Safe and Appropriate Application of Filtered Fume Hoods

by Ken Crooks
Director, GreenFumeHood Technology

Agenda

- Review advances in Filtered Fume Hoods.
- Determine safe and appropriate applications
- Understand best practices via case studies.

Image Credit: McMaster Univ.

Ductless Hoods (aka “filtered enclosures”)

- Routine, repetitive procedures
- Limited chemical handlings
- User ‘Ownership’ and User-based safety
- Manual or minimal automatic filter testing
- Limited changes to usage
- Portable, lightweight, low cost

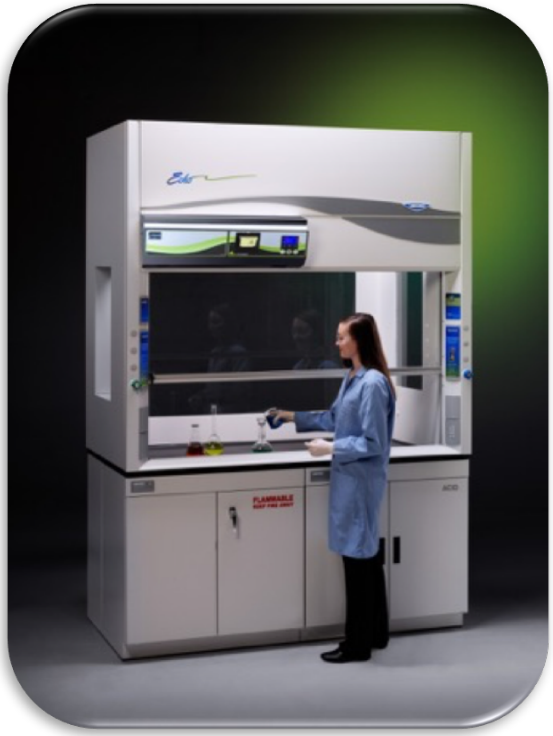
Filtered Hoods (aka “green hoods”)

- Teaching / Instructional use
- Controlled research
- Greater chemical handlings
- Automatic, continuous filter testing
- Connectivity with EH&S and Facilities
- Broader range of change is acceptable
- Fixed in place, heavier, costlier than ductless

Ducted Hoods (aka “hoods”)

- Research & Development
- Greatest chemical handlings
- Few limitations (e.g. Perchloric, Acid Digestion, Radioisotopes)
- Connectivity with EH&S and Facilities
- Broadest range of change is acceptable over life of hood
- Fixed in place, heavy, highest total first and operational costs

Filtered



Improvements: vs.

Universal Filtration

Detection

Communication

Hood Structure

Sash Design

Services/Utilities

Sizes

Ductless

Image Credit: Labconco Corp.

Operational Protocols

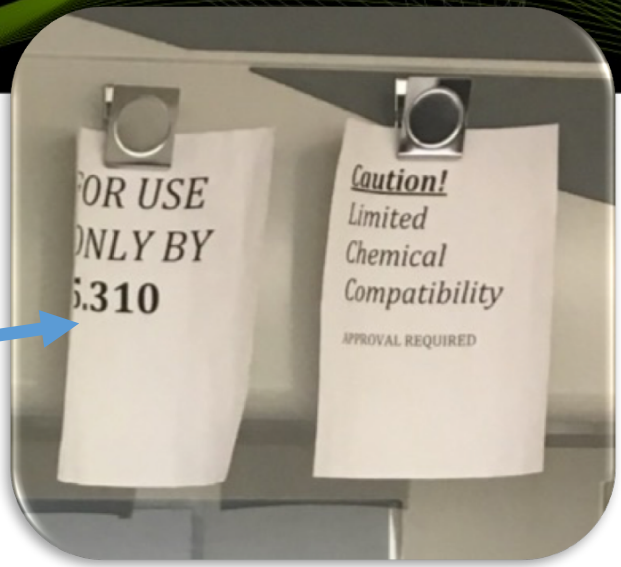
- **Ductless and Filtered Hoods:**
  - Personnel training – proper usage
  - Signage of limitations
  - Administration-level control of chemicals introduced
  - SOP for change of usage
  - Scheduled maintenance (filters, sensors)

