The Science & Compliance of process pollution control –

Air in its most natural, purified form is colorless, odorless and tasteless, completely free of unnatural elements – and except for laboratory or CleanRoom environments, hard to find on planet earth. Fortunately mankind has evolved to the point where air of absolute purity is not necessary to survival, or even normal life - built-in respiration systems protect us from the need.

Regardless, the workplace environment must be kept free of pollutants that influence health and comfort, affect the products or components we manufacture and damage our machinery and buildings - and Fumex air purification systems can make this a workplace reality.

Legally binding workplace air quality standards in the USA are established and regulated by the Occupational Safety & Health Administration (OSHA), industrial processes that are exhausted outdoors are regulated by the Environmental Protection Agency (EPA).

Achieving and maintaining OSHA mandated workplace air quality standards has become more complicated though, due to the proliferation of newly-formulated, synthetic materials being processed at ultra-high speed - generating plumes of gas and particulate of unknown composition and unexpected volume. To cope with these uncertainties Fumex has developed a line of next-generation air purifiers with intrinsic high flexibility and efficiency on a wide range of gaseous and particulate contaminants.

Fumex Air Cleaners combine dust removal and gas/odor control for intermittent or continuous-duty processes.
Hybrid units with simple or sophisticated control systems provide efficient, economical control for a wide range of pollutants.
Self-Cleaning air cleaners purge dust and gaseous pollutants from high-volume, continuous-duty processes at
the lowest possible operating cost – and automatic self-cleaning filtration and digital control operation are standard features.
Fumex Gas Scrubbers are available with a wide range of blowers and media that eliminate odors and gaseous
contaminants from the workplace environment for extended periods at low cost.

For unequalled performance select from the broadest range of high-efficiency air cleaners in the industry –
From light-duty, manually controlled dust collectors to continuous-duty dust/gas/odor control units with
intelligent filter monitoring and microchip controlled gas-specific sensors

SOURCE CAPTURE HOODS –
Shape, Size & Placement are critical
to performance
Optimum hood size and type is determined by the
dynamics and geometry of the pollution source.
Enclosing hoods have highest efficiency but are
large in size and have large air volume requirements.
Non-enclosing hoods are very effective with proper
design and placement considerations.

High volume, Low velocity Source Capture Hoods

Enclosed Plenum
High efficiency, least affected
by room air currents.
Requires openings for
inspection and maintenance.

High Velocity Slot
Very effective using
proper shape, size,
positioning and
capture velocity.

Receiving Type
Provides high efficiency on buoyant plumes with negligible room cross currents.

High velocity, Low volume Hoods

Improve performance,
adding a flange
to the hood perimeter improves capture
velocity and expands
the capture envelope
in front of the
hood by 25%

Pollution
Source

The importance of slot hood placement -
If Hood A required 100 cfm for effective plume capture
Hood B would need 400 cfm to achieve equal efficiency.

ALL FUMEX HOODS FEATURE A
SMOOTH, WELL-ROUNDED ENTRY
FOR OPTIMUM POLLUTANT CAPTURE.

A blower's ability to forcefully BLOW air should not be confused with a very limited effect on the inlet or suction side. To maximize plume capture, place slot hoods as close as possible to the pollutant source.

Blowing – 10% of face velocity is realized 30 diameters from jet opening.

Suction side - 10% of face velocity is felt a maximum of just 1 diameter from inlet opening.

4,000 fpm face velocity at face

Capture

PARTICLE FILTRATION – The Principles of Mechanical Air Filtration

Relative sizes of airborne pollutants
Particle diameter, microns – log scale

0.0001
0.001
0.3
1.0
10
100
1,000
Gas molecules
Lung-damaging
Mists
Diameter of human hair
Fume
Dust
Electron microscope
Microscope
Visible w/ human eye
Gas Scrubber Cells
HEPA Filters
99.97% efficient @ 0.3 µ
Dustbags
99% efficient @ 1.0 µ
MERV 11 Panel filters
ASHRAE 52.2 Test Standard

Fumex filters -
effective range, by filter type

Represents 10 micron diameter particle,
the smallest size visible to the human eye

Represents a 0.3 micron diameter particle.
HEPA filters remove over 99.997 % of particles this size

This dimension represents the diameter of an average human hair = 100 microns

Fumex Hybrid Filtration System

A. The primary filter is a large capacity, low cost dustbag that removes large particles to a 1.0µ level; it protects the more expensive HEPA filter from premature loading.

B. A large capacity HEPA filter removes 99.997% of residual pollutants to a 0.3 µ level; virtually particle-free air is then passed to the gas cell.

C. The standard gas cell containing 15 lbs. of blended activated carbon and alumina impregnated with $KMnO_4$ is then used to purge a broad range of organic gases; numerous gas-specific adsorbent and chemisorbent media are optionally available.

Particle Filter Selection Guide
Type Construction Efficiency Range / Utility
Polyester

(prefiltration) Non-woven, multi-ply, non-toxic, with odorless “tackifier” adhesive incorporated into the media and skin backing on the exit side.Prefiltration of large particles. Graduated density provides high loading capacity and long life.

