



Effects of Modular Ventilation Systems on Internal Air Quality of Flammables Cabinets

Chambre, Andre: CEO, Air Science, LLC
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Abstract

Personnel in manufacturing environments, research laboratories, analytical testing facilities and educational laboratories use flammable storage cabinets to protect from flash fire, prevent containers from building up undue pressure due to off-gassing, and contain spills that could further spread fire. However, in some applications flammable storage cabinets are also used to protect personnel from exposure to high concentrations of volatile vapors and may be mechanically vented according to occupational regulations and internal company standards.

In instances where venting existing flammables cabinets is not feasible due to lack of adequate HVAC capabilities or cabinet location, modular ventilation and filtration systems are sufficient options to meet OSHA requirements. The Air Science Vent-Box is a new type of modular ventilation system designed to protect personnel from chemical vapors found inside of stand-alone chemical safety cabinets.

The laboratory services section of We Energies, a municipal utilities provider servicing Wisconsin and Michigan, tested the effectiveness of the Vent-Box filtration system by measuring the concentration of volatile vapors inside of a flammable storage cabinet with and without the Vent-Box installed.

Control monitoring in which no ventilation was installed on the storage cabinet identified concentrations of up to 350 ppm of unknown chemicals in the cabinet interior. When vented with an Air Science Vent-Box modular attachment, volatile organic concentration in the flammable storage cabinet consistently remained under 10 ppm.

The Vent-Box system significantly reduced volatile organic particulates from internal cabinet space. The continuous stream of fresh, filtered air entering the cabinet decreased detectable volatile concentrations by more than 97% over non-vented cabinets. These results represent a significant increase in user protection from volatile vapors and may indicate a lowered risk of flash fire upon door openings over non-vented flammable storage cabinets.



Background

Flammable liquid storage cabinets are used in a variety of applications to effectively separate substances with volatile vapors, from sources of ignition. Personnel in manufacturing environments, research laboratories, analytical testing facilities and educational laboratories use flammable storage cabinets to protect from flash fire, prevent containers from building up undue pressure due to off-gassing, and contain spills that could further spread fire.¹

The Occupational Safety and Health Administration (OSHA) regulations consider ventilation as it pertains to volatile, flammable liquids to be largely for the prevention of fire and explosion. Ventilation is adequate if it is sufficient to prevent accumulation of significant quantities of vapor-air mixtures in concentration over one-fourth of the lower flammable limit, or the minimum proportion of vapor in air in which flame propagation can occur.²

However, in some applications flammable storage cabinets are also used to protect personnel from exposure to high concentrations of volatile vapors. In these instances, flammable storage cabinets may be mechanically vented according to occupational regulations and internal company standards.

Regulatory Requirements

Flammable storage cabinets are designed as sealed systems with no direct venting to the outside. This prevents ventilation serving as a potential point of entry for ignition sources and ensures a completely closed system. However, risk of potentially dangerous concentrations of volatile gases does exist and has led to regulations on ventilation use on flammables cabinets based on application.

The primary basis of regulation for flammable and combustible liquids is OSHA's 29 CFR 1910.106 standard. This standard is derived from the National Fire Protection Association's publication NFPA 30, Flammable and Combustible Liquids Code and applies to the handling, storage, and use of flammable and combustible liquids with a flash point below 200°F.

Depending on a variety of factors, including industry, process and the requirements of individual corporate insurance carriers, flammables cabinets may be required to be vented in some industrial and academic applications. OSHA requires that employers store flammable and potentially volatile chemicals in properly rated flammables cabinets to protect against fire hazards. Flammable storage cabinets are typically double-walled and made out of 18-gauge or thicker steel, with a door secured by a three-point lock system. Flammable storage cabinets must maintain internal temperatures of less than 325°F during a 10-minute fire test to meet OSHA regulations.

In some instances, OSHA also recommends venting of flammable cabinets to prevent the buildup of chemical vapors which could be potentially hazardous to employees if exposed while accessing the cabinet. In these instances, venting is addressed through removal of specially designed bungs that allow connection of ventilation hoses to tie into an existing HVAC system.³

1 W.W. Grainger, Inc., "Flammables and Liquids, 29 CFR 1910.106". *Quicktips: Technical Resources – Safety*. 2:2013.

2 United States Office of the Federal Register National Archives and Records Administration, "29 Code of Federal Regulations Parts 1900 to 1910," Washington: GPO 1994.

3 Occupational Safety & Health Administration. "Flammable and Combustible Liquids, 29 CFR 1910.106". *OSHA Training Materials*.

