

**ACTIVATED CARBON SYSTEMS
FOR PCB REMOVAL**

CARBETROL® Corporation
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ACTIVATED CARBON SYSTEMS FOR PCB REMOVAL

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Activated carbons are widely used for the adsorption of many organic compounds from contaminated water and air streams. The adsorption process results from a physical attraction which holds molecules of the adsorbate at the surface of a solid by the surface tension of the solid.

Activated carbon is produced from carbonaceous materials such as coal, coconuts, wood and petroleum coke. Granulated activated carbon has an extensive pore structure which provides an enormous amount of surface area for each particle of material.

For example, the surface area available in one pound of granular activated carbon is equivalent to six football fields. (Refer Figure 1)

A measure of the capacity of a carbon to adsorb chemical compounds is the iodine number used for the liquid phase, and the carbon tetrachloride number used for the gaseous phase.

These standard tests signify the amount of a given quantity of iodine or carbon tet which will be adsorbed in one gram of the test carbon. Iodine numbers usually are in the range of 900-1100 and carbon tet numbers are 60 to 65 for good quality carbon.

Generally speaking, activated carbon adsorbs organic compounds with a molecular weight greater than 50 and a boiling point greater than 50°C. Certain non-polar or high boiling point compounds (above 250°C) will not respond effectively to carbon adsorption.

The ability of activated carbon to adsorb a particular organic chemical compound varies with the compound and also its concentration in the waste stream. In order to evaluate the adsorption rate of carbon for a given compound, isotherms are developed. The isotherm for a specific compound such as benzene, trichlor or PCB, can often be obtained from a carbon manufacturer, EPA literature, or it can be developed using simple laboratory procedures.

Figure 2 shows isotherms for PCB 1221 (molecular weight 201) and PCB 1232 (molecular weight 232). These isotherms were obtained from EPA.

These isotherms show two things. First, the good adsorption capability of these PCB's. The "X" axis shows the concentration of PCB's. The "Y" axis shows the amount of PCB in mg. which will be adsorbed in a gram of carbon. For example, for PCB 1221 at 0.1 mg/l initial concentration (100 ppb), 50 mg. of PCB 1221 will be adsorbed by one gram of carbon. This is a 5% adsorption rate. At 0.01 mg/l concentration, 10 mg. will be adsorbed on 1 gm (a 1% adsorption rate).

Second, while the slope of the two isotherms are the same, it can be seen that PCB 1232 adsorbs about twice as well as PCB 1221. Therefore, it is necessary to develop a separate isotherm for each PCB type which is to be treated.

It must also be remembered that these isotherms are developed under laboratory conditions and that field conditions may cause some variation.

Contact time is an important factor in the adsorption process. In gaseous streams, adsorption occurs almost instantaneously. However, in liquid streams such as groundwater, 10 to 15 minutes detention may be required.

When dealing with groundwater which has been contaminated with PCB spills, the solubility of PCB's in the water is in the range of 20-60 ppb. Above that level, the PCB's will be found as free product.

These isotherms indicate that PCB's are effectively adsorbed by activated carbon and theoretically, the adsorption process can produce final effluents below 1 ppb. However, field experiences has shown that often under turbid conditions the PCB levels in the effluent from carbon adsorbers will only be reduced to a level of 3 to 5 ppb. The reason is that the PCB's will attach to colloidal material or carbon fines and pass through the carbon bed without being adsorbed.

In order to decrease these residual levels of PCB's, both pre and post filtration of the waste streams is recommended for removal of these colloidal fines. We have found that with properly designed suspended solids filtration and activated carbon systems, effluents can be obtained having 1 ppb PCB or less.

A flowsheet for such a system is attached (Figure 3). The system shown is for 20 gpm. It has two trains of activated carbon adsorbers, each rated for 10 gpm, connected in parallel. Each train has two adsorbers in series. A sample valve is located between the adsorbers so that the discharge from the first canister can be tested and determination can be made when intermediate concentrations are high enough to require changing the canister.

