Wilson Environmental
ENGINEERED WATER & WASTEWATER SYSTEMS

Industrial Wastewater Treatment Using Granular Activated Carbon

Introduction:

The intent of this paper is to provide general information to assist in understanding the use of Granular Activated Carbon (GAC) to treat industrial wastewater. Commonly used to remove organic compounds, taste and odor form water.

We do not intend to describe carbon adsorption in detail. We only deal with general properties and let specific selections be made by the designers and their customers with the aid of carbon isotherms, as described below.

What is Granular Activated Carbon?

Granular Activated Carbon, GAC, sometimes called activated charcoal, is a type of carbon processed to have a very large surface area available for adsorption or chemical reactions. It is made from a number of carbon sources such as coal, saw dust, pecan shells, coconut shells, or any other material with a high carbon content. The carbon base material is treated thermally in a furnace to create the final GAC product. The various carbon sources have different adsorption characteristics.

Due to its high surface area, the surface area of one gram of activated carbon is measured in square meters of surface are per gram of carbon. Further chemical treatment can enhance adsorption properties.

How does Granular Activated Carbon work?

GAC works through physical adsorption to remove contaminates from liquid or vapor phase streams. GAC holds the contaminates because the attractive forces of the carbon surface is stronger than the forces that would hold the contaminates in the water.

We are referring to adsorbers, not absorbers, because the pollutant is adsorbed on the surface (mostly the internal surface) of a GAC granule, adsorbent material. It is not absorbed by a chemical reaction. This is an important difference.

Organic contaminates that have a high molecular weight and are non-polar in nature are easily adsorbed onto the carbon surface. Polar molecules such as alcohols, like methanol or ethanol, are not generally adsorbed.

Chemical reactions can also take place on the surface of the carbon. GAC is used for chlorine removal in water. The chlorine reacts with the carbon to form chloride ions, removing the chlorine.

Which Granular Activated Carbon is right for my application?

A common method to select a carbon is by use of the carbon isotherm. Each carbon type has an adsorption capacity which is referred to as the "adsorption isotherm". Generally the isotherm is a measure of the pounds of pollutant adsorbed per pound of adsorbent material at a fixed temperature. However, the adsorption isotherm is more complicated as it is also a function of pollutant concentration, partial pressure in a vapor, and ambient pressure around the adsorbent. But for practical purposes, we look at a carbon isotherm as the pounds of material that can be adsorbed per pound of adsorbent. From this we can calculate the size of GAC vessel needed and the amount of carbon and the cost required to treat a specific volume of wastewater.

Adsorption isotherms are readily available from suppliers of GAC.

The EPA also has a library of isotherms, " Carbon Adsorption Isotherms for Toxic Organics" published April 1980. Available through the National Service Center for Environmental Publications.

Granular Activated Carbon Disposal

Most spent GAC can be recycled and should be labeled as, "Spent GAC For Recycle". If not labeled as recycle material it may be considered a waste material and should be tested to determine if it considered hazardous, by EPA or state regulations.

Bench Scale Testing

Because of the potential presence of other chemicals that may interfere with the GAC's ability to adsorb the compounds of concern it is strongly recommended that the GAC procedure always be characterized through laboratory treatability tests before proceeding to plant scale.

Pre-Treatment

When other compounds are present that interfere with the adsorption process, pretreatment may be required. For example; oily wastewater will foul the carbon prematurely. In this case pre-treatment by organoclay is usually recommended. Organoclay removes free and emulsified oils from wastewater preventing fouling of the carbon.