10 Fume Hood Myths

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Many, if not most, people have strong mis-conceptions concerning fume hoods. These mis-conceptions are best corrected based on what I would consider new information, new performance capabilities of engineered hoods, heightened liability concerns due to high visibility lawsuits in the press and generally more recent focus on laboratory codes and safety. Most lab owners and designers have relied upon information filtered through lab furniture manufacturers and associated lab planners rather than directly on codes and standards themselves.

In discussing lab safety with various owners and designers the last few years, many of the myths are not only widespread, but almost universal. This paper attempts to provide the basis and source to correct the situation and assist owners and designers toward providing true safety and reduced employee risk.

Myth #1 - OSHA requires 100 fpm face velocity.

Quite to the contrary, OSHA specifically discussed this in the Federal Register January 31, 1990 when publishing the current version of 29 CFR Part 1910. OSHA wrote (page 3318),

> "As in the proposed standard, the final standard does not specify face velocities for fume hoods. OSHA's rationale for this approach was explained in the preamble to the proposed standard (see 51 FR at 26671). In brief, the preamble stated that OSHA recognized that there was considerable debate over what optimum velocities should be in light of differences in hood design and methods requiring specific face velocities was not consistent with the performance orientation of the standard."
>
> "Most commenters agreed with OSHA's approach in not specifying face velocities for fume hoods."

After highlighting comments in agreement and disagreement, OSHA continues,

> "However, these comments offered little or no substantive information to pursuade OSHA to abandon the performance approach which allows the employer to determine the appropriate face velocities on the basis of design, use patterns and other factors which influence the effectiveness and proper functioning of the fume hood."

Thus, since January 31, 1990 OSHA has been specific and clear stating that face velocity is not

what determines hood performance, nor is 100 feet per minute a requirement or recommendation.

Myth #2 - OSHA dictates fume hood testing methods.

The Director, Directorate of Compliance Programs of OSHA in responding to a request from Robert H. Morris in 2001 explained,

> "OSHA does not promulgate specific fume hood testing protocols."

Myth #3 - Past hood performance has been adequate.

The Director, Directorate of Compliance Programs of OSHA wrote again in 2001, to Robert H. Morris, discussing published research on current fume hood effectiveness. He stated,

> "When ANSI/ASHRAE 110 was used to evaluate hood effectiveness, both studies demonstrated that a portion of the hoods tested (28% and 38%) did not meet the standard specified in ANSI Z9.5 even after attempts to improve performance."

Fume hoods are personal protective equipment (PPE). I believe with a quarter of existing hoods failing in the field that one must determine that there is a safety problem of significant magnitude. OSHA wrote in 1991 when publishing the laboratory standard (Federal Register January 31, 1990, page 3326),

> "In short, there is a clear national problem related occupational safety and health for employees exposed to chemicals in laboratories."

Since fume hoods are the primary device to protect employees from exposure to chemicals in the laboratory, the above statement must be considered to include the fume hood as one source of the problem.

Myth #4 - Specifying ASHRAE 110 testing assures a safe hood installation.

ASHRAE 110 is a test procedure. There is no pass/fail criteria. Thus, no hood can fail to meet a specification calling for requiring conformance to ASHRAE 110.

Myth #5 - ASHRAE 110 test methods as written are adequate to provide a representative test procedure.

Workers are to be protected per OSHA's requirements but more importantly, because it is the right thing to do. OSHA references ACGIH as a source for information on lab design. The Industrial Ventilation manual of ACGIH explains that tracer gas testing can be done at various test gas release rates with the most stringent listed as 8 lpm gas release rate as "approximates

violently boiling water on a 500 watt hot plate". Additionally the manual lists 1 lpm as "approximates pouring volatile solvents back and forth from one beaker to another". The manual also lists "4 lpm is an intermediate rate between 1 and 8 lpm". As safety is the goal of installing hoods, it would be improper to test at less than the anticipated worse case. Unfortunately ASHRAE 110 calls for 4 lpm release rate, however to protect workers as OSHA has required, the boiling water approximation, 8 lpm, should be the minimum test release rate. This is the minimum as it is reasonably anticipated that over the life of a hood it is foreseeable that a boiling or heated experiment is possible. If the project is not to be designed to allow a boiling type experiment then prudent practice requires that the hood be labeled as a limited use hood, not allowing heated experimentation within the hood. Higher test gas release rates may be justified to provide safety factors.

Furthermore OSHA has also written Robert H. Morris in reference to specific questions on ensuring safety of workers less than average height and OSHA's Director, Directorate of Compliance Programs stated,

> "where the height of the laboratory falls below that of the "average" American worker, and therefore, such a worker may not be protected by ventilation control of the hood, the employer should take measures to ensure that such employee, in fact all employees, are not adversely exposed to hazardous chemicals."

ASHRAE 110 addresses testing for a nominal 5'10" person. As OSHA has required protection of all height workers, the ASHRAE 110 procedure must be modified to test performance for shorter workers as well.

Myth #6 - Factory testing is adequate, field testing is not needed.

Safety in the field is required to be provided per OSHA. Safety in the hood manufacturer's factory test lab is not. All relevant standards, codes and references document that there are many challenges in the field which affect hood performance. If an exposure ever occurs and performance testing has not been done on the installation, no claim of having provided safety could be made. As face velocity has been determined to not be a determinant of safety, the common practice of face velocity testing and marking the sash at the 100 fpm limit, is meaningless and in fact, misleading employees to suggest safety testing has been done when in fact it has not been.

Myth #7 - The ANSI/AIHA Z9.5 standard requires certain face velocities.

