Safety when dispensing solvents.

A ductless, filtered solution reducing overall operational cost.

By Peter Sampson and Jesse Coiro

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The Problem

A major concern among all researchers is the need to maintain the safety of their lab environment. This includes controlling spills, protecting the lab equipment and instruments, and preventing the contamination of on-going experiments from each other. An important characteristic associated with research lab operations and clean-up that is often overlooked, is the air. Gases and chemical fumes are constantly released into breathable air. Whether visible or not, these fumes are a constant health risk and without proper filtration the lab environment becomes contaminated. This is an ongoing issue as evidenced by a recent [2018 report of the top ten violations] from OSHA, that named *Respiratory Protection* as the number 4 violation, accruing 3,118 violations to date in the United States alone.

"Your best defense against solvent fumes is a properly ventilated workspace. Either general or exhaust ventilation (or a combination) may be used to provide protection. General ventilation is used primarily to bring fresh air into the workplace and dilute the solvent, while exhaust ventilation removes the vapors from confined workspaces."[1]

'Solving the Safety Challenges of Solvents' by Safety Management Group

Identifying and recognizing the risk of commonly dispensed solvents

A close examination of the most commonly used solvents being dispensed in research laboratories today would include: Hexane, Acetonitrile, Tetrahydrofuran (THF), and Pentane. All of these solvents are labeled as 'dangerous' by the GHS (OSHA's **G**lobally **H**armonized **S**ystem of classification and labeling of chemicals), and according to a recent article in ThoughtCo.com, "It's not just the skin on your hands that is at risk from chemical exposure, although this is the most common place to get hurt. You can inhale corrosive or reactive vapors."[1] Exploring in detail, one would find the following explanation and associated risks with these four commonly used non-polar and borderline polar aprotic solvents.

- **Hexane.** Hexane is used to extract edible oils from seeds and vegetables, as a special-use solvent, and as a cleaning agent. Acute (short-term) inhalation exposure of humans to high levels of hexane causes mild central nervous system (CNS) effects, including dizziness, giddiness, slight nausea, and headache. Chronic (long-term) exposure to hexane in air is associated with polyneuropathy in humans, with numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue observed.[2] GHS warnings on Hexane.

- **Acetonitrile**. Acetonitrile has many uses, including as a solvent, for spinning fibers, and in lithium batteries. It is primarily found in air from automobile exhaust and manufacturing facilities. Acute (short-term) inhalation exposure results in irritation of mucous membranes. Chronic (long-term) exposure results in central nervous system effects, such as headaches, numbness, and tremors.[3] GHS warnings on Acetonitrile.

- **Tetrahydrofuran.** THF is a colorless, water-miscible organic liquid with low viscosity. (It is mainly used as a precursor to polymers, for example, it can be used to dissolve rubber prior to determining its molecular mass using gel permeation chromatography. THF tends to form peroxides on storage in air). Tetrahydrofuran (THF) is a contaminant of exposure and appears in human biofluids. The Food and Drug Administration (FDA) has announced recommendations to revise the permitted daily exposures for THF. THF oxidizes readily, which can lead to instability and result in cytotoxicity. Tetrahydrofuran is essentially considered in occupational toxicology, and acute poisoning cases are extremely rare. THF is often used for hydroborations used to synthesize primary alcohols.[4] GHS warnings on Tetrahydrofuran.

- **Pentane.** Pentane is any or one of the organic compounds with the formula C5H12. This alkane is a component of some fuels and is employed as a specialty solvent in the laboratory. N-PENTANE is a clear colorless liquid with a petroleum-like odor.[5] Inhalation of N-Pentane can result in dizziness, drowsiness, headache, nausea unconsciousness or vomiting.[6] GHS warnings on Pentane.

Of course, these are only four of the many toxic solvents involved with chemical testing in labs, others include chloroform, dimethyl sulfoxide (DMSO), formaldehyde, 2-mercaptoethanol, methanol, sodium azide, sodium hydroxide, and sodium hypochlorite. These chemicals can also have adverse reactions with each other. Additionally, the cumulative effects of continuous exposure even at levels below the TLV/TWA set by NIOSH and OSHA can have significant adverse effects, so employing filter-based equipment, with proper containment to avoid inhalation risks, would be a logical benefit to lab personnel.