- **Ducted Hoods:**
  - Anything goes? No, some limitations
  - Scheduled Maintenance (fans, flow control device, etc.)
  - Training

- **All hoods:**
  - Flow alarms (audible and visual)
  - Periodic testing (face velocity, containment)


FILTERED FUME HOOD
AIRFLOW DIAGRAM
FOR USE WITH SUBSTANCES
that produce hazardous levels of airborne chemicals: gas, fumes, and vapors. HEPA filter required for: aerosols and dust.
DO NOT USE WITH:
Organophosphoric Compounds
Mercury
Hydrogen Cyanide
Radioisotope
Perchloric Acid
Highly exothermic reactions
NOT RETAINED WELL:
Helium and the Noble Gases
Hydrogen
Ethane
Ethylene Oxide
Methane
Carbon Monoxide
Carbon Dioxide
Nitrogen Monoxide
Propylene
Propyne, Propane
Acetylene
SERVICE ACCESS

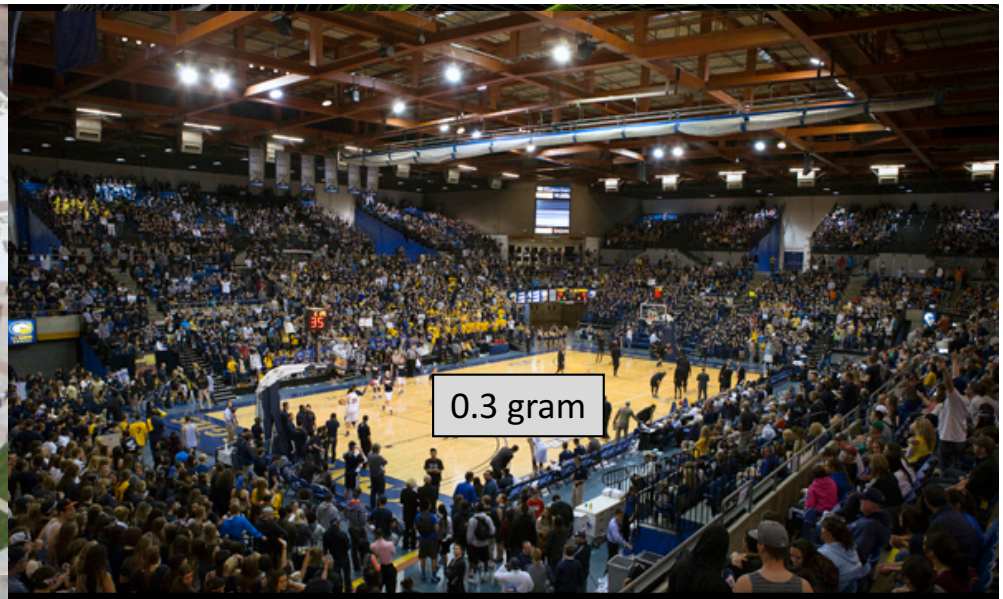

FILTERED FUME HOOD
SAFETY PRACTICES
FOR USE WITH SUBSTANCES
that produce hazardous levels of airborne chemicals: gas, fumes, and vapors. HEPA filter required for: aerosols and dust.
Do not put your head in the hood.
Minimize drafts and sudden movements in front of the hood.
Work a minimum of six inches inside the hood.
Elevate equipment above the work surface.
Keep sill and baffle unobstructed.
Do not use the hood for storage.
Adjust the sash to smallest opening possible when in use.
Close sash when unattended.
Do not remove any of the hood components.
Do not place flammable solvents near heat, flame or sparks.
Do not evaporate large amounts of liquids.
Wipe up spills immediately.
Routinely validate airflow.
If airflow alarm indicates unsafe condition, immediately close sash, discontinue hood operation and call for help.
SERVICE ACCESS


OR USE
NLY BY
5.310
Caution!
Limited
Chemical
Compatibility
APPROVAL REQUIRED

Carbon-based Filtration, Activation Process

- Organized structure
- Steam & Heat creates spaces between carbon layers
- 15,000 ft^2 surface area per gram

