InfraRan Specific Vapor Analyzer for Testing Fume Hood Flow Dynamics Using SF6 as a Tracer Gas

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Introduction

A safe laboratory environment requires an effective method for clearing toxic material from fume hoods. Since all handling of toxic materials is completed in these hoods, it is critical to have a procedure to evaluate their operation to assure adequate protection for laboratory workers. The InfraRan Specific Vapor Analyzer, factory calibrated for SF_6, is an ideal instrument for measuring fume hood efficiency in accordance with ASHRAE and other standards. Manufacturers identify the flow dynamics (factors that affect air flow in the hood and performance with air) using the ratings AM (as manufactured), AI (as installed), and AU (as used). A fume hood evaluation conducted under its operational environment is critical, as these tests will indicate any installation shortcomings as well as direct workers in proper laboratory hood techniques.

Methodology

The most commonly referenced test procedure for determining SF_6 at the face of hood is ASHRAE- 110, “Method Of Testing Performance of Laboratory Fume Hood” (American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.)

The condensed test method is as follows:

- Apply power to detector instrument and allow enough time to warm up to a stable operating condition according to manufacturer’s instructions.
- Select a release rate for the gas in accordance with hood purchasing documents or other specifications. The ASHRAE Standard rate of 4 L/min. is normally specified by most manufacturers.
- Install the SF_6 injector at three positions inside the hood. The positions are right, left, and center – 15 cm from the face of the hood. The left and right positions are 300 cm from the side of the hood.
- Place a mannequin which is 67 inches tall, 56 inches, +/- 1 inch, tall and 16 inches (+/- 1 inch) wide from shoulders at the face of the hood and place the sampling probe at the mouth of the mannequin.
- Turn on the gas valve and record data for ten minutes.
- Close the gas valve and move the gas injector to another position.

After the data has been collected, give the hood a rating that reflects the maximum of the three average values for the three test positions. It should be noted that this is the most commonly cited method. Various alternative methods are being successfully used with multiple types of diffusion injection methods, as well as without a mannequin.

Detector System Requirements

The detector instrument shall be a continuously reading instrument specific for tracer gas. The range of detector should be from at least 0.01 ppm to 100 ppm, accuracy of the instrument should be +/- 10% above 0.1 ppm and +/- 25% between 0.01 to 0.1 ppm. The response time shall not exceed 10 seconds for 90% indication. The instrument shall not exhaust more than 50 Lpm, The specifications of a standard InfraRan Specific Vapor Analyzer, factory calibrated for SF_6, (Part No. 405-2000-1017) meets the requirements for accuracy and response time. The standard range of 0 – 10 ppm is suitable with modern practice in fume hood testing that minimizes the amount of SF_6 released to the atmosphere.

Performance Rating

A series of numbers and letters consisting of the letters AM, AI, or AU, and a two- or three-digit number.

AM yyy AI yyy AU yyy

Where AM identifies an "as manufactured' test, AI identifies an "as installed' test, AU identifies an "as used" test, and yyy is the control level of tracer gas established by the test. A test rating of AU 0.5, for example, would indicate that the hood controls leakage into the laboratory to 0.5 ppm at the mannequin's sensing point with the tracer specified standard release rate of 4.0 Lpm (70 mL/s).

The AU "as used" rating is considered as the operational test value. This rating reflects the hood's control of releases when the hood is configured with normal equipment used in the laboratory hood environment. Field testing in a normal use situation is the preferred configuration for testing fume hood performance. External factors such as air supply to the room, personnel traffic, cross drafts, and internal factors such as configurations, chemical emissions, and operator work practices become factors affecting the fume hood's performance.

Conclusion

There is a definite need to monitor fume hood leakage rate using an in situ method that gives immediate feed back for educational and safety purposes. Any fume hood testing method or procedure, in order to be effective, must have an analyzer that is simple to operate, able to monitor accurate levels of tracer gas, log and store data. The InfraRan Specific Vapor Analyzer meets all the necessary criteria for accurate data reporting with a detection limit that enables you to report leakage level to 0.01% with exhaust volume about 1000 CFM, and a SF_6 release rate of 4.0 L/min.

InfraRan Specifications

Power Requirements (Battery Charger – External Operating Supply)	**100 – 250V AC 50/60 Hz**
Battery Pack Rechargable, Nickel Metal Hydride	**12V, 9 Amp-hr capacity**
Dimensions cm (inches)	**38.1 cm(15") x 18.5 cm(7.3") x 19.1 cm(7.5")**
Weight kg (lb)	**8.2 kg (18 lb)**
Enclosure	**High Impact Polymer**
Type	**Single Beam Infrared Spectrophotometer**
Optics	**Cell: Polished aluminum Tube Photometer: Fixed Band Pass Filter – Pyroelectric Detector**
Cell Pathlength	**6 meters**
Sample Cell Volume	**18.1 cm^3**
Sample Flow	**1 L/min**
Gas Purge	**5 cell volumes for 99% gas exchange**
Measurement Cycle	**Display updated every 1.5 sec**
Source	**Pulsed thin-film element**
Communications Data Port	**USB & RS-232 for connection with PC**
Concentration Alarm	**Two-level settable audible alarm**
Outputs	**Analog for use with integrated ventilation software packages. 8 bit digital to analog converter gives 0.01 ppm steps for 0 - 2 ppm range** **Digital for real-time ASCII output of current data. Download of data previously logged with InfraRan logging function.**
Display	**Vacuum Fluorescent Display**

References:
1) ASHRAE Standard 110 Method Of Testing Performance Of Fume Hoods
2) Laboratory Hood Studies W.G. Mikell and L.R. Hobbs, E.I. Dupont & Co. Wilmington, DE