The following factors should be considered when designing a system which utilizes a vapor adsorption cartridge:

1. Adsorbents are effective for vapors. Since liquids will damage or inactivitate most solid adsorbents, it is essential that a cartridge or DIA must be preceded by an efficient coalescing filter. (I.E. – 70C or 50C)

2. In contrast with Microfiber Filters, which operate at their initial efficiency throughout their life, absorption cartridges have a limited holding capacity. When the adsorption capacity is reached, no further adsorption occurs. The limiting capacity, or "breakthrough" point, is not sharply defined, and the exit vapor concentration will increase rapidly as saturation approaches. To avoid unwanted vapor contaminants downstream, it is necessary to change the adsorption cartridge well before it has reached its ultimate adsorption capacity. How is this determined? There is no definite answer since many factors are involved. A simple "Rule of Thumb" is that most adsorbents will hold 20% of their weight at ambient temperature. However, the being said, many factors will affect efficiency and life span of a particular media (See #3).

3. The efficiency of a given adsorbent for a given vapor depends very much upon the specific operating conditions. Therefore, again in contrast to filtration, it is not possible to assign a single efficiency rating to an adsorbent. In addition to the relative affinity of the adsorbent for the vapor, other factors which influence the efficiency of adsorption include:

- Temperature – Adsorption efficiency is usually much higher at low temperature than at high temperature.

- Concentration of Vapor - Percentage removal efficiency is higher at low impurity vapor concentration. However, total adsorption capacity is higher at high vapor concentration.

- Contact Time – Adsorption efficiency increases with increased contact time. The lowest possible flow rate should be maintained for optimum results.

- Presence of Competing Vapors – Adsorption efficiency for a given vapor is generally reduced by the presence of another vapor for which the adsorbent is active. For example, the presence of a high concentration of water vapor will interfere with adsorption of other vapors by carbon, silica gel, or molecular sieves.

4. In general, adsorption is reversible – if operating conditions change a vapor may desorb rather than adsorb. This fact is the basis for regeneration of adsorbents by heating, treating with vacuum, or purging with gas of low contaminant concentration. However, it should be recognized that desorption can also occur inadvertently through change in process conditions. For example, if a temporary surge in vapor impurity concentration causes a relatively high concentration to be adsorbed on the solid, a subsequent decrease in inlet vapor composition will result in desorption of vapor from the solid to the gas stream.

   While it is not possible to predict or guarantee an adsorption efficiency for any specific set of conditions, it is possible to enhance the conditions beneficial to adsorption and avoid conditions which interfere with adsorption.

In closing, adsorption cartridges must be closely monitored for optimum service.

Adsorbent	Final Numbers in Designation	Vapor Adsorption Activity	
		Good to Excellent Adsorption	**Little or No Absorption**
Carbon	**CC**	Most C_4 and heavier hydrocarbons, ketones, alcohols, esters, ethers, organic acids, chlorinated organic, Freons, all aromatic hydrocarbons, carbon disulfide	Carbon monoxide, carbon dioxide, amines, ammonia, acetylene, most C_3 and lighter hydrocarbons, sulfur dioxide
Molecular Sieve Type 4A	**4A**	Carbon Dioxide Ammonia Sulfur Dioxide Hydrogen Sulfide Acetylene Propylene Methane Ethane Water Vapor Ethylene Ethylene Oxide Carbon Disulfide	Organic compounds C_4 or larger, carbon monoxide
Molecular Sieve Type 13X	**13X**	All materials adsorbed by Type 4A Sieve plus: Methanol Straight Chain Mercaptans Freon 11, 12, & 114 Sulfur Hexafluoride Straight Chain Hydrocarbons to C_{22} Cyclohexane Diphenyl Butene-1 Isopentane Benzone, Toluene, Xylene Boron Trifloride Triethylamine and Smaller Amines	Organic Compounds C_7 Or larger, Carbon Monoxide
Silica Gel	**SG**	Water vapor Drying of gases, refrigerants, organic solvents, transformer oils Desiccant in packings and double glazing Dew point control of natural gas	Recommended only for water vapor adsorption
Drierite - Anhydrous Calcium Sulfate	**DR**	Water vapor	Recommended only for water vapor adsorption
Copper Sulfate	**CS**	Ammonia	Organic or acidic gases
Hopcalite	**HO**	Removal of CO by catalytic oxidation to CO_2 Carbon Monoxide	Acid Compounds
Sodium Bicarbonate	**SB**	Removal of acidic gases, Neutralizing Agent	Hydrocarbons or water vapors
Mixed Sodium and Calcium Hydroxides*	**MB**	All acidic gases, including: Sulfur Trioxide, Sulfur Dioxide, Nitrogen Dioxide, Carbon Dioxide, Hydrogen Sulfide, Hydrogen Chloride, Chloride, Phosphorus Chlorides	Inert and non-acidic gases
Potassium Permanganate Impregnated Aluminum*	**PP**	Removal of SO_X in stack gas	