Previous methods of ventilation in the lab space

It is difficult to justify, but some solvents are still being dispensed directly from ungrounded drums in an open source area. This presents a myriad of dangers from escaping toxic fumes to possible bodily burns and electrical explosions or fires. A potential danger exists when metal pumps are used in an open-use situation for dispensing solvents as this allows VOCs (Volatile organic compound) to escape into the air and increases the chance of leakage and solvent ejecting over the lab worker. Some pumps may also lack a stop-flow mechanism risking a potential spill hazard. This type of solvent dispensing does not comply with the preferred method of using fume hoods as advised in the OSHA CHP (Chemical Hygiene Plan).

The conventional fume hood system in place today, is designed to remove harmful emissions from the users breathing zone but requires complicated, expensive, space consuming HVAC integration, as well as problematic maintenance and cleaning of the ventilation systems which calls into question its effectiveness. It has also been noted that this ventilation process, employed during solvent dispensing, may also be less efficient in containing escaping toxic fumes.[8] We are left to wonder what solution currently exists to counter these unsatisfactory options.

The Solution

In search of an answer for the safe and simple dispensing of solvents in the lab environment

Part I – The vital role of filtration technology

A more recent, popular solution, that creates a safer work environment for laboratory professionals is the 'ductless hood' system. While there are many definitions of 'safe' hood systems, we offer, through this document, an updated definition to what Wikipedia refers to as 'Ductless (recirculating) fume hoods'. There is a lack of high level, easily attainable information on this subject however, without googling and exhaustive research among a myriad of websites. While well intentioned writers and editors have contributed to the Wikipedia explanation and description of these products, major discrepancies exist in the information as presented. This paper addresses the issues by way of a comparative explanation between current knowledge vs. a breakthrough, high-quality market solution. This relatively new but widely accepted product continues to challenge previous models, becoming the industry standard filtration system. A filter, that when combined with other quality cabinet and dispensing components, (see Part II) is introducing a revolutionary, safe and convenient alternative to dispensing solvents. The following narrative lists the information as found on Wikipedia with a clarification or rebuttal of the information as presented. It is meant to bring to light the current facts of a new, alternative filtered dispensing solution that may as yet, be unknown to laboratory professionals and directors.

Current knowledge base vs. new product evidence
The following information is taken from **W**ikipedia (Fume Hoods https://en.wikipedia.org/wiki/Fume_hood) and the rebuttal and/or edits to the Wikipedia article are provided by Jesse Coiro, Director of Business Development & Filtered Laboratory Solutions at Erlab, Inc.

W: "Mainly for educational or testing use, these units (ductless fume hoods) generally have a fan mounted on the top (soffit) of the hood, or beneath the worktop. Air is sucked through the front opening of the hood and through a filter, before passing through the fan and being fed back into the workplace. With a ductless fume hood it is essential that the filter medium be able to remove the particular hazardous or noxious material being used. *As different filters are required for different materials, recirculating fume hoods should only be used when the hazard is well known and does not change*."

Erlab: "Erlab's technology provides one filter for solvents, acids, in-organics and bases. So, while the above statement is true for other manufacturers, this does not hold true for Erlab's filtration technology. In fact, our filters allow for the changes in handlings to occur, with the same filter and configuration in place. The handlings must be known in order to provide an analysis of the customers handlings, which allows our PhD chemist to perform a feasibility study of the chemistry which will be handled under the hood and an efficiency study of the filters, or filter life cycle. This study guarantees the safety of the user throughout the entire life cycle of the filters, based on the analysis performed. In fact, the studies performed are so efficient, it is guaranteed that there will never be release exceeding 1% of the TLV of the cumulative chemicals released at the filters exhaust. Additionally, this analysis is a continuous service offered by Erlab, allowing the user to be flexible with their handlings, if needed, therefore validating any changes which may occur, providing the customer with complete flexibility. All handlings changes however, are required to be validated by the lab to ensure safety is never compromised."

W:" Air filtration of ductless fume hoods is typically broken into two segments:

•Pre-filtration: This is the first stage of filtration, and consists of a physical barrier, typically open cell foam, which prevents large particles from passing through. Filters of this type are generally inexpensive, and last for approximately six months depending on usage.

•Main filtration: After pre-filtration, the fumes are sucked through a layer of activated charcoal which *absorbs the majority of chemicals* that pass through it. Ammonia and carbon monoxide will, however, pass through most carbon filters. Additional specific filtration techniques can be added to combat chemicals that would otherwise be pumped back into the room. A main filter will generally last for approximately two years, dependent on usage."

