Using Activated Carbon Effectively for the Control of Gases and Odors

The advantages of removing airborne contaminants, odors and gases from industrial and commercial environments have evolved over time. Studies published in the peer-reviewed Indoor Air Journal, and on the website of U.S. Environmental Protection Agency (EPA) provide the "hard numbers" on IAQ's influence on workers' ability to perform tasks, the incidence of sick leave, and overall workplace productivity.

Markets that can benefit from the use of activated carbon (both standard and chemically-enhanced versions) include, but are not limited to, commercial buildings, health care, residential, pharmaceutical, microelectronics, nanotechnology, biotechnology, cabin air, personal protection, U.S. DOD, and many more. The filtration processes whereby activated carbon is typically employed are decontamination, purification, deodorization, protection and recovery.

Gaseous organic compounds and particulate are the most common issues in workplace IAQ. Virtually every sector of the manufacturing and process industries, and every department, from executive suite to loading dock that supports these operations – continuously release undesirable organic compounds, including the VOCs that cause sick building syndrome (SBS). New data shows that VOCs entering the indoor environment from the out-gassing of new construction materials, fabrics and carpet is not a temporary phenomena, but one that lasts for years after the materials are installed.

There is also important new evidence indicating that common process gases such as sulfur dioxide and hydrogen sulfide, even when released intermittently or in small concentrations, can be harmful – to people, processes, instrumentation, or artifacts.

Facilities as different as institutional buildings, chemical plants, semiconductor production, apartments and museums have a critical stake in providing clean indoor air.

One of the most effective means to eliminate organic compounds and gases is adsorption, specifically adsorption using activated carbon. Adsorption is the physics of attracting and retaining molecules of the undesirable compound on the surface of a solid, as a result of the solid's surface tension and other characteristics.

Activated carbon originates with carbonaceous materials such as wood, coal, lignite – or the shells from certain nuts – such as coconuts. The material is engineered for a specific porosity, with a greatly enhanced inner surface area that capture molecules of specific types and sizes.

This "engineered porosity" is created through one of two methods of activation. Thermal activation, which involves the application of high heat (1400-1800°F) is preferable for the small molecule adsorption needed in air filtration. Chemical activation, generally using phosphoric acid followed by moderate heat (575-750°F), is used to produce the carbons used to remove larger molecules.

Scrubber

Replacement trays

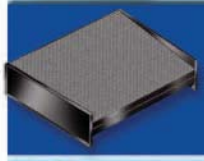
Side access housing

Vari-Pure® high capacity activated carbon filter

Vari-Klean™ ultra high efficiency gas phase adsorber

Fresh Air™ activated carbon pleated panel filter

CARBON PRODUCTS SELECTION CHART

	Concentration of Containment	Recommended Filter Type	Approx. Weight of Carbon per 24˝ x 24˝ Opening	Applications
	10 ppm and Up	Deep bed scrubbers with compartments containing granular activated carbon	Varies	Heavy industrial
	5 - 10 ppm	Large units with refillable trays containing granular activated carbon	60 - 72 lbs.	Industrial/Light commercial
	1 - 5 ppm	Modular housings with refillable V-bank trays or bonded carbon panel trays containing granular activated carbon	90 lbs.	Commercial/ Industrial
	0.5 - 1 ppm	Disposable cells with honeycomb panels containing granular activated carbon	18 - 26 lbs.	Very light commercial
	Low ppb - 500 ppb	Disposable cells with pleated textile media containing bonded carbon granules	7 - 9 lbs.	HVAC/Extremely light commercial
	Low ppb - 500 ppb	Disposable panels or pleated filters with bonded carbon granules	.25 - 5 lbs.	HVAC/Extremely light commercial

In addition to standard activated carbon, this media can be further enhanced using specific chemical treatments. These chemisorptive media can be used to target specific contaminants. For example, if one is attempting to remove acid gases such as hydrogen sulfide (the smell of rotten eggs), the activated carbon is typically treated with a base compound in order to neutralize the acids.

The benefits of using a well-designed activated carbon filter include high first-pass removal efficiency that is independent of the recirculation rate, lower HVAC costs as a result of higher percentages of recirculated air, and applicability against a broad range of offensive compounds.

Activated carbon filtration is compatible with a relatively broad range of humidity conditions (roughly 20 to 65% RH) and temperatures (typically 0°F up to 110°F for non-treated carbons). It has a high loading capacity that does not decline substantially over time. And, while retaining organic compounds, activated carbon also catalytically destroys ground level ozone.

This makes activated carbon filters highly effective in areas where stationary combustion sources and industrial processes generate these contaminants. Examples include refineries, breweries, chemical storage, automotive refinishing and facilities where lasers are used to seal, cut, mark, join or irradiate products. Photocopiers and printers are other culprits. Ironically, even electrostatic precipitators, which are used to eliminate airborne particulate, emit ozone.

Activated carbon and its chemically enhanced counterparts may be used in a wide variety of filtration products. For applications where contaminant concentrations are high, deep bed scrubbers are typically used. As concentrations decrease, different filter configurations can be used. See chart above for details.

The selection of a carbon grade, and filter type, is determined by the contaminant mix, its concentration, the use of pre-filters, and the presence of particulate.

The last two points are particularly important for applications involving submicron particulate. If the carbon particles are exposed to fine dusts, their ability to adsorb odors and gases will be lost as the carbon will be blinded or masked by this fine particulate.

Carbon filter material is either loose fill (granulated and honeycombed into cells with packing media) or bonded to a substrate. Granulated material is best suited to deep-bed filters and higher contamination levels; HVAC systems used for commercial and industrial facilities are best served with bonded (textile) filter configurations, which typically have lower resistance to air flow and higher carbon content. Given like exposures to contaminants and gases, the service life of loose fill and bonded material is approximately the same.

One important point to remember: Carbon filters require a different level of maintenance to assure proper performance. Where filters used for dusts readily signal when they're approaching capacity, an activated carbon filter approaching its saturation point will not, and periodic testing should be scheduled to assure the filters are working. With that said, there is a straight forward program available to help customers make the most effective decisions regarding filtration, and estimate the service life of a carbon filter in a specific application.

The first consideration is the primary and secondary contaminants the filter will encounter, and their respective concentrations in parts per billion (ppb), and molecular weight. It is important to be specific: For example: toluene is treated differently than toluene 2,4 diisocyanate, etc.

System airflow, the percentage of recirculated air, the number of filters in the system and the hours of operation per day are also factors that influence the choice of a media or media blend. The final factors are average relative humidity and average operating temperature.

With those factors determined, the choice between major types of removal methods – coconut shell carbon, impregnated carbons, or potassium permanganate – becomes clear.

Because our program is based on more than 40 years of experience and feedback in the development and manufacture of activated carbon filtration for virtually every commercial and industrial environment, the "best decision" for your application becomes clear – and convincing.

As seen in the August 2004 issue of Processing Magazine.