Issues with Venting

Venting flammables cabinets can be cost and logistics prohibitive, depending on the existing setup of the flammables cabinets within the facility. The National Fire Protection Association requires flame arrestor screens and metal ducting be used when tying a flammables cabinet into an existing HVAC system. To comply with the regulations, runs of ductwork must not exceed 25 feet and cannot be set up in a manifold system with other cabinets. The cabinets have to be vented from the top to the bottom and cannot be directly ducted to a fume hood. No spark fans and motors are preferred when using mechanical ventilation systems to mitigate risk of ignition sources.⁴

Figure 1: Compliant Ventilation System

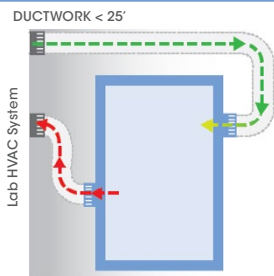
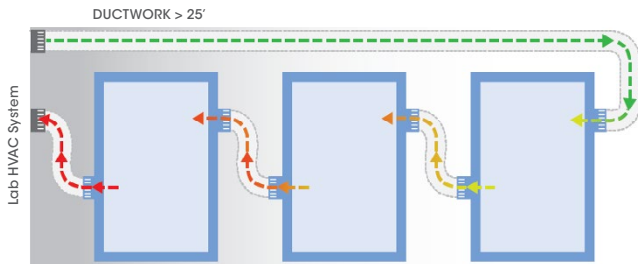


Figure 2: Non-Compliant Manifold System



In many cases, existing laboratory HVAC systems are not designed to incorporate flammable storage cabinets and must be retrofitted to incorporate additional ductwork for this purpose. More ductwork and additional vented cabinet space may require the entire ventilation system to be recalibrated in order to meet required standards.

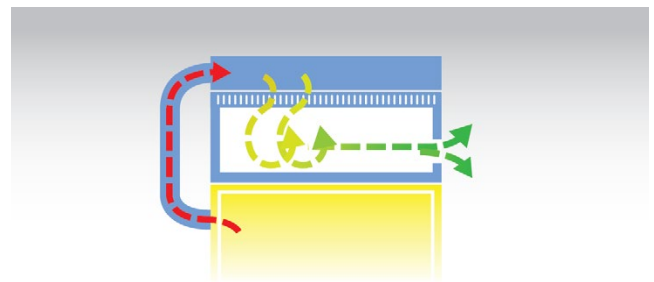
Modular Ventilation Systems

In instances where venting existing flammables cabinets is not feasible due to lack of adequate HVAC capabilities or cabinet location, modular ventilation and filtration systems are sufficient options to meet OSHA requirements.

The Air Science Vent-Box is a new type of modular ventilation system designed to protect personnel from chemical vapors found inside of stand-alone chemical safety cabinets. These ductless filtration systems are designed to protect laboratory personnel from chemical vapors found inside of stand-alone chemical safety cabinets and serve as modular ventilation and filtration that fits all chemical safety cabinets. The modular systems connect to the cabinet via a metal hose or ductwork to the flame arrestor on one side of the cabinet while the other flame arrestor is open (bung, if installed, should be removed).

The Vent-Box incorporates the Air Science Multiplex™ Filtration System, a unique configuration that includes a pre-filter and main filter to create a chemical, physical or combination architecture to adsorb, neutralize or trap the target chemicals or particulates while constant negative pressure removes vapors and particulates from the cabinet's interior.⁵

Figure 3: Vent-Box System



The Vent-Box draws contaminated air from the cabinet interior and filters it through the Multiplex Filtration system.

⁴ National Fire Protection Association, *Flammable and Combustible Liquids Code Handbook*. Sixth edition, ed. Robert Benedetti, 1996.

⁵ www.airscience.com/21

Hypothesis

Mechanical, modular cabinet ventilation systems can drastically reduce volatile vapor concentration from liquid off-gassing within properly maintained flammables cabinets. Modular, ductless flammables ventilation systems developed by Air Science can offer additional benefits that include short runs of ventilation ducting, individualized exhaust options for easy configuration, and easy accommodation of “no manifold” policies.

Methods

The effectiveness of the Vent-Box filtration system was evaluated by measuring the concentration of volatile vapors inside of a flammable storage cabinet in use by the laboratory services section of We Energies, an electric utilities provider servicing Wisconsin and Michigan’s Upper Peninsula.⁶ The cabinet contained a variety of solvents typical of testing facilities in a number of industries, including acetone, isopropyl alcohol, hexanes, decane, petroleum, fuel, lubricating oils, as well as unknown samples awaiting testing.

Vapor concentration inside the cabinet was measured with a 3M Quest EVM-7 indoor air quality monitor. The 3M Quest EVM-7 measured volatile organic vapor concentration in the air via photo-ionization detection (calibrated with 100 ppm isobutylene).⁷ Internal air samples were taken every minute, on the minute for a period of six days in early 2013 with no ventilation system installed. The process was repeated 10 months later with an Air Science Vent-Box filtration system installed on the storage cabinet.