Erlab: "To clarify, *absorption* is not the physical reaction that occurs, it is adsorption. Absorption is just that, an absorbent, like a sponge, will desorb the contaminants present if proper caution isn't used during replacement. HEPA filters are an absorbent. As for the statement; '*a majority of the chemical will be adsorbed*,' this needs to be better defined. For example, Erlab adheres to the AFNOR NFX 15.211 filtration efficiency standard, providing a guarantee that any chemical introduced to the filters will be captured at an efficiency of 99% and that under normal operating conditions there will never be release at the filters exhaust exceeding 1% of the TLV, of the cumulative chemicals used during the user's chemical handlings. To clarify regarding retention of Ammonia, this chemical is absolutely captured with Erlab's filtration technology. In fact, we have a retention capacity of 310 molecular grams, before any possible release has been detected. Again, the release limits we detect at is at 1% of the TLV and is the point at which we consider the filters to be saturated. With variables in hood size and total filters required, we could see a total retention capacity of 1,240 molecular grams."

W: "Ductless fume hoods are often not appropriate for research applications where the activity, and the materials used or generated, may change or be unknown. As a result of this and other drawbacks, some research organizations, including the University of Wisconsin, Milwaukee,[14] Columbia University,[15] Princeton University,[16] the University of New Hampshire,[17] and the University of Colorado, Boulder[18] either discourage or prohibit the use of ductless fume hoods."

Erlab: "While, we concede that the changes in handlings in research labs is a challenging application because of the unknowns, this is certainly not a reason to disregard ductless filtering fume hoods all together. Following the Pros and Cons chart, on page 9, is an in-depth response to the expanded above-mentioned select University discouragement of the use of ductless fume hoods."

W: "A benefit of ductless fume hoods is that they are mobile, easy to install since they require no ductwork, and can be plugged into a 110 volt or 220-volt outlet."

Erlab: "We Agree with the above statement but contest some of the Pros and Cons of the ductless fume hoods below."(see page 9)

Wiki Stated Pros	Wiki Stated Cons / Erlab Response
Ductwork not required.	**W**: Filters must be regularly maintained and replaced. **Erlab:** True – but you need to look at the overall big picture, mainly maintenance. The Erlab filters average change cycle will be every other year and are extremely easy to replace. While with ducted hoods, when maintenance is required, this typically incurs significant down time and costly repairs. Let's not forget where the fans and blowers are located (roof tops) which are not very easy to access and let's not forget the dangers associated with roof top maintenance and emissions which are released near the breathing zone of the technician.
Temperature controlled air is not removed from the workplace.	**W**: Greater risk of chemical exposure than with ducted equivalents. **Erlab**: False – as stated in the above, with Erlab's filtration technology, we provide guarantee's that there will never be a release greater than 1% of the TLV, of the cumulative chemicals used in the hood. Additionally, we also adhere to ASTM and ASHRAE 110:1995 standards for containment, ensuring that there is not any propagation of chemicals released outside of the fume hood – This is the same standard used for any ducted hood. As with all hoods (ducted or ductless) the proper administrative controls must be in place in order to achieve optimal safety. However, with Erlab's technology, we monitor critical performance criteria of the hoods and provide visual and push notifications of any potential issues that may compromise safety , so that they can be remediated in a timely fashion. The criteria monitored is face velocity, filtration efficiency, spike in concentration past the primary level of filtration, and fan functionality. It is important to note, that even if we have detected a spike in concentration, because of back-up carbon filter redundancy, it is still guaranteed that release at the filters exhaust will never exceed 1% f the TLV, or the cumulative chemicals used in the hood.
Contaminated air is not pumped into the atmosphere.	**W**: The extract fan is near the operator, so noise may be an issue. **Erlab**: False – each hood has a noise dba of 52. (see chart for comparison)

Addressing previous University concerns against the use of ductless fume hoods in laboratories.

A major potential user of ductless fume hoods are the many Universities who post rules and documentation for use of chemicals in their labs that aim at discouraging the use of ductless fume hoods. The following are examples of such lab policy with rebuttals supplied by experts at Erlab, Inc.