The standard bases performance rating of fume hoods specifically upon tracer gas testing via ASHRAE 110 test procedures. A "Class A" hood must rate" 4.0 AM 0.05 or better". Face velocity is not a criteria. Hoods rating below this are Class B. Why would one ever specify a class B safety device?

In section 5.7 the standard states,

> "This standard does not establish a standard face velocity because of the importance of other parameters and the existence of an applicable performance test (ANSI/ASHRAE 110). Evidence has accumulated indicating that a hood meeting these standards with a face velocity of 80 to 100 fpm, tested in the manufacturer's laboratory under (presumed) ideal conditions, will rate 4 AM 0.05 (0.05 ppm at the breathing zone with a release rate of 4.0 liters per minute of tracer gas inside the hood). The same hood installed in an operating laboratory that, in general, conforms to this standard will rate 4 AU 0.1."

The standard in other areas references 60 to 100 fpm and 80 to 100 fpm, however the above is the most detailed explanation of the standard relating to face velocities and, as does OSHA, bases safety on performance, i.e. tracer gas testing, not face velocity.

Myth #8 - Peak spillage values need not be specified when testing hoods.

Once inhaled a chemical or other contaminant remains in the lungs for some period of time. The next breath will not expel all of the contaminant. The ASHRAE 110 test rates peaks for dynamic conditions. Again no pass fail criteria is given by ASHRAE. ANSI/AIHAZ9.5 also does not provide a required peak value. General acceptance has been discussed as allowing perhaps double the average as a limiting acceptable peak value. The employer must determine the acceptable peak. Some comments have been to suggest peak values as no higher than the AM 0.05 or AU 0.1 averages in Z9.5. To look for current standards which specify a peak value, the Invest UK standard for an excellent hood is <0.010 peak.

Myth #9 – “But 100 fpm face velocity still seems to be a safe value to specify.”

I bring this up again because most of my meetings with owners and specifiers return to this major misconception repeatedly. 100 fpm is 1.13 mph. 80 fpm is 0.91 mph. If a hood doesn't work at 0.91 mph, how can one be convinced in the absence of stringent testing that 1.13 mph is safe. Testing as referenced by OSHA has found over 25% of existing hoods are failing. Clearly the 100 fpm mistaken assumption does not provide safety. The reason that face velocity increase or decrease of 0.22 mph doesn't change performance is that the interior vessel of the hood, properly designed, has to develop and maintain a bi-stable vortex to provide containment. It is this internal vortex that develops hood performance and containment, not face velocity. The vortex development and maintenance is a high level gas dynamics and fluid flow engineering analysis and design. Properly developing and maintaining this vortex allows for a range of air volumes for a hood to work to a high performance level. A high performance bi-stable vortex hood will maintain safety with air volumes as low as half the value traditionally used by hoods.

Supporting the elimination of face velocity as a hood performance criteria, OSHA, AIHA, ACGIH, ASHRAE are all on record that face velocity is not a determining factor for safety in hoods. Reliance on face velocity specification for safety has no sound basis in fact. To believe so or to be led to believe so is negligent in lab design.

Myth #10 - Specifying a partial open sash is an acceptable safety and energy saving methodology.

OSHA states all workers are to be protected from exposure. If a hood can be opened fully, as all chemical fume hoods can be for hood loading and unloading, then safety has to be maintained at full open. The industry and users have set 27" as full open. Testing needs to be done at this full open sash. ASHRAE 110 calls for this. On page 2 ASHRAE 110 states in the Foreword,

> "Since operation of the hood with the sash opened may be beyond the design criteria, it is prudent to also conduct the tests with the hood fully open to test potential conditions of misuse."

"To enhance the user's understanding of the subject as well as the standard", ASHRAE 110 again emphasis the point on page 14 in the Appendix,

> "The hood should be tested with the sashes full open to determine the effect of misuse of the hood."

What would one do if testing shows the hood to be unsafe in potential uses or misuses, especially if design can be done to prevent the unsafe condition? Certainly an owner or prudent specifier would expect the unsafe condition to be designed out of the system as the whole purpose and need for a fume hood is to provide safety.

If harmful exposure ever occurs when a limited sash opening hood is fully opened the standards and comments by OSHA are clear that liability would fall to the employer and in turn the designer. An analogy would be to specify safety glasses without side shields and telling the employee to never turn their head away from the risk. It is not a proper provision of safety as it is impractical to never turn one's head. Similarly to tell an employee never to fully open the sash, knowing that it must be opened at times, is negligent. Further eliminating the limited sash opening concept is the fact that some employees may not be fully aware of all recommended procedures, i.e. maintenance personnel, lab visitors etc. Some employees may be less knowledgeable to lab practices and procedures and some may not even read English. Remember, all employees are to be protected per OSHA. In my personal visits to laboratories, I routinely see fume hoods with fully open sashes.

Summary

The 10 myths discussed above are widely believed myths. The belief and following of a myth will lead one down an incorrect path. Research into the various laws, codes and standards needed to be done throughout multiple sources to document facts to dispel these myths. The awareness and need for safety in all pursuits is critical, and particularly so in laboratories. Lab workers, designers, owners, industrial hygienists, engineers, architects and suppliers all should want to

ensure the maximum achievable safety possible. The first step toward this end goal must be to ensure the basis of decisions are sound. When myths are held and followed an industry can find itself off-track. This has happened in the fume hood industry. The 100 fpm face velocity myth is the perfect example of heading off-track. Those that follow this, believing it is first, required, and second, ensures safety, have missed the need entirely. OSHA states specifically a set face velocity is not required and multiple sources including OSHA verify face velocity specification does not ensure safety. Thus, the myth leads many off-track. The goal of this paper has been to provide the documented sources to bring us all back on-track so that safer labs will be designed using the benefit of reality, not myths.