3 grams



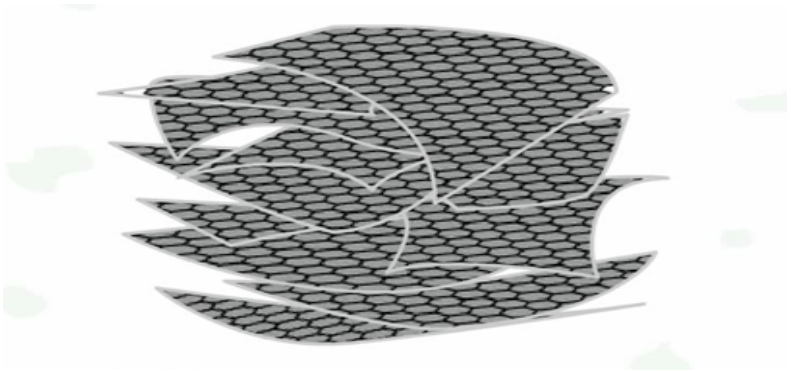
0.3 gram

1 gram

8ft Hood

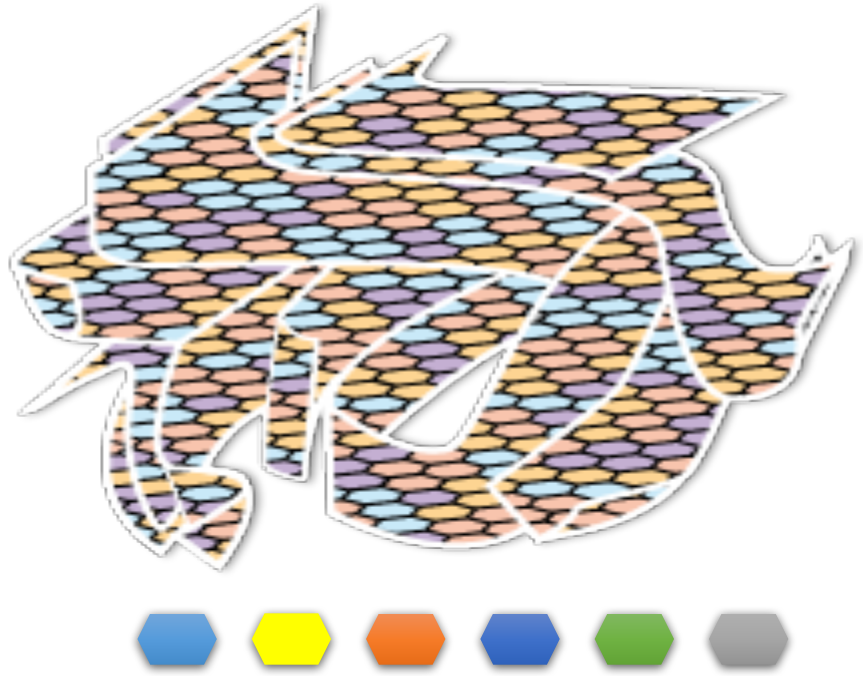
Activation Process

- Impregnation problem: decreases capacity
- Past use of heavy metals to increase capacity
- Specific filters types: (AS, BE, K, F, G…)



Filtered Fume Hood Media

- Universal filtration technology retains:
  - Polar organic solvents
  - Non-polar organic solvents
  - Inorganic Bases
  - Inorganic acids