University statement: “*Ductless fume hoods are designed to remove potential hazardous fumes and vapors from the work area as the exhausted air passes through absorbent material, such as activated charcoal. Occasionally, the REM department is asked to approve purchases of ductless, filtered fume hoods for use in research labs. We do not recommend ductless fume hoods. We do not believe ductless fume hoods provide reliable protection against chemical exposure, and think they may, in fact, give workers a false sense of security*.” [9]

Erlab: “We refute the above statement as ill-informed regarding Erlab’s filter technology. Erlab first validates the customer handlings to GUARANTEE the safety of the user during normal, detection and safety phase operating conditions. This guarantee is based on our PhD chemist’s analysis of the chemistry used in the hood and the overall efficiency of the filters, before we have seen release NO greater than 1% of the TLV, at the filters exhaust, of the cumulative chemicals used in the hood. Sensors are integrated within the hoods fan modules, located past the primary stage of filtration. These sensors will detect any possible breakthrough at levels which will not exceed 50% of the TLV. However, in addition to a primary level of filtration, redundancy filters are also integrated to further guarantee exposure limits are at an absolute minimum. Because of this, even at detection, we still guarantee release at the filters exhaust will not exceed 1% of the TLV of the cumulative chemicals will be released. All false sense of security theories are invalid. Erlab has never hinged our customers safety, on a false sense of security in the hopes that our technology works. It is validated and guaranteed. In fact, we at Erlab hold ourselves completely accountable, providing not only initial validation, but periodic follow up’s through our ESP program, ensuring our customer satisfaction and complete safety, at all times. This in addition to our communication of the hood’s performance criteria refutes any statement of a false sense of security. In fact, one can even say that Erlab’s technology provide additional security measures not available on a tradition ducted hood.”

University statement**:** *“The ductless hood's appeal is largely economical because it does not require the expensive ductwork that traditional hoods need to exhaust fumes to the outside. However, in practice these hoods require constant attention and, if not carefully selected, don’t provide adequate protection.”*[10]

Erlab: “The above statement is simply not true with Erlab’s technology. The hoods are designed with SMART® technology that literally allows the chemist and/or students to focus on their work, not the hood. One touch of the power button activates the hood and SMART® technology, constantly working to filter, detect and provide real-time communication of the hood performance. If performance has been compromised in any way, the SMART® technology will offer several forms of communication and has the ability for 24/7 remote monitoring. Maintenance is extremely simple with the filters being replaced on average every 2 years, a simple process with no tools required. Furthermore, the filter replacement schedule is monitored by Erlab’s safety specialist, so the customer doesn’t have to.”

University statement: *"In many cases, the filter is designed for specific chemicals and will not protect against the variety of current and future chemicals used in a typical research university lab. The problems associated with breakthrough and with desorption of vapors from the absorbent material plague ductless fume hoods."*[11]

Erlab: "Again, not true with Erlab's technology. With our 50 years of research and development, we have engineered a broad range filter that captures organics, in-organics, acids and bases. There is absolutely NO reason to change the filter based on chemistry. As for desorption, this is eliminated with Erlab as we have a complex system which works to transform the molecule before migrating to our adsorbent media. It is here the final adsorption process takes place. Because of this process, the capacity within each filter is massive, as the surface area is not interrupted by impregnated solutions. Furthermore, we have independent TCLP test data of used filters from a research chemistry department, proving that there is no desorption, or leaching that occurs (test data available upon request)."

University statement: "Departments would also face expenses to change charcoal filters and to dispose of the old/used filters, which would be classified as hazardous waste."[12]

Erlab Rebuttal: "Not true. Erlab performed studies and has a contract with Veolia environmental for disposal where the filters are not labeled as hazardous material. Again, this is due to the breakdown of the molecule before migrating to the adsorbent material. The total cost for disposal with Erlab is $45 per filter. As for the cost of the filters; yes, this is an expense, but when you look at the overall costs associated with ducted hoods, this is offset significantly (calculations can be performed upon request). In fact, because of the economical savings associated with Erlab's technology, we are the cornerstone to facilities achieving LEED silver plus and ZNE. If we breakdown the cost a bit further, the average annualized saving per six-foot hood is $4,000. This savings includes the cost of filters and disposal. Now, it must be pointed out that this is not true for all ductless fume hoods, as they are certainly not created equal. You must be able to achieve an average filter life cycle of 2+ years, with the average university changing their filters every 5 years. This can only be achieved because of Erlab's advanced molecular filtration technology."

