter with gas flow between 5 and 15 fps as typical for woodstove stacks. It may also be used in stacks or ducts where there is no stratification of the tracer gas. The tracer gas used must not react with any stack gas constituent and no stack constituent which interferes with the analyzer measurement may be present.

1. Apparatus.
   a. Tracer Gas Injector System. To inject a known concentration of tracer gas into the stack. This system consists of a cylinder of tracer gas, a gas cylinder regulator, a stainless steel needle valve or a flow controller, a nonreactive (stainless steel or glass) rotameter, and an injection loop to disperse the tracer gas evenly in the stack.

   b. Tracer Gas Probe. A glass or stainless steel sampling probe.

   c. Gas Conditioning System. System suitable for delivering a cleaned sample to the analyzer consisting of a filter to remove particulate and a condenser capable of lowering the dew point of the sample gas to less than 5 °C (40 °F). A desiccant such as anhydrous calcium sulfate may be used to dry the sample gas. Desiccants which react or absorb tracer gas or stack gas may not be used, e.g. silica gel absorbs CO_2.

   d. Pump. An inert (i.e., stainless steel or Teflon heads) pump to deliver more than the total sample required by the manufacturer's specifications for the analyzer used to measure the downstream tracer gas concentration.

   e. Gas Analyzer. Any analyzer capable of measuring the tracer gas concentration in the range necessary at least every 10 minutes. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate shall be provided unless data is provided to show that the analyzer is insensitive to flow variations over the range encountered during the test. The gas analyzer needs to meet or exceed the following performance specifications:

Linearity	$\pm$ 1% of full scale
Calibration Error	$\leq$ 2% of span
Response Time	$\leq$ 10 seconds
Zero Drift(24 hour)	$\leq$ 2% of full scale
Span Drift(24 hour)	$\leq$ 2% of full scale
Resolution	$\leq$ 0.5% of span

f. Recorder (optional). To provide a permanent record of the analyzer output.

2. Reagents.
   a. Tracer Gas. Sulfur Hexafluoride in an appropriate concentration for accurate analyzer measurement or pure Sulfur Dioxide as used in Method 5H. The gas used must be nonreactive with the stack effluent and give minimal (< 3%) interference to measurement by the gas analyzer.

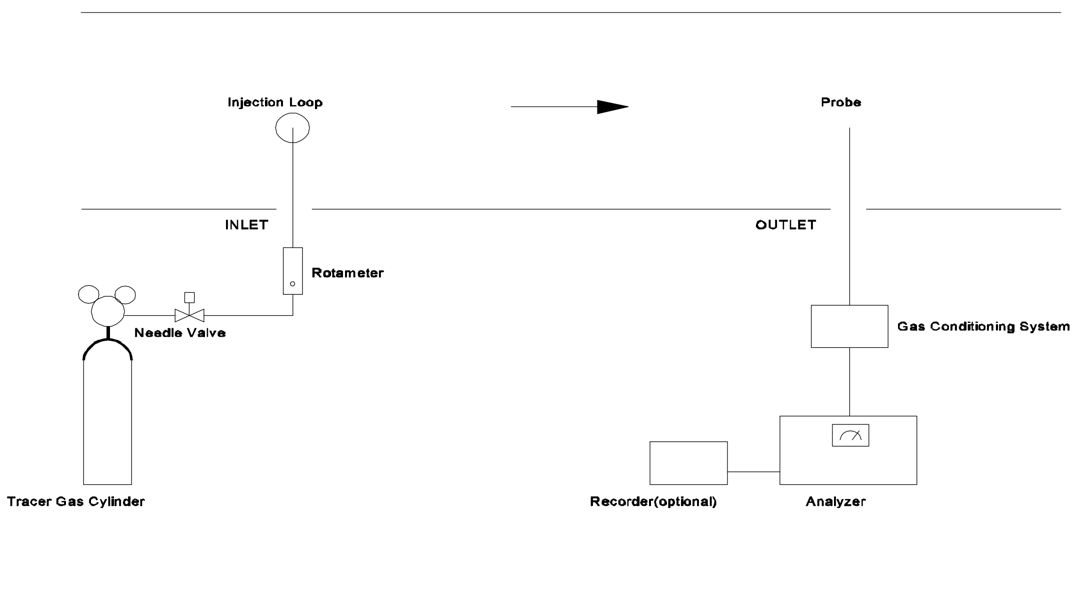
3. Procedure. Select upstream and downstream locations in the stack or duct for introducing the tracer gas and delivering the sampled gas to the analyzer. The inlet location should be 8 or more duct diameters beyond any upstream flow disturbance. The outlet should be 8 or more undisturbed duct diameters from the inlet and 2 or more duct diameters from the duct exit. After installing the apparatus, meter a known concentration of the tracer gas into the stack at the inlet location. Use the gas sample probe and analyzer to show that no stratification of the tracer gas is found in the stack at the measurement location. Monitor the tracer gas concentration from the outlet location and record the concentration at 10-minute intervals or more often at the option of the tester. A minimum of three measured intervals is recommended to determine the stack gas volumetric flow rate. Other statistical procedures may be applied for complete flow characterization and additional QA/QC.

4. Calculations. Use the following calculation to determine the stack gas volumetric flow rate.

$$Q_o = \frac{Q_i \times C_i}{C_o}$$

Where Q_o = Gas Volumetric Flow Rate at outlet, CFM (L/Min)
Q_i = Gas Volumetric Flow Rate at inlet, CFM (L/Min)
C_i = Tracer Gas Concentration at inlet, ppmv
C_o = Tracer Gas Concentration at outlet, ppmv

NOTE: This gives Q for a single instant only. Repeated multiple determinations are needed to track temporal variations. Very small variations in Q_i, C_i, or C_o may give very large variations in Q_o.



Equipment Schematic