

## TECHNICAL BULLETIN INFORMATION



### CHARCOAL FILTRATION

On NuAire's (Class II, Type A2) Biological Safety Cabinets, the optional Lay-in charcoal Filter Module may be used inline with our exhaust transitions when venting to the outside, or alone when units are vented into the room. The optional lay-in charcoal filter can be added on top of the exhaust HEPA filter on our Class II, type B1 or B2 Biological Safety Cabinets, with a special exhaust filter housing.

Charcoal will not remove hydrogen, carbon monoxide, mercury, etc., but, in general, it is very effective for removing aromatics - non polar, high molecular weight compounds.

The selection of the carbon used in charcoal filters is dependent upon the specific application. It is usually based on the type of contaminant filtration, pressure drop allowable, flashpoint temperature of contaminants that will be absorbed, relative humidity affecting absorption, and contaminant-removal efficiency desired.

Although charcoal is used extensively for contamination control, it also has some shortcomings -- it can explode or ignite if high concentrations of ozone are present in a highly contaminated bed -- and it will not remove gases such as NO, CO, CH<sub>4</sub>, etc.

For many toxic chemical removal applications, the charcoal must be impregnated to remove specific contaminants such as H<sub>2</sub>S, NH<sub>3</sub>, Hg, etc. By impregnating specific reactive chemicals over the surface area of carbon, various pollutants that might be difficult to handle can readily be removed from the stream. Sulfur and/or KI-impregnated charcoals are used to capture mercury. Metal oxide-type impregnated carbon improves the capacity for H<sub>2</sub>S. Many types of impregnates can be employed with charcoal. It should be realized, however, that as the capacity of the carbon for the difficult contaminants is increased, its ability to handle other pollutant is decreased. Unimpregnated charcoal does not have much absorptive activity with reactive gases, such as ammonia, chlorine or formaldehyde. [Potassium Permanganate odoroxidant (activated alumina and potassium permanganate) is reactive with ammonia, formaldehyde and many others.] Generally, activated charcoal has high capacity for less volatile materials. Also, the higher the boiling point of a given contaminant, the weight absorbed will generally increase accordingly.

## TYPICAL CAPACITY FOR 1000 M<sup>2</sup>/GM CHARCOAL

<u>HIGH</u>	<u>MEDIUM</u>	<u>POOR</u>
Acetic Acid	Acetone	Acetaldehyde
Alcohol	Acrolein	Carbon Dioxide
Benzene	Anesthetics	Carbon Monoxide
Odors	Amines	Ethylene
Butyl Alcohol	Ammonia	Formaldehyde
Caprylic Acid	Hydrogen Sulfide	Hydrogen
Carbon Tetrachloride	Solvents	Acetylene
Chloropicrin	Chlorine	Methane
Ethyl Acetate	Butyraldehyde	Nitrogen Dioxide
Mercaptans	Hydrogen Cyanide	Sulfur Dioxide
Phenol	Phosgene	
Pyridine	Sulfur Trioxide	
Toluene		
Turpentine		

The charcoal filter installed in the unit is customer specified and should be replaced according to the original manufacturers' recommendations. The following are some guidelines and general information concerning charcoal filters. (See the formula and TABLE on reverse side.) Cartridge life will vary with humidity, temperature, flow rate and contaminant inlet concentration. The service time will vary inversely to the flow rate and to the concentration. For example, reducing the flow through the cell by one half will double the service life if all other parameters are constant. Or, if the concentration is quartered, the service life is increased by a factor of four. It is emphasized, however, that the service life depends on specific conditions and therefore varies.

### Estimate of Activated Charcoal Service Lifetime

The following equation\* can be used to estimate the service lifetime for an activated charcoal filter under the following conditions:

1. no mixture of contaminants
2. no contaminants containing more than one functional group (i.e. a chlorinated alcohol)
3. less than 50% relative humidity

This service time interval is the point in time when 10% of the contaminant is allowed to pass through the filter.

$$T = \frac{3.85 \times 10^7 \times W_c \times (a + bt)}{C^{2/3} \times M \times Q}$$

- where:
- T = Time in minutes until 10% break through
  - W<sub>c</sub> = Weight of Carbon in pounds
  - a, b = Experimental coefficients from the table below
  - t = Contaminant boiling point
  - C = contaminant concentration entering filter in ppm
  - M = Containment molecular weight
  - Q = Airflow rate, CFM

TABLE OF COEFFICIENTS FOR CALCULATING CARBON SERVICE LIFE

Solvent Type	Boiling Point Range, C°	Coefficients		Examples
		a	b	
Acetates	50 to 190	-0.050	0.0038	Ethyl acetate, butyl acetate
Alcohols	60 to 160	-0.46	0.0071	Methanol, isopropanol, butanol
Alkanes	20 to 200	0.095	0.0022	Pentane, hexane, cyclohexane
Alkyl benzenes	80 to 220	0.12	0.0024	Benzene, toluene
Amines	-10 to 220	0.037	0.0033	Ethylamine, dipropylamine
Ketones	50 to 220	0.034	0.0029	Acetone, diisobutyl ketone
Monochlorides	-30 to 250	0.032	0.0033	Ethyl chloride, 1-chlorobutane
Dichlorides	40 to 250	-0.092	0.0048	Dichloromethane
Trichlorides	60 to 200	-0.080	0.0056	Chloroform, methyl chloroform
Tetrachlorides	70 to 200	0.19	0.0049	Carbon tetrachloride, perchloroethylene

Lower boiling solvents weighted more heavily when determining coefficients.

\*Nelson, G.O. and A.N. Correia "Respirator Cartridge Efficiency Studies: VIII. Summary and Conclusions", UCRL Preprint 77654 (Livermore, California, University of California - Lawrence Livermore Laboratory, 1976).