Erlab filter experts went on to define their process in comparison to some of the regulations or best practices often stipulated in University procedural safety documentation (•) for Ductless Filtered Fume Hood Installation:

- Mandatory performance of a hazard assessment related to its use in their location

Erlab: *A total chemical assessment is completed by all our customers and provides our PhD chemist the necessary information needed to validate their handlings to determine applicability, and overall efficiency of the filters. This efficiency determines the overall life cycle of the filters. This "life cycle" of the filters is the point at which we have seen some release, but not exceeding more than1% of the TLV (Threshold Limit Value).*

•Using it according to manufacturer instructions and recommendations

Erlab: *This applies to all laboratory equipment. All safety protocols and standards must be adhered to when using any safety devise to ensure performance is not compromised. However, we make following these guidelines simpler, with our SMART technology, monitoring all performance criteria of the hood's performance.*

•Using it only for nuisance vapors and dusts that do not present a fire or toxicity hazard

Erlab: *Though nuisance odors are absolutely captured extremely well, this is not the only use of Erlab's filtered fume hood. In fact, with the robust capturing abilities that our technology offers, we can handle chemistry handlings which include; synthesis, titration, extraction, organic & inorganic chemistry, mixing and research, to name a few. The filters are not flammable even when "saturated". This is a misconception that many people have. However, while a solvent is a flammable when free in the air, each solvent has different properties and needs sufficient energy to burn (ignition temperature). Because these solvents are adsorbed on a porous structure, like activated carbon, it is extremely challenging to burn as the energy needed to burn is a combination of energy needed for desorption and energy needed to ignite the molecule. Because the molecules strong bond within the porous structure (activated carbon), it is extremely challenging to get "the fuel" into the gas phase, therefore, the larger the activation energy needs to be.*

Below is an example of official postings in labs (•), and on solvent dispensing equipment, which often states the following info for users and lab personnel as part of the institution's safety plans.

Posted •The chemicals allowed to be used in the hood

Erlab: This is provided as part of the validation process and published chemical listing of approved chemicals

Posted •The type of filter used, its limitations and change schedule

Erlab: This is provided as part of the validation process, which provide an overall efficiency of the filter's performance and the appropriate filter configuration.

Posted •Filter collection efficiency and breakthrough properties may change where multiple chemicals are used, resulting in earlier filter breakthrough

Erlab: As we validate the customer handlings based on all chemistries used within the hood, early breakthrough and detection properties shouldn't change under normal operating conditions. With our vast knowledge, we understand the mixture of chemicals and what the potential of gasses generated may be. Furthermore, as we absolutely detect for the breakthrough of a prominent chemical, which is determined by its vapor pressure, and molecular weight, we also utilize a broad range PID, which allows for us to detect vast variation of solvents, or acids.

Posted •Notice and warnings that the hood recirculates air inside the room and many low molecular weight chemicals can be stripped from the filter and reenter the room

Erlab: While this may be true for many others brands, Erlab takes a completely different approach to molecular air filtration, eliminating the potential derogation of the adsorbent to retain the molecules. How? – because we prepare the molecule for the carbon. This process transforms the molecular structure. Additionally, if any desorption does occur, it is guaranteed to be at such low levels (less than 1% of the TLV), there is absolutely no reason to be alarmed or concerned, as this is also far less than ASHREA allows for re-entrainment with ducted hoods. And with the required laboratories fresh air exchange rates (ACH) all, if any, release will be taken out by ACH.

**All above bullet points have been answered through the Erlab validation process, published chemical listing, and independent studies. **

Completing the search for the safe and simple dispensing of solvents in the lab environment

Part II – Cabinet and dispensing components complete the total product solution.

The cabinet and dispensing components of a solvent dispensing system, from a quality manufacturing industry leader such as Pure Process Technology, are paramount to the overall safety and success of any SDS. The combination of these components, with Erlab's SMART® technology and filtration system, however, comprise a revolutionary product called PureCapture™ SDS (Solvent Dispensing System). This marriage of technology (Erlab) and engineering (Pure Process Technology), celebrates a new and improved method of solvent dispensing that should be given serious consideration by every lab director responsible for personnel, lab safety and efficiency.

The PureCapture™ SDS cabinet frames are constructed with durable extruded aluminum, and a phenolic resin tabletop work space that is mounted to an extrusion frame, while kegs** are stored securely under the tabletop in a stainless-steel safety cabinet. All cabinets are designed in accordance with specs from the National Fire Protection Agency and comply with OSHA regulations. They are composed of a double wall with 1 1/2" air space and leakproof sills in the event of accidental spills. In addition, each cabinet has a self-closing mechanism that is segregated from the hazard area and a fusible link assembly. The link melts at 165°F for automatic closure in case of fire. All cabinets come with an NFPA compliant, FM defined static ground connection. A dispensing valve plate with color coordinated controls is mounted to the extrusion frame to allow safe dispensing of solvents, likewise all vessels, hoses, piping and valves, are color coded to ensure that when using the system, the operator knows exactly which solvent they are handling. All vessels and take-off valves are clearly labeled with the solvent name as well.