Ahead of the canister is a basket or cartridge prefilter, used to filter out the larger particulates before the activated carbon adsorbers. Following the adsorbers, a 1 to 3 micron post filter is used. This filter will remove any residual colloidal material or carbon fines which may be sloughed off the adsorber bed.

Field experience has shown, that with this type of filter system, influent PCB levels of 3 to 15 ppb can be reduced to non-detection levels (measured at a detection level of 0.5 ppb).

We have supplied such a system for treatment of monthly well sampling water. Prior to the use of this system, all sample water was put in 55 gallon drums and hauled away at considerable expense.

These systems were mounted in trailers, 6' x 8', so that they could be easily moved from site to site. The trailers contained a gas driven generator, pump sump, pumps, filters and two carbon canisters.

Figure 4 is a picture of a trailer and the interior showing the sump for untreated water, the pre-filter system and one of the two canisters. The canisters produce an effluent, which meets discharge standards.

CONCEPT OF MOLECULAR SCREENING IN MICROPORES

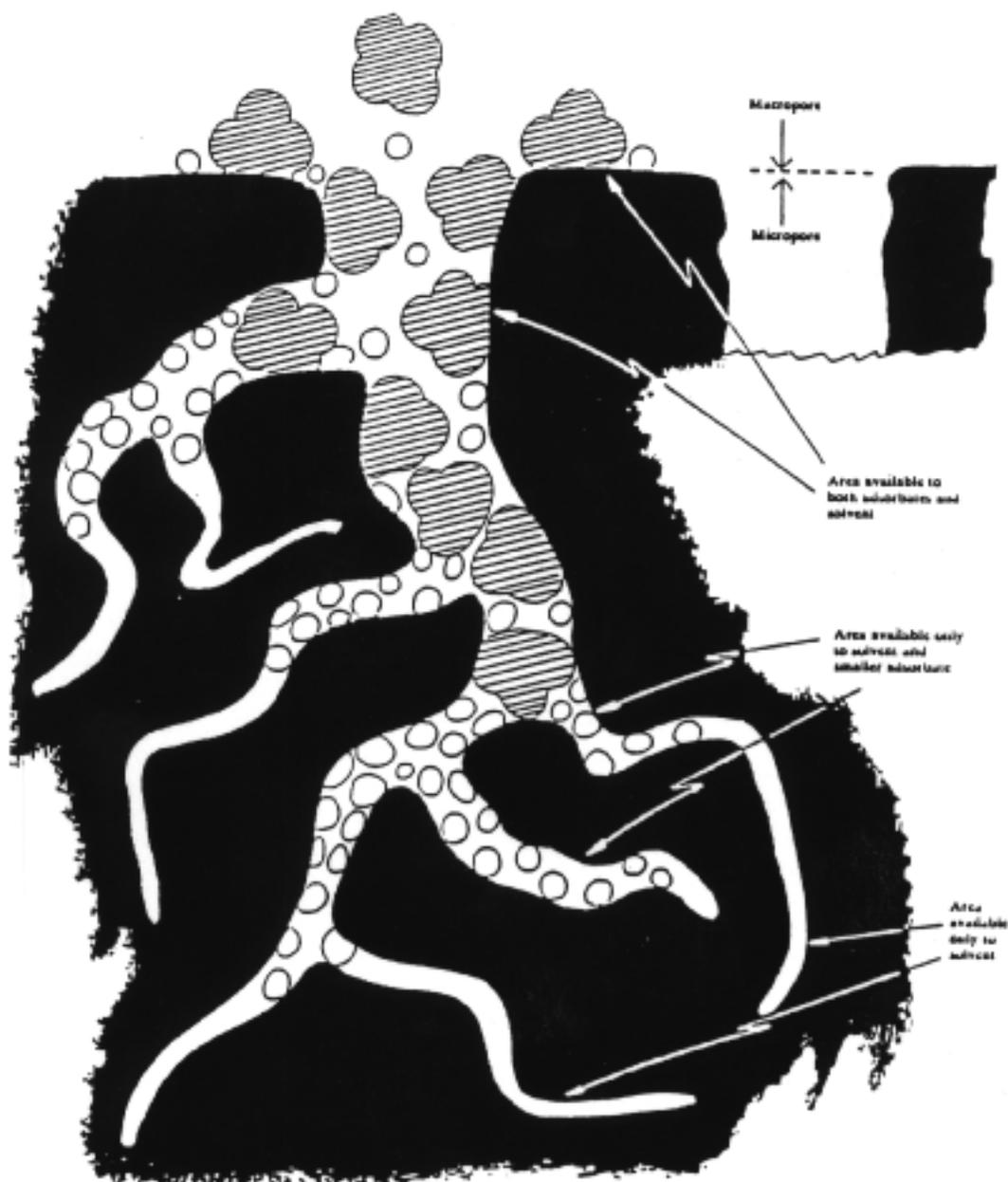


FIGURE 1

From Calgon Corporation "Basic Concepts of Adsorption on Activated Carbon"
Pittsburgh, PA.

