RESPONSE-TIME ISSUES: VAV FUME HOODS

APPLICATION NOTE LC-101

Introduction

Fume hoods are used by pharmaceutical companies, universities, industrial companies and government agencies as safety devices. Since the early 1980's, these organizations have had the option of installing Variable Air Volume (VAV) fume hood controllers. VAV hood controllers provide added safety by maintaining a constant face velocity at all sash openings and also provide energy savings by minimizing the volume of exhausted air.

One issue that must be considered when specifying VAV controls is speed of response. The controller and associated exhaust system components must be able to respond to sash movements and other changing conditions with sufficient speed so that potentially hazardous fumes within the hood cannot escape.

An Industry Standard Definition of Response Time

The American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) has published a standard titled BSR/ASHRAE 110-1985R Method of Testing Performance of Laboratory Fume Hoods. This standard is currently (June 1994) in the proposal stage but is expected to be released with few changes. The standard contains methodologies for measuring hood performance and face velocity, as well as VAV hood response time. Hood performance is defined as the hood's ability to contain a tracer gas. For the purposes of this discussion, we will use the term containment to mean the same as hood performance. Also, for simplicity, we will refer to the BSR/ASHRAE 110-1985R standard as ASHRAE 110.

The proposed ASHRAE 110 definition of response time for VAV hoods requires the measurement to start when the sash begins to move and end when the face velocity is restored and maintained to within 10 percent of the design face velocity.

Performance of TSI Controls

We tested a TSI Model 8650 SUREFLOW™ Face Velocity Controller by carefully following the ASHRAE 110 procedure. The face velocity set point or "design face velocity" was 100 feet per minute and the sash was opened at the specified rate of 1.5 feet per second.

This test was performed on a commercially available 4-foot hood with a vertical sash (Figure 1). Air flow was controlled using an actuator driven damper in a manifold exhaust system. This configuration had a 3.1 second response time. Other types and sizes of fume hoods with different configurations may perform differently. For example, tests TSI ran on an 8-foot hood with a vertical sash yielded a 2.7 second response.

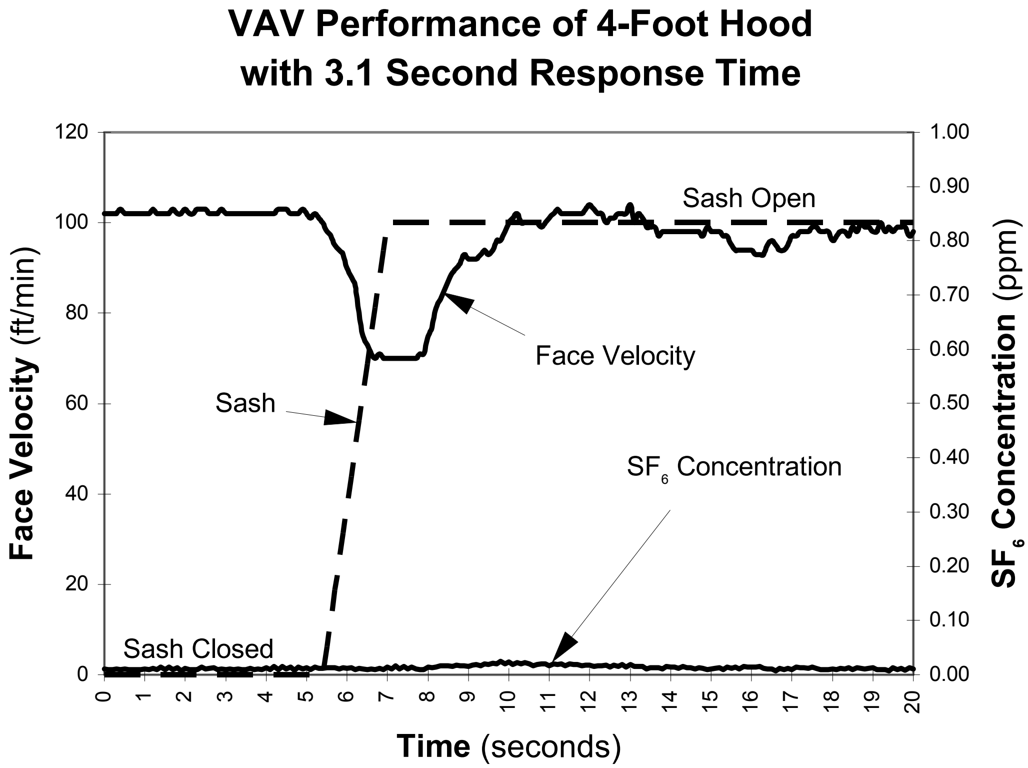

Figure 1.

Alternate Definitions of Response-Time

Some manufacturers of fume hood controllers have created their own definition of VAV response time. For example:

The time period from when the sash passes 90 percent of final position to when the exhaust volume reaches 90 percent of its final value without undue oscillations.

This perplexing definition yields very fast response times on the order of one second. For example, using this definition of VAV response time for a TSI Model 8650 SUREFLOW ™ Face Velocity Controller results in an apparent response time value of 0.8 seconds (Figure 2). TSI does not recommend using this definition of VAV response time because the starting point is not when the sash begins moving, the sash speed is not defined, and the stopping point does not relate to the parameter of interest (face velocity). The industry standard definition as stated in ASHRAE 110 is the proper definition to use.