Pure Process Technology
Delivering Pure Solutions On Demand

Basis of operations for the Pure Process Technology PureCapture™ SDS

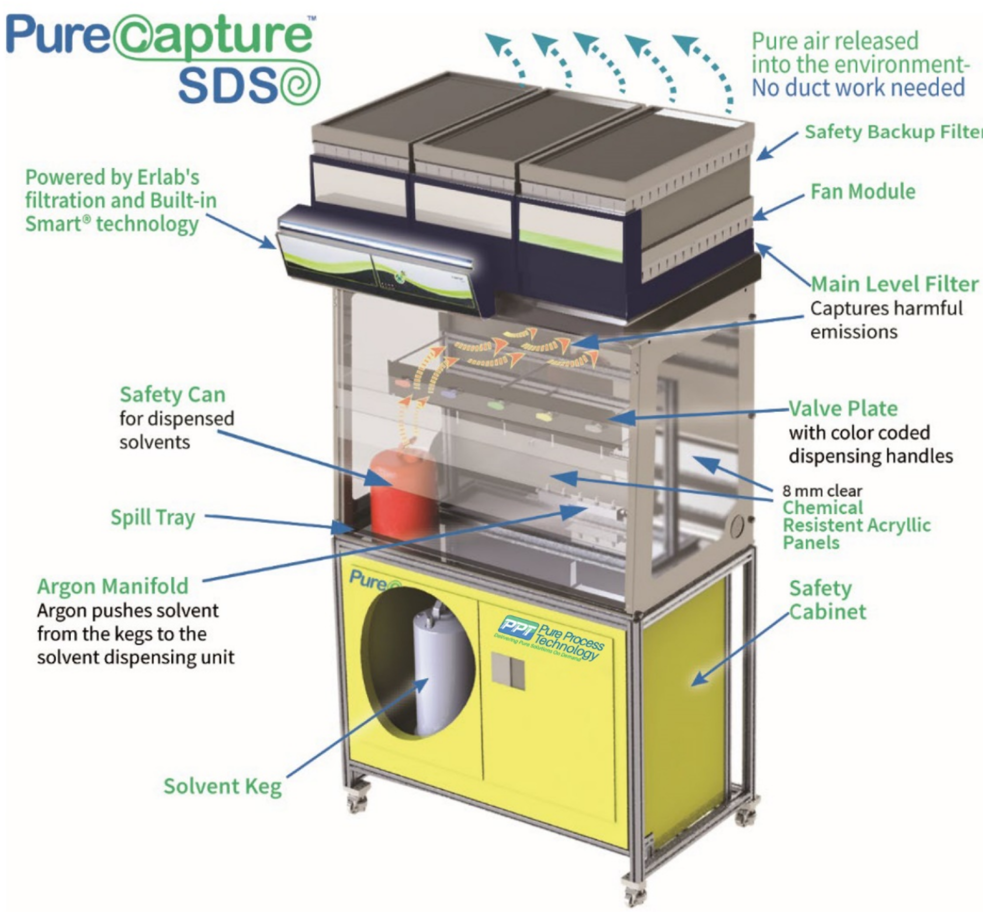
PPT's dispensing systems are operated with an inert gas such as argon or nitrogen.* (see system flow graphic below) The inert gas is plumbed into the solvent kegs** and pushes the solvent out of the vessel to the dispensing point through either stainless-steel lines or teflon lines with a stainless steel over braid. The system remains under constant pressure (5-8psi) with the POU (point of use) valve being the end point. Dispensing valves are stainless steel with teflon seats and function as simple on/off valves.

Solvent keg size is typically in the 5-20-gallon range. Vessels are re-filled or swapped out as needed, this occurs on some regular basis. Some systems utilize pre-filled vessels, and these are swapped out simply by disconnecting the empty vessel and connecting the full one. Quick couplings are the recommended easiest method to avoid spills.

*Argon/nitrogen not supplied with system. **Solvent Kegs are not included with system purchase unless requested.