Notes: (*) More details listed in the chart below

Chart Table:

MB – Represents Mixed Bases

PP – Represents Potassium Permanganate

Y – Denotes that chemical is Adsorb

N – Denotes No Adsorption

Chemical Substance	Formula	PP	MB	TLV (ppm)
Acetic Acid	CH_3COOH	Y	Y	10
Acetone	$CH_3CO\ CH_3$	Y	N	750
Acrylic Acid	$H_2C\ CH\ COOH$	Y	Y	
Alcohols	ROH (General)	Y	N	
Aldehydes	RCHO (General)	Y	N	
Allychloride	$H_2C\ CHCH_2Cl$	Y	N	1
Ammonia	NH_3	Y	N	25
Arsine	AsH_3	N	Y	0.05
Bromoform	$CHBr_3$	Y	N	0.05
Butyl Alcohol	$CH_3(CH_2)_2CH_2OH$	Y	N	50
Carbon Dioxide	CO_2	N	Y	5000
Carbon Oxysulphide	COS	N	Y	
Chloroform	$CHCl_3$	Y	N	10
Diacetone Alcohol	$CH_3COCH_2C(CH_3)_2OH$	Y	N	50
Diesel Fuel	General Hydrocarbons	Y	N	
Esters	General	Y	N	
Ethers	ROR (General)	Y	N	
Ethyl Acetate	$CH_3COOC_2H_5$	Y	N	400
Ethyl Alcohol	C_2H_5OH	Y	N	1000
Ethyl Benzene	$C_6H_5C_2H_5$	Y	N	100
Ethylene	C_2H_4	Y	N	
Formaldehyde	HCHO	Y	N	1
Formic Acid	HCOOH	Y	Y	5
Gasoline	Hydrocarbon Mixture	Y	N	100
Hydrogen Chloride	HCl	N	Y	5
Hydrogen Cyanide	HCN	N	Y	10
Hydrogen Sulphide	H_2S	Y	Y	10
Ketones	R_1COR_2 (General)	Y	N	
Mercaptans	RSH (General)	Y	Y	
Methyl Alcohol	CH_3OH	Y	N	200
Methyl Chloroform	$CH_3C\ Cl_3$	Y	N	
Methyl Ethyl Ketone	$CH_3COC_2H_5$	Y	N	
Nitrogen Oxides	NO_X ($NO+NO_2$)	NO oxidized	N	
Ozone	O_3	Decomposed	N	0.1
Petrols	Hydrocarbon Mixtures	Y	N	
Phenol	C_6H_5OH	Y	N	5
Phosphine	PH_3	Y	N	0.3
Pyridine	C_5H_5N	Y	N	5
Stibine	SbH_3	Y	N	
Sulphur Dioxide	SO_2	Y	Y	2
Toluene	$C_6H_5CH_3$	Y	N	100
Vinyl Acetate	$CH_3COOCHCH_2$	Y	N	10
Vinyl Chloride	CH_2CHCl	Y	N	5
Xylene	$C_6H_4CH_3CH_3$	Y	N	