Application Bulletin

Heavy Hydrocarbon Treatment for Gas Processing Applications

Heavy Hydrocarbon Removal or Recovery from Gas Stream

There are many instances in which process engineers are successfully using activated carbon adsorption to remove or recover aromatic and heavy hydrocarbons from gas feedstock for process control or product recovery.

The economics of recovery can be quite attractive if the aromatics and heavy hydrocarbons are present in sufficient quantity. In any event, removal of trace organic impurities is an important requirement for the protection of catalytic processes downstream.

Applications include hydrogen recycle streams, acetylene purification, carbon monoxide purification, solvent recovery and air purification.

Other technologies, such as cryogenic or liquid absorption systems, may not be suitable for removal of low levels of aromatics and heavy hydrocarbons because they are energy-intensive and costly.

The advantages of using a carbon adsorption system include:

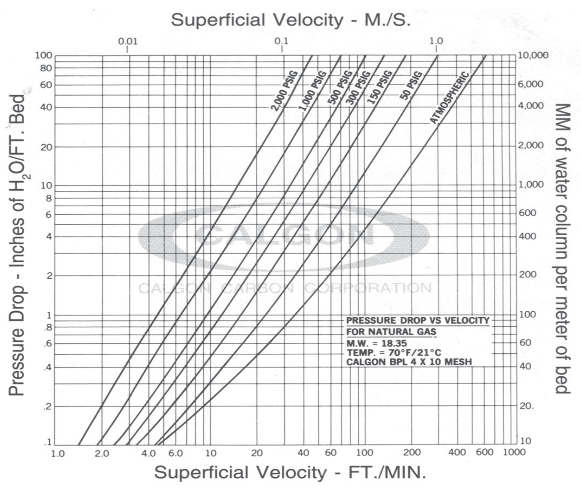
- Effective removal of low level or high level concentrations of organic gases.
- Operation at ambient temperatures.
- Utilization of simple equipment without moving parts or circulating liquids.

Recommendations for Design Parameters

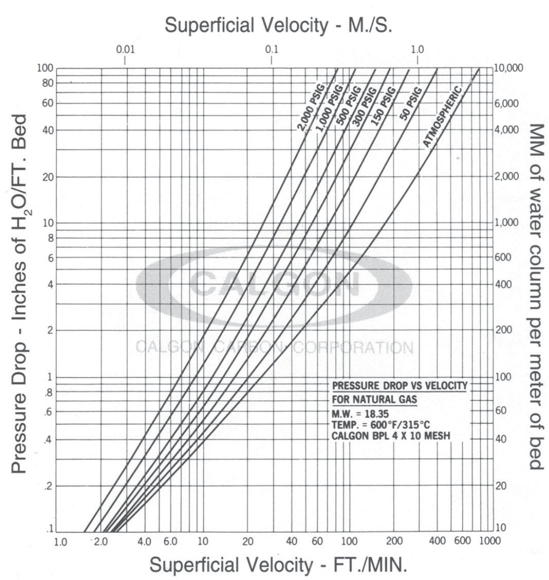
Although individual requirements will vary, some general guidelines can be followed in determining adsorption system parameters. A Calgon Carbon adsorption specialist can assist you with design parameters.

Adsorption units usually consist of two beds of activated carbon operating in parallel on a fixed time cycle between 2 and 8 hours. One bed remains on stream while the other is regenerated by passing a hot gas through the carbon to remove adsorbed components into the gas stream. The regeneration is followed by a cooling period using cold gas before the carbon bed is returned on stream.

The regeneration gas stream may be one of the reject stream from a cryogenic unit or another suitable gas stream. In solvent recovery systems and air purification systems, the beds are normally steam regenerated and sometimes cooled before going back on stream.



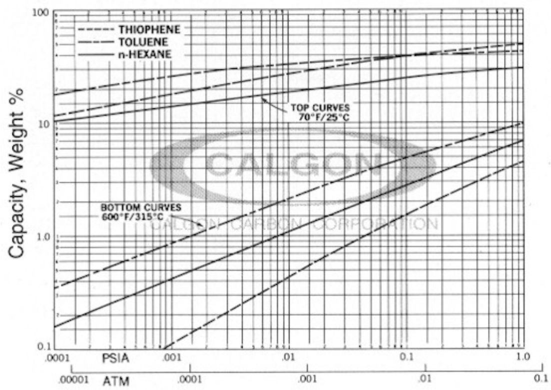
Supervicial Velocity - FT./MIN.