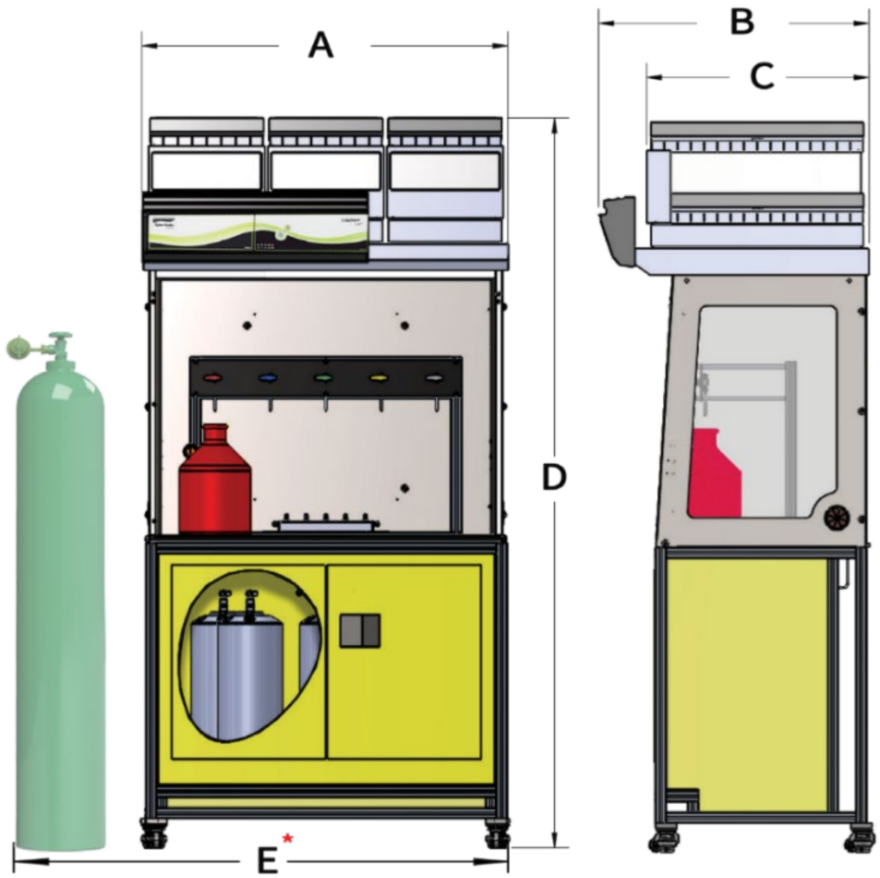
PureCapture™ SDS

Solvent dispensing system flow graphic



PureCapture™ SDS

Product specifications



	A	B	C	D	E*
PC-SDS-4 Dispensing Capacity up to 6 solvents	51.25” (4’- 3-1/4”)	37.75” (3’- 1-3/4”)	31.00” (2’- 7”)	102.00” (8’- 6”)	66.75” (5’- 6-34”)
PC-SDS-6 Dispensing Capacity up to 9 solvents	71.50” (5’-11-1/2”)	37.75” (3’- 1-3/4”)	30.88” (2’-6-7/8”)	103.35” (8’-7-1/4”)	91.50” (7’-7-1/2”)
*Argon tank shown as item E is for dimensions only, not included with system. Kegs are not included with system unless requested.					
115 volts required for fan filter unit					

For more information on the PureCapture™ SDS contact Peter Sampson at 603-598-0691 or psampson@ppttech.com

Conclusion

Laboratory directors and purchasing agents have the difficult, time-consuming responsibility of recommending large state-of-the-art equipment for lab use that will fit budget, space, personnel safety and research requirements. This document presents the facts on SDSs to aid and guide decisions when choosing the best solvent dispensing system for safety and accurate research results.

Executive Summary

Based on the supporting facts in this document, we submit that the clear choice for laboratory solvent dispensing is PureCapture™ SDS, an innovative solvent dispensing system designed to reduce risk and increase safety for lab personnel without the need for HVAC venting. In addition to PPT's secure safety cabinet, rugged frame, stainless steel dispensing, expert engineering, and color coordinated security controls, the system has the benefit of Erlab's integrated filtration technology including an innovative fume hood that traps and retains a broad range of molecules which includes, organics, inorganics, acids and bases with one filter. This is all done while protecting the environment from harmful emissions being released into the atmosphere. Removing the HVAC component, drastically reduces a complex installation process and provides a substantial annual cost savings on energy. Your lab can reduce their overall carbon footprint, without the need for duct work, while reducing infrastructure and energy cost.

About Our Companies

The PureCapture™ SDS with SMART® technology and advanced filtration system is a collaborative manufacturing endeavor brought to market by Pure Process Technology, an innovative solvent dispensing system industry expert, with over two decades of successfully designing, manufacturing, and maintaining standard and customized purification & dispensing systems, and Erlab, a 50 year international leader in the field of filtered laboratory safety enclosures, whose quest is to transform current laboratory environments into zero emission laboratories, while also providing a safer laboratory environment.