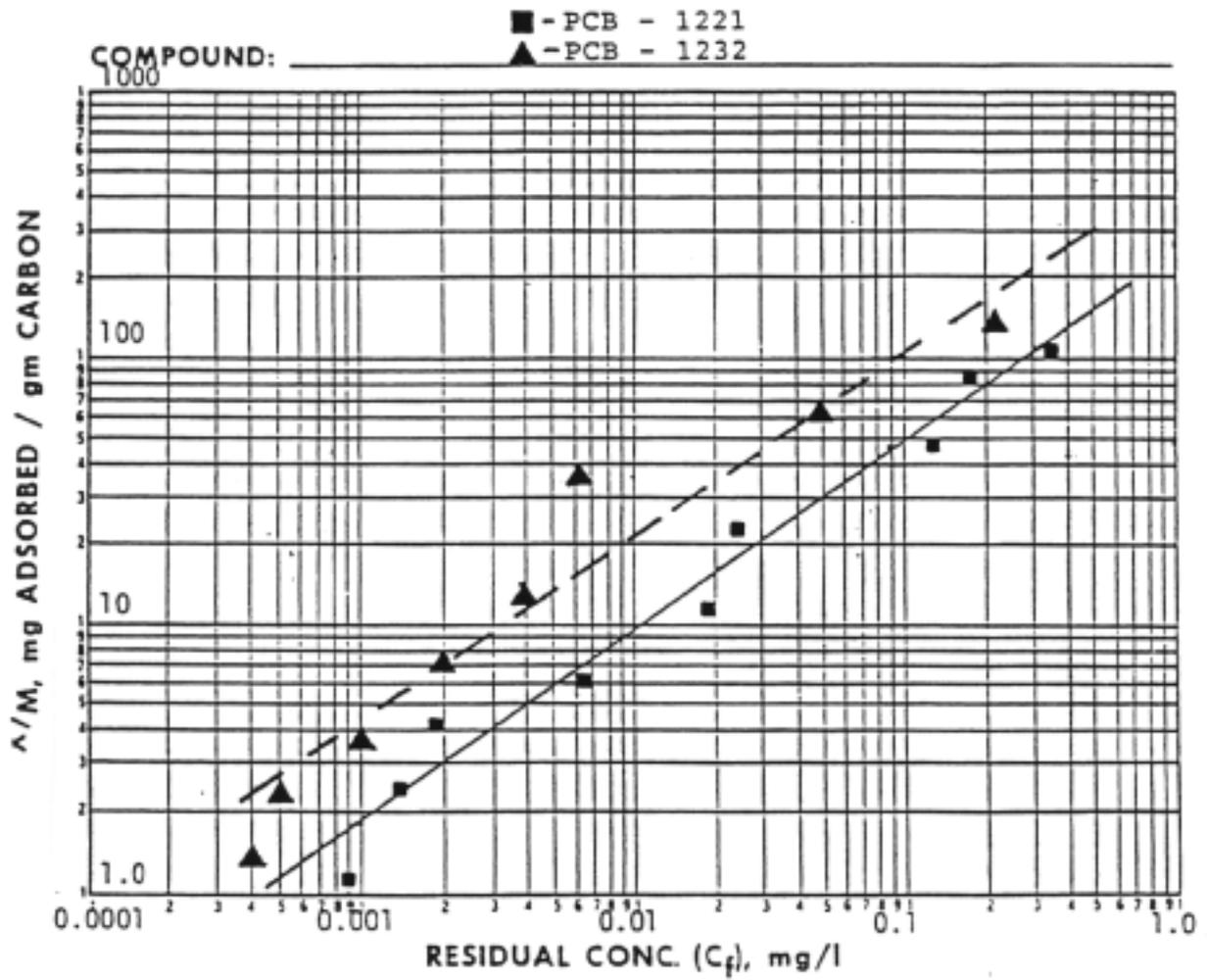