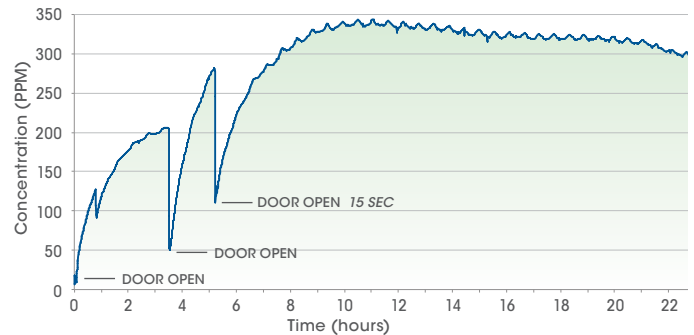
Data on concentration of volatiles over time was compiled into line graphs and results analyzed through visual comparison.

Results

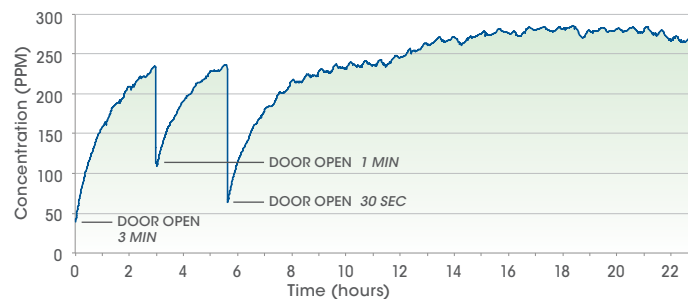
Control monitoring identified concentrations of up to 350 ppm of unknown chemicals in the unvented cabinet. The only major deviations to these levels were the result of door openings, which allowed an infusion of air into the cabinet and consequent dilution of volatile vapors.

Figure 4: Internal air quality of flammables cabinet with no ventilation installed

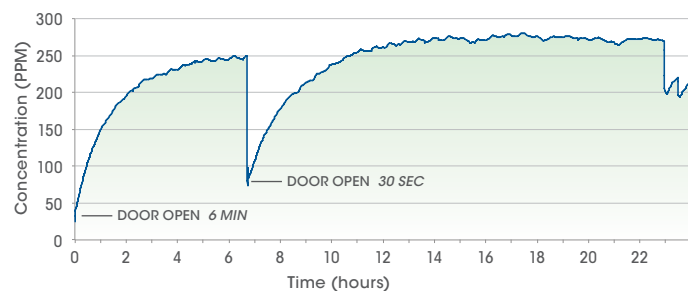
Graph 1: 2-19-13 to 2-20-13



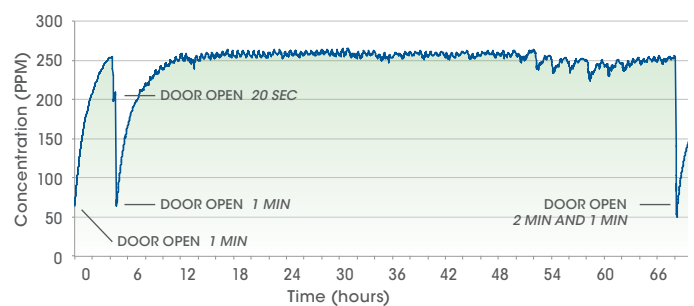
Graph 2: 2-20-13 to 2-21-13



Graph 3: 2-21-13 to 2-22-13



Graph 4: 2-22-13 to 2-25-13



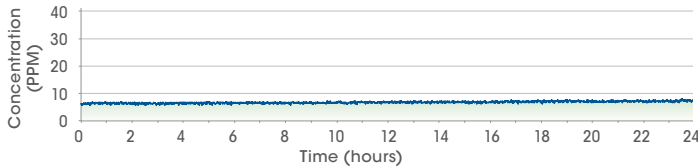
⁶ www.we-energies.com

⁷ www.3M.co.uk/ohes

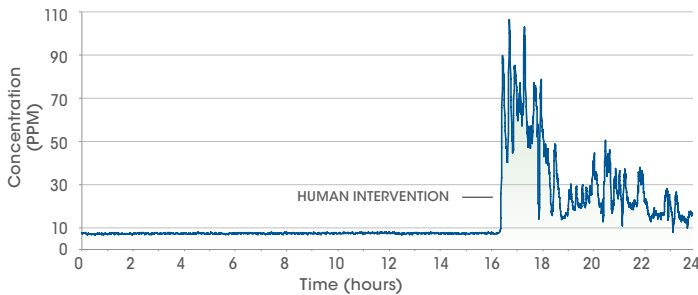
When vented with an Air Science Vent-Box modular attachment, volatile organic concentration in the flammable storage cabinet consistently remained under 10 ppm. The only variation to this data resulted from human intervention in the early morning of two of the monitoring sessions (noted below).