Superficial Velocity - FT./MIN.

The designer of an activated carbon system must consider the following points:

- **Cycle time and adsorbent requirements.**



Partial Pressure, PSIA & ATM

One may obtain from an isotherm the saturation capacity for the component to be removed and divide this into the amount of component to be removed by the adsorbent during a cycle. The method is imprecise because it neglects the co-adsorption of other components which are also present. This necessitates adding a considerable safety factor which may lead to massive over-design. However, the method is rapid and may be used for preliminary and screening process studies. Isotherms for toluene, n-hexane, and thiophene are presented herein. Isotherms for other gases can be obtained from Calgon Carbon.

Design may also be based on the more rigorous concept of mass transfer zone. Components flowing into a bed are adsorbed at differing rates which can be visualized as a mass transfer zone. Upstream from the zone, the gas contains the component almost at its inlet composition. Downstream of the zone, the gas and the bed essentially lack the component until the mass transfer zone passes through. The component appears at the end of the bed when the mass transfer zone reaches the bed outlet. The bed can be sized on breakthrough of the fastest moving component to be removed.

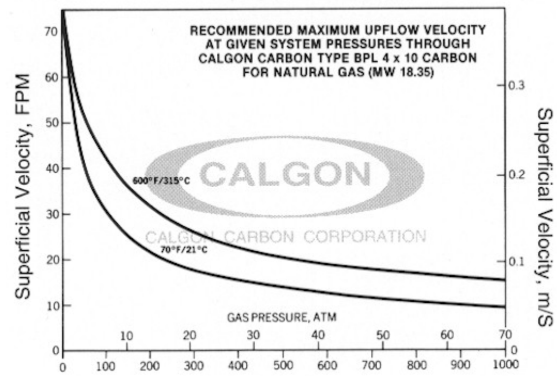
- **Regeneration**

The amount of regeneration gas (heat input) required to remove the components adsorbed may be calculated from:

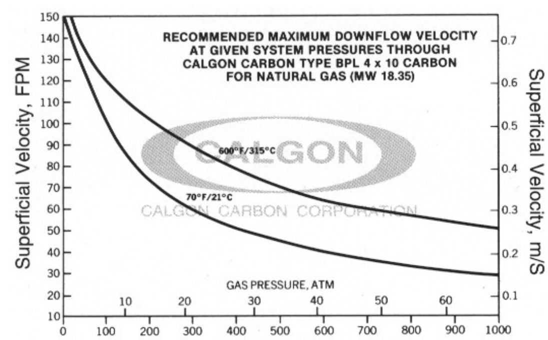
- The amount of activated carbon (Specific heat of Calgon Carbon BPL carbon = 0.25 kcal/kx°C).
- The specific heat of the components adsorbed which may include feed gas.
- The heat of desorption of the components adsorbed (available on request from Calgon Carbon). Doubling the latent heat of vaporization is a conservative assumption for the heat of desorption and may be used for preliminary calculations.
- Heat requirements for heating vessel.
- Heat losses.
- A 20% safety factor should be applied to the calculated heat input to allow for transient conditions.

- **Velocity**

The minimum diameter of the bed is determined by the requirement for a reasonable average gas velocity. A graph of maximum superficial gas velocities for BPL 4x10 as a function of pressure is given herein.



Gas Pressure, PSIG



Gas Pressure, PSIG

- **Cooling**

Standard solid adsorbent cooling calculation procedures apply directly to activated carbon systems.

- **Composition of the regeneration and cooling gas**.

The composition of the regeneration and cooling gas affects the next cycle of adsorption. If an adsorber is regenerated with a hydrogen or nitrogen stream, for example, there is little effect on the capacity of the gases to be adsorbed. However, if feed gas or treated gas is used, there will be a decreased capacity for the components which are to be adsorbed.

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