Panel Filters

(prefiltration) Electrostatically-charged, dual-layer synthetic media increases initial efficiency and provides high dust holding capacity. Media is laminated to galvanized steel backing for high stability during operation. Primarily used as a prefilter, MERV11 rating provides high initial and sustained efficiency, also used as a primary filter on non-hazardous dusts. 90% efficiency @ 10.0µ, 58% efficiency @ 1.0µ,

Dustbags

(prefiltration) Electrostatically-charged, laminated polypropylene with ultrasonically-sealed seams; high initial efficiency, low PD, chemical-resistant; high tear & burst strength.
Primarily used as a prefilter.
99% efficiency @ 1.0µ.

Multi-bag

(prefiltration) 100% synthetic media, galvanized steel frame and support ribs. Extended surface, primarily used as a prefilter, MERV9 rating provides high loading capacity for dry, bulk dusts.

HEPA

(final filter) Gasketed particle-board frame, individually leak-tested,
Class 2 UL Std. 900. High efficiency on respirable particles. 99.97% efficiency @ 0.3µ.

GASEOUS CONTAMINANT CONTROL – Gas Scrubbing

What is a Gas?

Gases are molecular, formless fluids that tend to occupy an entire space uniformly. Air is the most familiar gas on earth and as much as we reflexively think of it as a single gas, we know it a mixture of several gases – 78% nitrogen, 21% oxygen and lesser amounts of other gases and impurities. Air is compound like many of the process plumes encountered in industry – exothermic material processes in particular can produce complex plumes of gaseous and solid particulate of varying types, sizes and characteristics – laser-generated-air-contaminants are typical of this phenomenon.

How many Types of gas are there?

Gases are generally classified as: Toxic, Corrosive, Irritant or Odorous
Toxic effects are generally considered to be proportional to the dose. The allowable workplace concentrations for short exposures is, understandably, higher than for long exposures – refer to OSHA or ACGIH guides for specific gas information
Corrosive gases will damage machinery, electronic apparatus, even a building structure, or cause harm to humans , HCl for example from PVC processing.
Irritant gases include ammonia and chlorine and may cause discomfort or pain to the eyes, skin or respiratory system.

Controlling Gaseous Process Pollutants

Most manufacturing process plumes are complex fusions of gases and dust – they are seldom just ambient air carrying a solitary pollutant gas and dust particles of uniform size. Process plumes may be best described as concoctions of small and large solid particles swimming in a sea of molecular gases – often difficult to identify and quantify. To facilitate high removal efficiency on chemicals of such physical diversity requires equipment and media of great diversity and flexibility. Initially, an air handler must provide effective capture and transport of the pollutants to the air cleaner where carefully selected particle filters and gas cells provide high efficiency cleaning for extended periods at the lowest possible operating cost. A wide range of Fumex air purifiers and filtration media are available to ensure removal of the most difficult and hazardous of process pollutants.

Activated Carbon media is used to control most organic compounds; compounds with high molecular weight, increased concentration and lower temperatures favor activated carbon adsorption.
Impregnated Adsorbents (chemisorbents) are used when physical adsorption alone is too weak to remove a particular gas from a pollutants stream. Activated carbon or alumina may be impregnated, or infused, with a reactive chemical that covers the complete internal surface of the media. The impregnates react spontaneously and irreversibly with the gases, forming stable compounds which are bound to the media as organic or inorganic salts, or released into the air as CO, water vapor or a more readily adsorbed material.
Blended Media is a combination of unimpregnated and impregnated media is often used to improve both capacity and retentivity of contaminant gases.
Specialty media, numerous media is available to purge corrosive/highly toxic gases.

Characteristics of Common Gaseous Air Contaminants

	Allowable concentration, ppm							
Contaminant	IDLH (ppm)	TLV ppm	* Odor threshold	BP ºF	M			
methyl ethyl ketone peroxide ($C_8H_{16}O_4$)						0.20	16	244	176
acetone	2,500	250	62	133	32				
methyl alcohol (methanol)		6,000	200	160	147	32			
acrolein	2	0.1	1.8	127	56				
benzene		500	0.5	15	61	78			
toluene 2,4 diisocyanate		2.5	0.005	1.6	484	174			
ozone	5	0.10	0.2	-170	48				

IDLH, immediately dangerous to life & health. TLV, Threshold Limit Value (not to be exceeded in any 8-hr. shift of a 40-h week. BP, boiling point. M, molecular weight.
Organic substances with molecular weights greater than 300 are generally odorless.

- Odor threshold is detection threshold.

What is Odor?
Matter that stimulates human olfactory glands – humans detect the presence of certain airborne chemical compounds through stimulation of the olfactory glands in the nose.
The lowest concentration at which humans can detect an odor is referred to as the Threshold level – the lower the Threshold Level the lower the concentration at which humans can sense it.

Gas Measurement
Gas concentrations are usually expressed in ppm
(parts of contaminant per million parts of air by volume)
or ppb (parts per billion); 1,000 ppb = 1 ppm.