Figure 5: Internal air quality of flammables cabinet with Air Science Vent-Box installed

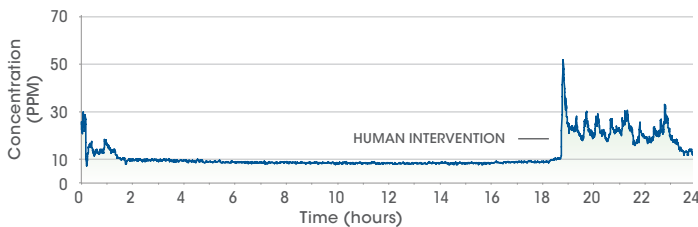
Graph 5: 12-7-13 to 12-8-13



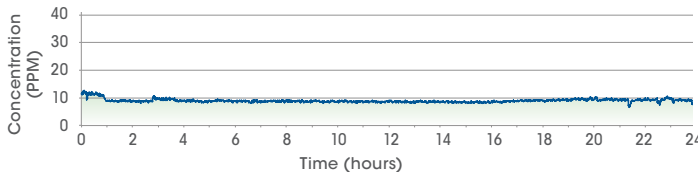
Graph 6: 12-8-13 to 12-9-13



Graph 7: 12-9-13 to 12-10-13



Graph 8: 12-10-13 to 12-11-13



Discussion

The tested modular ventilation and filtration system significantly reduced volatile organic particulates from internal cabinet space. The continuous stream of fresh, filtered air entering the cabinet decreased detectable volatile concentrations by more than 97% over non-vented cabinets. These results represent a significant increase in user protection from volatile vapors and may indicate a lowered risk of flash fire upon door openings over non-vented flammable storage cabinets.

Data from this study indicates that the Vent-Box is an easy to install, efficient modular ventilation system that can drastically increase the safety of operations in environments where flammables storage is required. Additional unquantifiable benefits of this ventilation system lie in its ability to minimize considerations that may otherwise be prohibitive to venting flammable storage cabinets, such as HVAC configuration, cabinet placement, and cabinet contents.

Unquantifiable benefits include:

- **Easy lab configuration** that complies with OSHA and NFPA regulations but requires minimal HVAC construction considerations. This minimizes costs and operational downtime.
- **Utilizes a versatile filtration system** that is easily configured for use with all types of chemical safety cabinets. Allows transition to other types of chemical storage cabinets according to operational demands.
- **Construction meets all international standards and NFPA-defined regulations** for flammable storage cabinet ventilation, including UL-approved electrical componentry, "no-spark" fan design, and the capability to use flame arrestors and metal ducting.

In conclusion, the Air Science Vent-Box provides sufficient ventilation and air filtration to warrant use within flammable storage cabinets, increasing safety and reducing the risk of concentrated vapor exposure. However, as with any regulated practice, the suitability of each cabinet application should be thoroughly evaluated by a qualified Safety Manager to ensure the chemicals to be stored, the carbon filtration and all maintenance procedures adequately maintain user safety.

Andre Chambre

Andy Chambre is the founder and CEO of Air Science, LLC and has been associated with the ductless fume hood industry for more than 25 years. He was formerly the US Vice President for Captair Labx and President of Astec Microflow US. He was named President of Filtco Corporation in 2003 and currently also serves as a Director of Air Science Technologies Ltd. in the UK. Mr. Chambre has written numerous articles on fume hood safety and assisted in the development of safety standards by serving on various committees such as the Canadian Standards Association subcommittee on fume hoods and the SEFA 9 Ductless Enclosures Committee.

Acknowledgements

This study was completed as an independent test by We Energies on products purchased from Air Science USA LLC. We would like to recognize Dave Kollakowsky for his role in compiling data and providing for review.

Sources

- National Fire Protection Association, Flammable and Combustible Liquids Code Handbook. Sixth edition, ed. Robert Benedetti, 1996.
- United States Office of the Federal Register National Archives and Records Administration, "29 Code of Federal Regulations Parts 1900 to 1910," Washington: GPO 1994.
- W.W. Grainger, Inc., "Flammables and Liquids, 29 CFR 1910.106". Quicktips: Technical Resources – Safety. 2:2013. Available: <http://www.grainger.com/content/qt-safety-flammables-combustibles-179>.
- Occupational Safety & Health Administration. "Flammable and Combustible Liquids, 29 CFR 1910.106". OSHA Training Materials. Available: https://www.osha.gov/dte/library/flammable_liquids/flammable_liquids.pdf.

Additional Information Sources

- www.we-energies.com
- www.airscience.com
- www.3M.co.uk/ohes



120 6th Street • Fort Myers, FL 33907
 T/239.489.0024 • Toll Free/800.306.0656 • F/800.306.0677
www.airscience.com

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