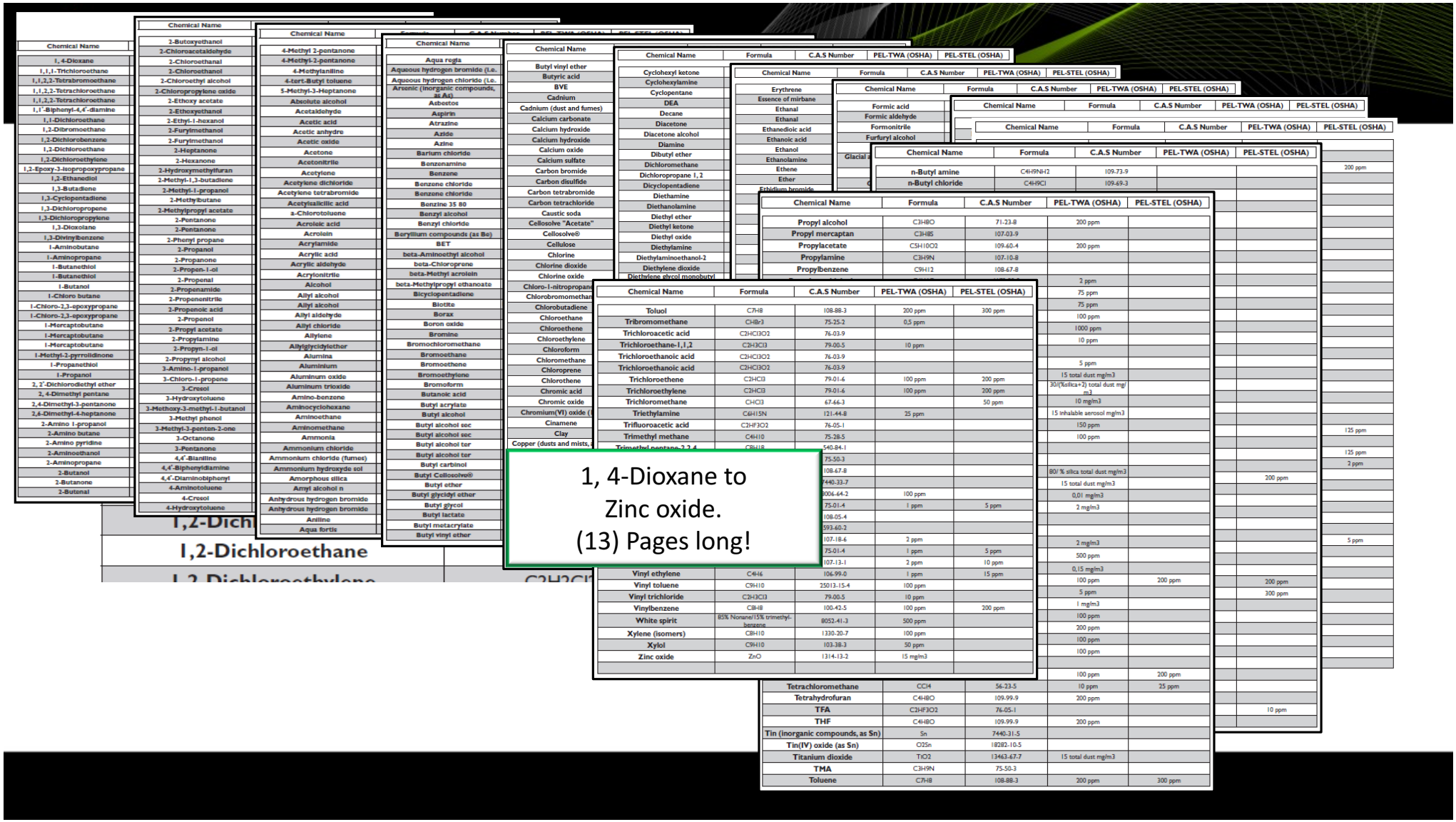


Application Review

- Steps to Evaluate Acceptability are:
  - Chemical Lists as per AFNOR NFX 15-211
  - Detailed chemical questionnaire
  - Analysis report: Approved or Denied
  - Programming sensitivity of sensors

Chemical “Long List”

- 500+ chemicals, each tested with 6 or more different concentrations.
- Each test performed twice.
- Represents thousands of chemicals.


1, 4-Dioxane to
Zinc oxide.
(13) Pages long!