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Source reference links:

[1]Solving the Safety Challenges of Solvents. Excerpt from Blog: Solving the Safety Challenges of Solvents, by Safety Management Group
https://safetymanagementgroup.com/solving-the-safety-challenges-of-solvents/

[2]*Source: The most common injuries in a chemistry lab. Author-Anne Marie Helmenstine, Ph.D. Updated July 08, 2018.*
https://www.thoughtco.com/most-common-injuries-in-chemistry-lab-608153

[3] *Source: EPA Air Toxics*
URL: https://www.epa.gov/sites/production/files/2016-09/documents/hexane.pdf
Description: EPA Health Effects Notebook for Hazardous Air Pollutants

Hexane properties referred to in article link:
H225: Highly Flammable liquid and vapor [Danger Flammable liquids]
H304: May be fatal if swallowed and enters airways [Danger Aspiration hazard]
H315: Causes skin irritation [Warning Skin corrosion/irritation]
H336: May cause drowsiness or dizziness [Warning Specific target organ toxicity, single exposure; Narcotic effects]
H361f ***: Suspected of damaging fertility [Warning Reproductive toxicity]
H373 **: Causes damage to organs through prolonged or repeated exposure [Warning Specific target organ toxicity, repeated exposure]
Laboratory Chemical Safety Summary for CID 8003
https://pubchem.ncbi.nlm.nih.gov/compound/8058#datasheet=lcss&section=Top

[4]*Source: EPA Air Toxics*
URL: https://www.epa.gov/sites/production/files/2016-09/documents/acetonit.pdf
Description: EPA Health Effects Notebook for Hazardous Air Pollutants

Acetonitrile
GHS Hazard Statements- Signal:Danger
H225: Highly Flammable liquid and vapor [Danger Flammable liquids]
H302: Harmful if swallowed [Warning Acute toxicity, oral]
H312: Harmful in contact with skin [Warning Acute toxicity, dermal]
H319: Causes serious eye irritation [Warning Serious eye damage/eye irritation]
H332: Harmful if inhaled [Warning Acute toxicity, inhalation]
Laboratory Chemical Safety Summary for CID 8003
https://pubchem.ncbi.nlm.nih.gov/compound/6342#datasheet=lcss&section=Top

[5]*Source: Human Metabolome Database (HMDB)*
URL: http://www.hmdb.ca/metabolites/HMDB0000246
Description: The Human Metabolome Database (HMDB) is a freely available electronic database containing detailed information about small molecule metabolites found in the human body.

THS
GHS Hazard Statements – Signal:Danger
H225: Highly Flammable liquid and vapor [Danger Flammable liquids]
H319: Causes serious eye irritation [Warning Serious eye damage/eye irritation]
H335: May cause respiratory irritation [Warning Specific target organ toxicity, single exposure; Respiratory tract irritation]
H351: Suspected of causing cancer [Warning Carcinogenicity]
Laboratory Chemical Safety Summary for CID 8003
https://pubchem.ncbi.nlm.nih.gov/compound/8028#datasheet=lcss&section=Top

[6]*Source: CAMEO Chemicals*
Physical Description from CAMEO Chemicals
URL: https://cameochemicals.noaa.gov/chemical/1288

[7] *Source: The National Institute for Occupational Safety and Health (NIOSH) https://www.cdc.gov/niosh/ipcsneng/neng0534.html*

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Pentane
GHS classification: Danger
H336 (90.65%): May cause drowsiness or dizziness [Warning Specific target organ toxicity, single exposure; Narcotic effects]
H340 (93.68%): May cause genetic defects [Danger Germ cell mutagenicity]
H350 (95.78%): May cause cancer [Danger Carcinogenicity]
H361 (57.97%): Suspected of damaging fertility or the unborn child [Warning Reproductive toxicity]
H372 (21.08%): Causes damage to organs through prolonged or repeated exposure [Danger Specific target organ toxicity, repeated exposure]
H373 (36.89%): Causes damage to organs through prolonged or repeated exposure [Warning Specific target organ toxicity, repeated exposure]
Laboratory Chemical Safety Summary for CID 8003
https://pubchem.ncbi.nlm.nih.gov/compound/8003#datasheet=lcss&section=GHS-Classification

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[12] University of Milwaukee, Office of safety and health/Ductless/ Fume Hoods: Procedures and Practices / Fume Hood Policy. Source - https://uwm.edu/safety-health/laboratory-equipment/