TerranearPMC Safety Share

Week of April 24, 2017 – Laboratory Fume Hoods

It happened in December, 2008, at an organic chemistry lab at UCLA. That was when a research assistant was working at a laboratory hood, using a syringe to transfer about 50 mL of tert-butyl lithium, a pyrophoric chemical (a substance that catches fire spontaneously once exposed to air), dissolved in pentane (a flammable solvent) when the plunger of the transfer syringe came apart, causing the material to spew onto the researcher. Because the substance was pyrophoric, it immediately burst into flames causing second and third degree burns. About a month later the research assistant died.

A number of accident investigations were conducted, with findings centered on deficiencies with the laboratory chemical safety management and practices. Investigations showed that a risk assessment for operations to be conducted in the laboratory were never performed, while training for proper handling of chemicals, and knowledge of emergency showers was inadequate (the investigation revealed that the researcher ran in the direction *away* from the nearest emergency shower). Lack of proper protective clothing and inadequate supervision were other findings (the victim was wearing a pair of rubber gloves, which were not flame-proof, and she was not wearing a laboratory coat when the accident occurred. Instead, she wore a sweater that was made of highly flammable synthetic material). It was also found that the laboratory fume hood was not used appropriately (possibly due to a lack of training), as the sash was raised at a height that did not act as a shield, which if done, could have restricted injuries to only the hands.

In 1990, OSHA promulgated the Chemical Hygiene Plan (CHP), which was designed to provide various requirements to protect persons working in laboratories; both in industry and academia. This standard, 29 CFR 1910.1450, specifies the requirements for having a written program (developed and implemented by the employer) which establishes procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by those chemicals used in that particular workplace. It establishes criteria that the employer will use to determine and implement control measures to reduce exposure to hazardous materials. These typically consist of engineering controls, the use of personal protective equipment (PPE), and hygiene practices. The CHP requires that particular attention is given to selecting control measures for extremely hazardous materials.

29 CFR 1910, 1450, also has a strong focus on employee training programs for proper use of fume hoods. This includes medical consultation, hazard identification, respirators, recordkeeping, and fume hood education. Under paragraph (e)(3)(iii) of the CHP, employers are required to ensure fume hoods and other protective equipment are functioning properly while incorporating specific measures that shall be taken to ensure proper and adequate performance of such equipment; however, OSHA's CHP does not provide specifics on how the employer shall verify proper equipment performance. For instance, the CHP does not specify what safe hood operations would entail or to specify operating flowrates or face velocities. These are important characteristics of a fume hood, as they can help determine how well chemical vapors, gases, particulate, etc. remain within the confines of the fume hood and do not escape, resulting in employee exposure. Another important factor for safe hood operations is the sash position. The sash is a sliding "door" at the front of the hood. It is adjustable so that hands can freely enter the hood to perform the necessary work while maximizing the hoods'

capability to control contaminant from leaving the hood. Therefore the sash acts as a physical barrier to protect the worker while allowing maximum air flow efficiency.

Face velocity is a term that describes the pull of air at the vertical plane of the sash location (i.e. front of the ventilation hood) that moves airborne materials from the fume hood through the ductwork. Face velocities that are too low, may prove to be ineffective to maintain harmful airborne contaminants inside the hood, while face velocities that are too strong, would actually create air turbulences inside the hood, thereby causing chemical vapors and/or gases to be uncontrolled and even force air currents to be redirected outside the hood and towards the employee. Therefore, it is important that during the design/installation phase, appropriate face velocities are determined.

It is not uncommon for the term face velocity to be confused with *capture velocity;* a ventilation characteristic that refers to the air velocity at any point in front of the hood and capture the contaminated air at that point by causing it to flow into the hood. Therefore, because work associated with a laboratory hood typically occurs at the hood face (where the sash is located), in many instances, the face velocity and capture velocity are the same. This is not the case when discussing localized ventilation systems where a worker's position and distance from the portable ventilation apparatus can vary at any moment.

Probably the factor that has the greatest influence on face velocities, is the hoods' volumetric flow rate. This is a characteristic that is determined by the hoods' motor or fan. Another important consideration is the ducting, where *drag* and abrupt directional changes (e.g. elbows) can reduce air flow to such a degree that without proper consideration of the ducts' design, the intended flow rates based on the motor capability can be drastically reduced to the point where face velocities can be ineffective.

Bottom line with regards to the entire ventilation design configuration, fan size and ducting: it is the face velocity where periodic checks need to be performed as inadequate face velocities are indicators of when the ventilation hood needs to be serviced or even redesigned.

While the face velocity is an important operating factor, OSHA, through its CHP regulation, does not specify what the minimum and maximum velocities need to be. However, other organizations, including Cal-OSHA and the American Conference of Governmental Industrial Hygienists and the American Society for Heating Refrigeration and Air Conditioning Engineers have indicated that a hood's face velocity is recommended to be between 60 fpm and 100 fpm (note: Cal OSHA's specifications are actual requirements).

It is important that when the face velocity is used to evaluate the effectiveness of a fume hood that the sash is placed at the appropriate position. That is, the particular sash level for which the hood is intended to be used. Parameters such as temperature and the laboratories' general ventilation (creating cross-currents) can be important influencing factors. As a way to ensure the hood is used properly, all persons who have been assigned to use the hood need to be trained as to operation protocol and how to recognize when the hood is not operating correctly. Also, the employer needs to check the hoods' face velocity at least annually or whenever conditions change.

There is only one way to avoid criticism: do nothing, say nothing, and be nothing – Aristotle

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