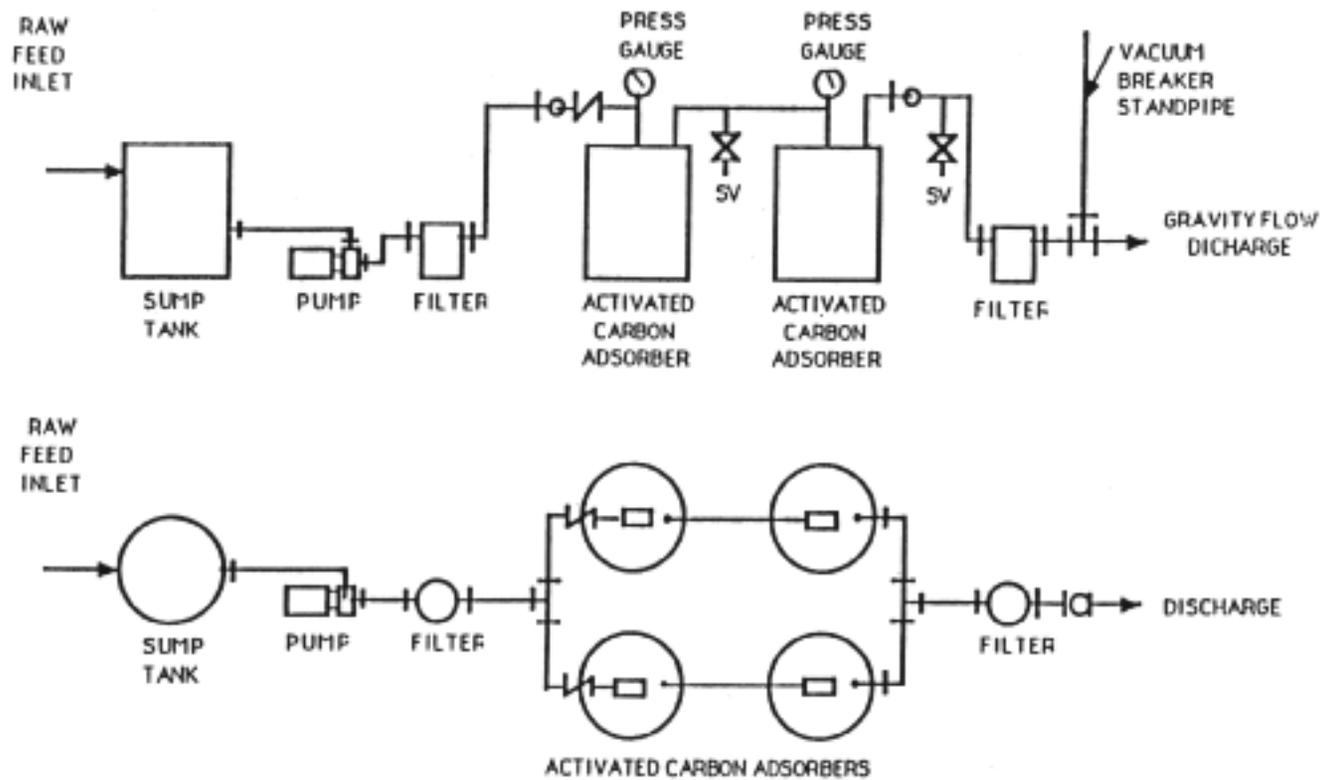