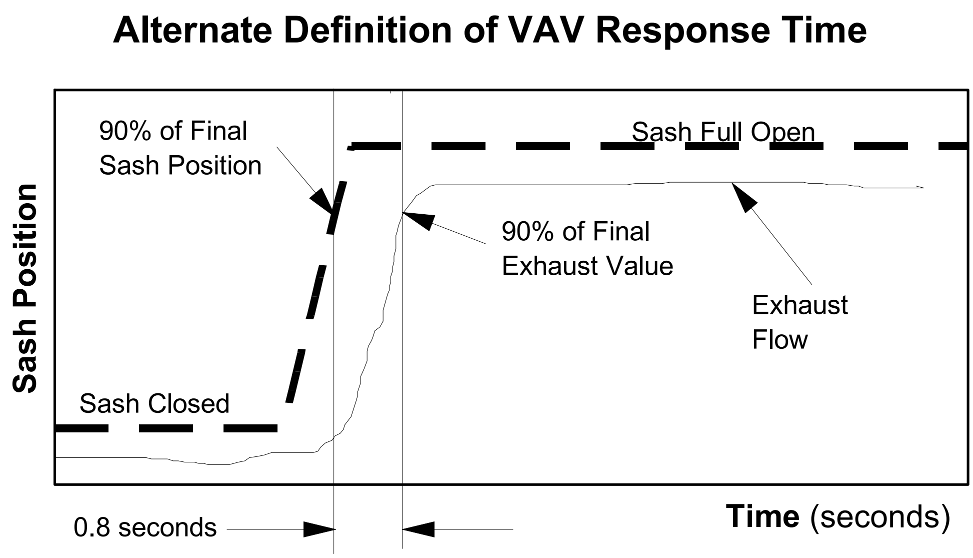

Figure 2: Alternate definition yields misleadingly fast response time measurements.

How Fast Does VAV Response Time Need to Be?

To determine the required response time you must address the issue of containment. Containment is the ability of a fume hood to contain hazardous fumes so that none is allowed to escape into the lab.

ASHRAE 110 contains an explicit test procedure for determining hood performance with regard to containment. We followed this test protocol precisely at slower and slower VAV response times to find the point where containment was compromised. The full test report is available from TSI.

For the 4-foot hood, containment was maintained until the response time reached values greater than 10.1 seconds. A response time of 20 seconds resulted in significant loss of containment (Figure 3).

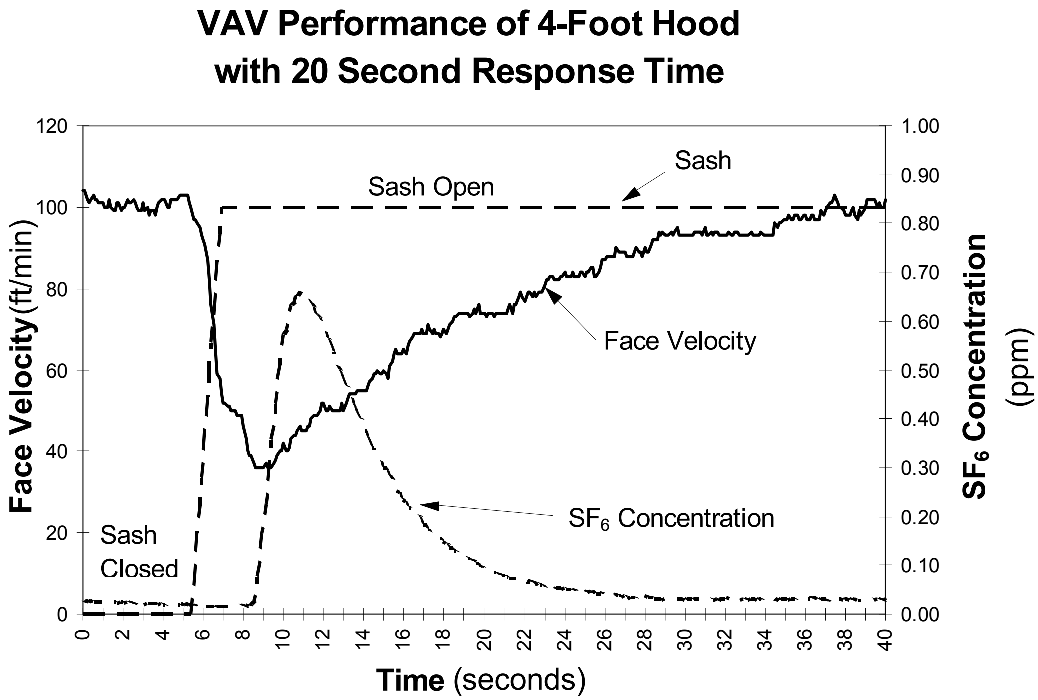

Figure 3.

For the 8-foot hood, response times greater than 3.0 seconds resulted in some loss of containment. The 4-foot and 8-foot hoods exhibited different required response times because of their different designs and different exhaust systems.

Moving the sash at the high rate of 1.5 feet per second is unlikely to occur in practice. The ASHRAE 110 test procedure represents a worst-case scenario. Repeating the above tests using the more reasonable sash rate of 1.0 feet per second typically doubled the allowable response time. For example, at 1.0 feet per second the 4-foot hood did not lose containment at a response time of 22.4 seconds and the 8-foot hood did not lose containment until the response time reached 6.6 seconds.

Conclusion

VAV fume hood response time can be defined in several ways, some of which may be misleading. Based on the industry standard definition as stated in ASHRAE 110, TSI controls have demonstrated response times capable of maintaining full containment.

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