Chemical “Short List”

Not retained well (gases):

1. Hydrogen
2. Helium and all Noble Gases
3. Methane
4. Ethane
5. Ethylene Oxide
6. Carbon Monoxide
7. Carbon Dioxide
8. Nitrogen Monoxide
9. Propylene
10. Propyne, Propane
11. Acetylene
12. SOx and NOx

Applications not recommended:

- Perchloric Acid, Radioisotope or Acid Digestion Hoods
- Highly exothermic reactions
- Mercury - Well retained but remains extremely toxic (TLV = 0.05 ppm) and difficult to detect
- Evaporations

Use Best Practices:

- Large volumes of Methanol, Ethanol, Acetonitrile need condensers or closed containers.

Chemical Review Spreadsheet

Type of handling	CHEMICAL NAME	TYPE OF CONTAINER	Opened / Closed	Dilution (%)	Temperature (°C)	Handling Frequency	Handling Quantity	Duration (min)
CONCENTRATION	ACETIC ACID	VOLUMETRIC FLASK	Opened	0.82%	22°C	From 1 to 2	From 26 to 50 ml (or g)	From 46 to 60 min.
CONCENTRATION	BENZOIC ACID	VOLUMETRIC FLASK	Opened	0.99%	22°C	From 1 to 2	From 26 to 50 ml (or g)	From 46 to 60 min.
CONCENTRATION	HYDROCHLORIC ACID	VOLUMETRIC FLASK	Opened	0.38%	22°C	From 1 to 2 handlings/month	From 76 to 150 ml (or g)	From 46 to 60 min.
EVAPORATION	BUTYL ALCOHOL	VOLUMETRIC FLASK	Opened	0.99%	22°C	From 1 to 2 handlings/month	From 26 to 50 ml (or g)	From 46 to 60 min.
EVAPORATION	ETHYL ALCOHOL	VOLUMETRIC FLASK	Opened	0.82%	22°C	From 3 to 4 handlings/month	From 76 to 150 ml (or g)	From 46 to 60 min.
EVAPORATION	ISOPROPYL ALCOHOL	VOLUMETRIC FLASK	Opened	0.99%	22°C	From 3 to 4 handlings/month	From 76 to 150 ml (or g)	From 46 to 60 min.
EVAPORATION	METHYL ALCOHOL	VOLUMETRIC FLASK	Opened	0.99%	22°C	From 3 to 4 handlings/month	From 26 to 50 ml (or g)	From 46 to 60 min.
DILUTION, WEIGHING	SODIUM BICARBONATE	VOLUMETRIC FLASK	Opened	1%	22°C	From 1 to 2 handlings/month	From 0 to 5 ml (or g)	From 46 to 60 min.
DILUTION, WEIGHING	SODIUM BROMIDE	VOLUMETRIC FLASK	Opened	1%	22°C	From 1 to 2 handlings/month	From 0 to 5 ml (or g)	From 46 to 60 min.
DILUTION, WEIGHING	CALCIUM CARBONATE	VOLUMETRIC FLASK	Opened	0.9%	22°C	From 1 to 2 handlings/month	From 0 to 5 ml (or g)	From 46 to 60 min.
DILUTION, WEIGHING	SODIUM CARBONATE	VOLUMETRIC FLASK	Opened	1%	22°C	From 1 to 2 handlings/month	From 0 to 5 ml (or g)	From 46 to 60 min.
EVAPORATION	CYCLOHEXANE	VOLUMETRIC FLASK	Opened	100%	22°C	From 1 to 2 handlings/month	From 11 to 25 ml (or g)	From 46 to 60 min.
EVAPORATION	CYCLOHEXENE	VOLUMETRIC FLASK	Opened	95%	22°C	From 1 to 2 handlings/month	From 11 to 25 ml (or g)	From 46 to 60 min.
DILUTION, WEIGHING	BARIUM CHLORIDE	VOLUMETRIC FLASK	Opened	97%	22°C	From 1 to 2	From 0 to 5 ml (or g)	From 46 to 60 min.