FIGURE 2

Isotherms

PCB 1221 & PCB 1232



**ACTIVATED CARBON PCB REMOVAL SYSTEM
FOR 20 GPM THROUGHPUT**

FIGURE 3

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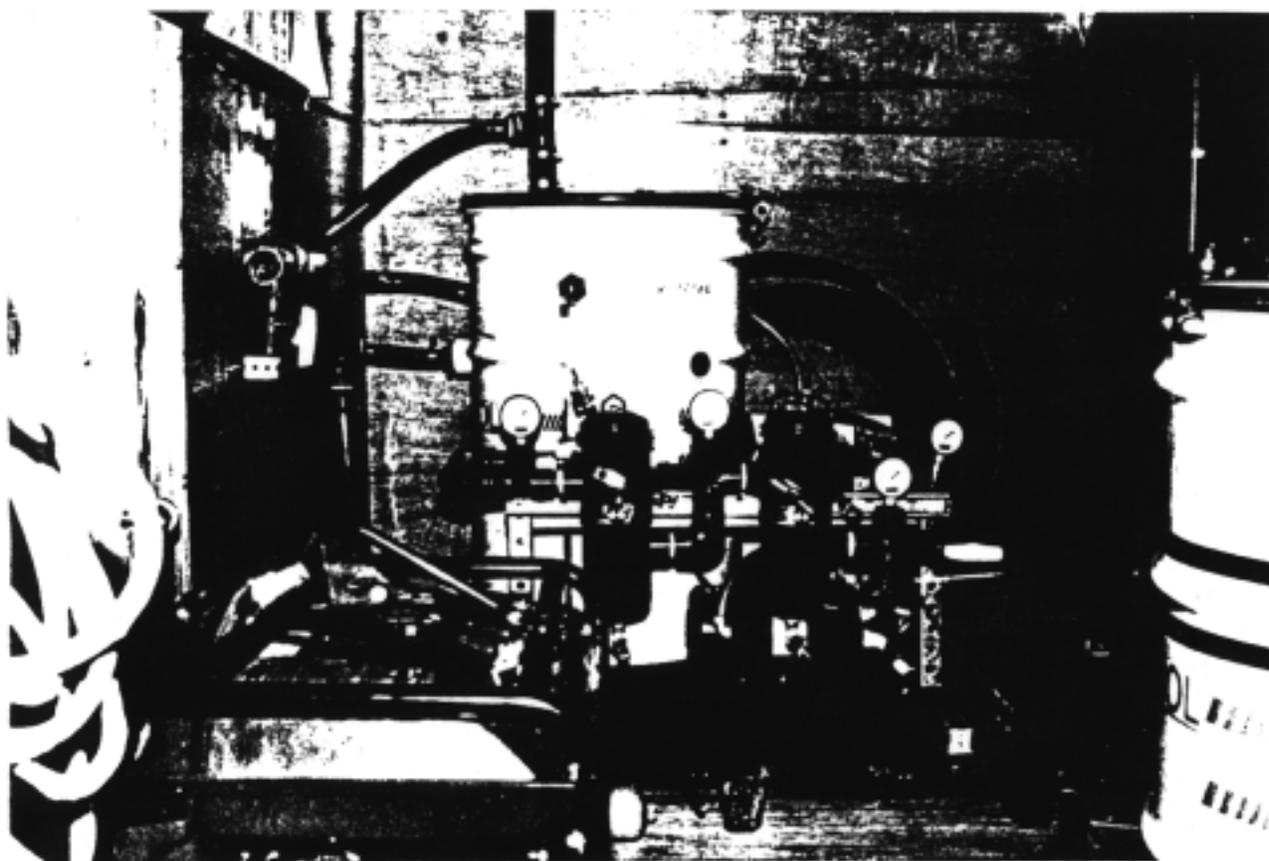
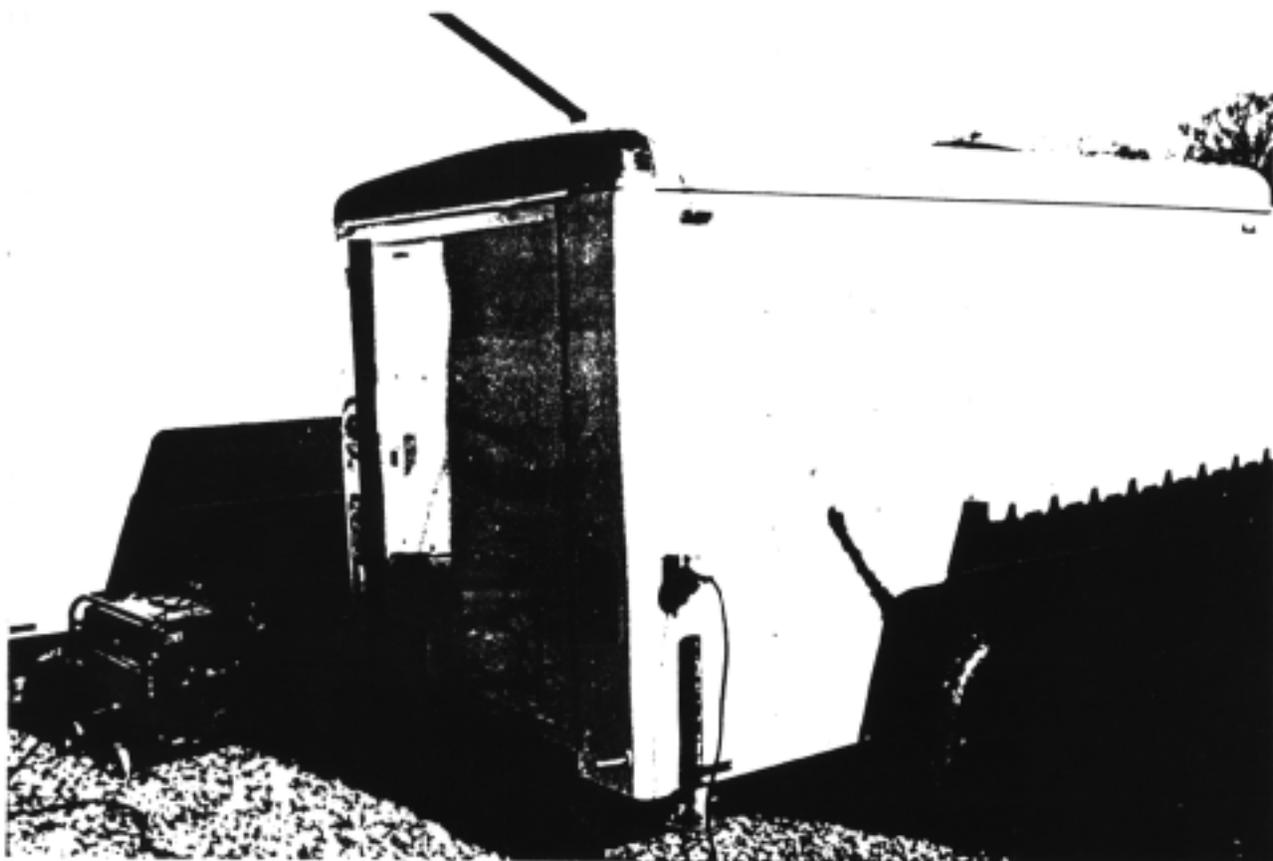


FIGURE 4

Trailer System for PCB Removal