Addition of Trace Capacity Number
As a Measure of Carbon Performance in Trace Removal Applications

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Market Need for Trace Removal Capabilities

Recent advances in monitoring instrumentation, as well as information regarding the health effects of certain organic compounds, have created a need for removing increasingly lower concentration levels of contaminants from water. For example, Methyl Tertiary Butyl Ether (MTBE) is a highly soluble gasoline additive that has been detected in extremely low concentrations in many underground aquifers primarily due to leaking underground storage tanks. Although the health effects of MTBE are controversial at this point, many water providers look to remove MTBE even at these low concentration (1-100 ppb) ranges. Like MTBE, Dibromochloropropane (DBCP), trihalomethanes (THMs), and various pesticides also often require removal from water at low concentration levels.

While activated carbon has been the traditional solution for remediating contaminated water sources, the ability to predict and control activated carbon's performance at trace levels cannot be achieved using historical characterization methods available in the industry. Traditional test methods such as iodine number are not sufficient to predict trace removal capacity; therefore, Calgon Carbon has developed the trace capacity number.

Pore Distribution and Its Relationship to Capacity

The mechanics of adsorption in activated carbon relates to a specific compound's affinity to be attracted to specific adsorption pores within the activated carbon structure (an adsorption pore being defined as the volume between the graphitic plates that constitute the activated carbon's skeletal structure). Adsorption is dictated by the specific characteristics of the activated carbon structure, as well as the concentration and composition of the contaminant.

The magnitude of adsorption forces is directly related to the amount and orientation of the graphitic plates surrounding the pore. Adsorption pores that are surrounded by a larger number of graphitic plates have high adsorption forces and are termed "high energy." Adsorption pores that are surrounded by fewer graphitic plates are termed "low energy." Depending on the raw material used to make the carbon and the activation process, different carbons may have different distributions of high or low energy adsorption pores.

The amount and type of pores within an activated carbon granule defines the relative performance for a specific application. For higher concentrations and/or easily adsorbed compounds (low solubility, high molecular weight), an activated carbon possessing mostly low energy pores would be desired to optimize the capacity. For compounds that are difficult to adsorb (high solubility, low molecular weight) or compounds at trace concentration levels, an activated carbon containing primarily high energy pores would provide the most benefit.

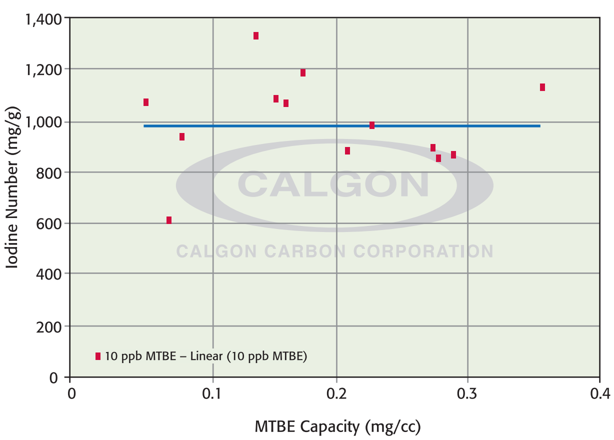
Iodine Number and its Relationship to Activated Carbon Capacity

Although activated carbons have been described by a variety of quality control specifications, the most common measure of an activated carbon's capacity has been iodine number, measured in milligrams of iodine adsorbed per gram of carbon. In many applications, this measurement has provided a quick and easy test method to quickly rank activated carbons in terms of their overall capacity. The potential drawback with this approach is that the test method uses a high concentration (0.2N) of iodine (an extremely well absorbed material). At this concentration, both high energy and low energy pores will be filled with the adsorbate. The final iodine number measurement does not differentiate between low energy pore volume and the high energy pores critical for trace removal applications.

To demonstrate the fact that iodine number does not present a good measure of high energy pores required for trace removal applications, isotherm testing was conducted on various carbons with iodine number plotted versus MTBE loading at low concentrations (1 ppb and 10 ppb). No clear relationship between the two parameters exists. (see Figure 1

Effect of Iodine Number on MTBE Capacity

Figure 1



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Trace Capacity Number

To properly account for an activated carbon's trace removal capacity, a new measurement has been developed to allow the ranking of various activated carbons in accordance with their capacity at trace levels. As the iodine number test method uses iodine as a surrogate for higher level and readily adsorbed compounds, a surrogate compound is also used to better evaluate the performance relative to lower level and lower concentration compounds. Acetoxime has been selected as that compound; its adsorption capacity on the activated carbon measured in milligrams of acetoxime per cubic centimeter of carbon provides a much more reliable indicator of the trace capacity and is, hence, defined as the Trace Capacity Number.

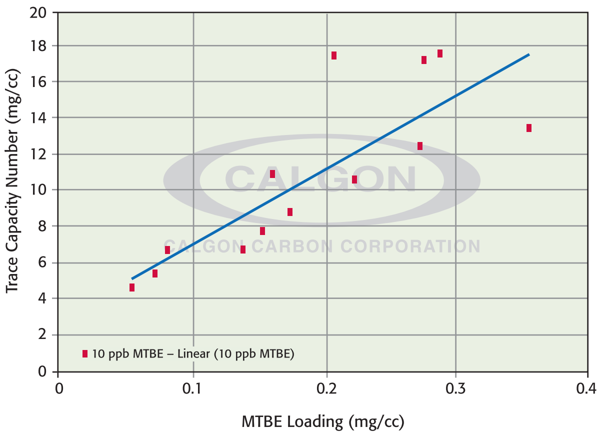
Figure 2 shows how the acetoxime number provides a very high correlation when compared with actual MTBE loading at low concentrations.

Although the iodine number still does have value in characterizing activated carbons, by defining both the iodine number and the acetoxime number you can define the entire range of adsorption pores (both high and low energy) and thus create a unique fingerprint for each type of activated carbon under evaluation.

When evaluating activated carbons for the various trace removal applications prevalent in the marketplace today (removal of MTBE, DBCP, pesticides, etc.), using Trace Capacity Number in addition to iodine number will provide the best measure of the carbon's success in the application. Activated carbon products with higher Trace Capacity Numbers will be ideally suited toward low concentration applications.

Effect of Trace Capacity Number (TCN) on MTBE Loading

Figure 2



Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable Federal and State requirements.

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Making Water and Air Safer and Cleaner

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