Chemical Review – Analysis & Report

GFH Approval Level: 1-4

1 Containment	Approved
2 Detection	Approved
3 Neutrodine Compatibility	Approved
4 Neutrodine Estimated Life Expectancy	Approved

Comments

Solvent trigger: 3600 Expected filter lifetime: M2: 24 Months M3: 24 Months M4: 24 Months M5: 24 Months

Cedric Herry (PhD)
R&D Manager

Feasibility Study performed by: Cedric Herry, PhD - ERLAB
ERLAB has approved the use of the GFH technology based on the information provided by the client. Client acknowledges that the GFH technology should always be used in accordance with approved usage.

Detection at <1% TLV Exposure

- Suite of Detectors:
  - Acid
  - Solvent
  - Lab Ambient Air
  - Temperature
  - Sash Sensor

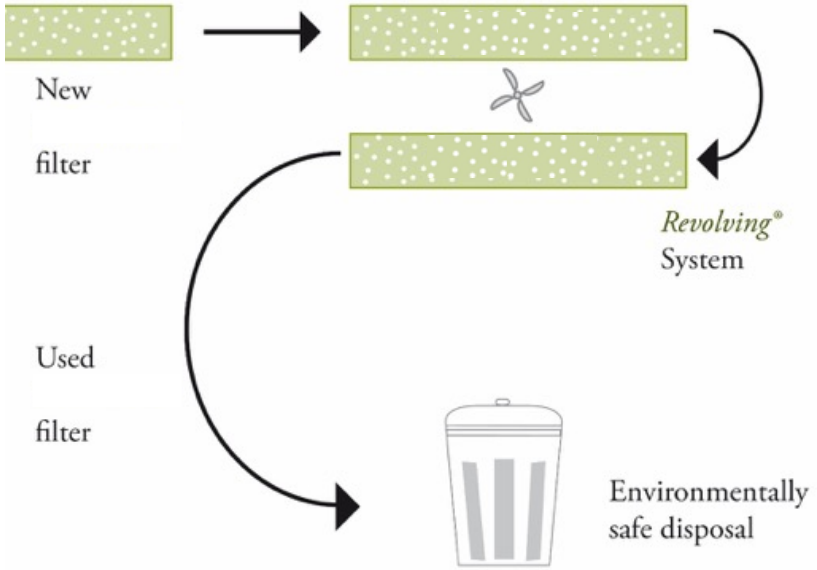
(side view of hood)

Standards / Certification

- Containment: **ASHRAE Std. 110** in North America
- Retention: **AFNOR NFX 15-211**
  (as referenced in ANSI Z9.5-2012)
  - All (3) phases of operation
  - Class 1 (back-up filter)
  - Class 2 (no back-up filter)

Filter Replacement/Disposal

- Standard PPE
- Secondary filter becomes primary, new secondary installed
- Old filter incinerated through your established process and vendor, or TCLP testing.



Bridgestone Technical Center

- Akron, OH
- 4-story research building
- 265,000 Sq.Ft.
- (600) employees
- Wet Chem Lab
- (12) Fume hoods:
  - (11) Filtered
  - (1) Floor-Mounted
- LEED Gold (v2.2)

Image Credit: SoL Harris/Day Architecture

Bridgestone Technical Center

- Tested a filtered hood for 20 months, over 300 chemicals
- Purchased 10 more hoods
- $5,000 annual energy savings per hood ($60k/yr total)
- 32% less total building energy consumption

Image Credit: SoL Harris/Day Architecture

Bridgestone Technical Center

Operational Costs:

- Filter replacements = $4,000 in 3 years
- Acid Sensor replacements = <$3,000
- Misuse repairs for acid digestion = $11,240 (includes all new technology and filters)
- Estimated energy cost savings = $165,000

- Net savings = $146,000+ in 3 years

U of Rochester – Hutchinson Hall

- $1.5mil, 6-month Renovation
- Organic Chemistry Teaching
- (15) Fume hoods:
  - (13) Filtered
  - (2) Ducted (Dispensing)
- Supply and Exhaust system ‘challenges’

Image Credit: Univ. of Rochester

U of Rochester – Before

U of Rochester – After

- Operating costs savings: $136,100 annually
- 300% increase in hoods!

- NYSERDA rebate: $36.6k
- GFH portion: $12,975
- Annual kWh Savings: 32,727
- Peak Reduction: 110.5 kWh
- Fuel Savings: 8,233 Therms

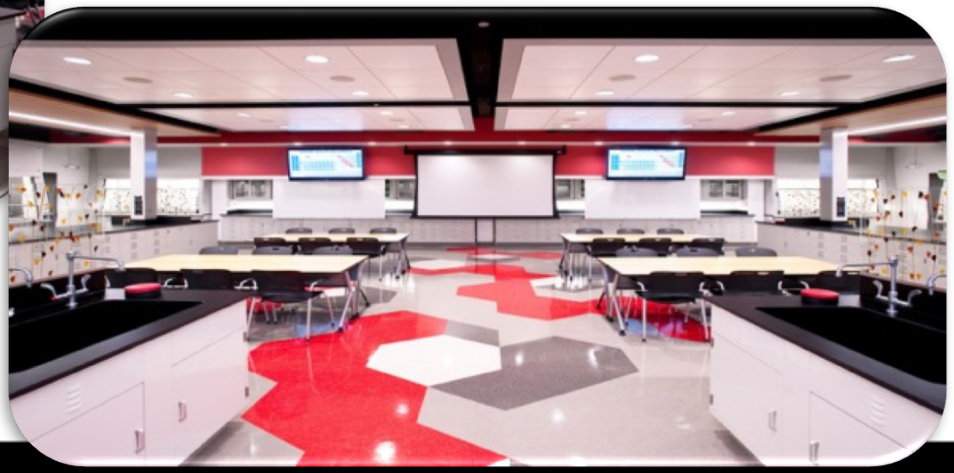
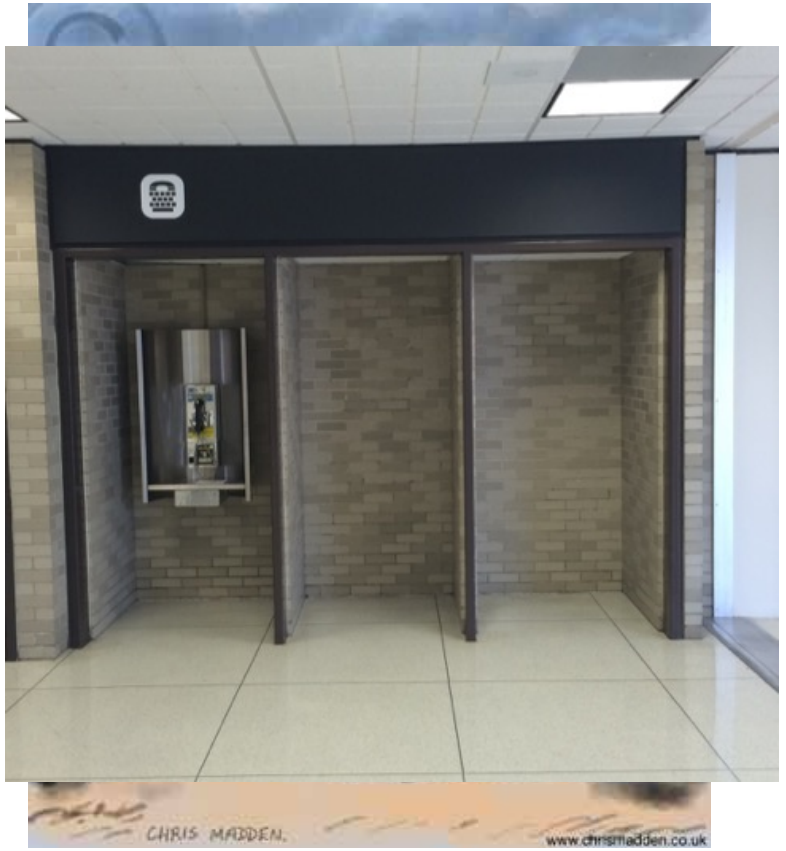


Image Credit: Univ. of Rochester

FINAL THOUGHTS

- Pollution is Pollution regardless of Dilution!
- Safety and increased flexibility.
- Lower first costs AND operational cost savings.

There is a better way!



Thank You

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