

Importance of Third-Party Evaluation of Activated Carbons, Products and Services

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Obtaining independent, unbiased third-party professional opinions are good in personal and business practices. There is hardly a day that goes by that we could not benefit from having an outside opinion on our personal and business issues and practices.

Personal issues include medical, financial and retirement among others. Professional issues that would benefit from third-party evaluations are numerous and also highly individualized, depending on the industry. The best available technology to clean water and air and a myriad of other applications should also remain in focus.

Activated carbon certification

A company will buy an activated carbon and certify it with an independent laboratory, thereby ensuring the level of quality so it works reliably in their adsorption or chemisorption process systems as expected. All activated carbons are not the same in their performance levels.

Selecting the best activated carbon and process can increase the process systems operational performance by two to three times. This results in less media change-outs. Different activated carbons have needed properties specific to their different applications.

For example, a sulfurized carbon material may be needed to maximize the removal of mercury from water and industrial air streams, but is not necessary for municipal potable water plant operations. The performance of sulfurized carbon depends on its type, concentration, form, particle size and homogeneous or heterogeneous distribution.

Just as you may get a third-party evaluation regarding a proposed medical procedure, you may want a third-party evaluation on an activated carbon product or process equipment which you have or will purchase. With already installed equipment, this is usually a troubleshooting and corrective-action task.

Even before you purchase media and equipment, getting benchmark inputs to your selection is wise. This will allow you to certify the quality of the carbon media for your intended use.

Laboratory testing services

The only way you can evaluate an incoming unused or reactivated carbon (or your carbon before and after it has been used) is to have it analyzed by a qualified laboratory. Table 1 contains a list of specific test methods that have been developed by the American Society for Testing Materials (ASTM) Committee D on activated carbon.

These activated carbon test methods provide a business relationship between buyer and seller. These well-established test methods allow buyers to compare different vendor products and different lots of material purchased.

For most users, selecting the best test methods and outside

Table 1. ASTM activated carbon test method numbers and descriptions

ASTM #	Method
D 2652-94	Terminology relating to activated carbon
D 2854-96	Test method for apparent density of activated carbon
D 2862-97	Test method for particle size distribution of granular activated carbon
D 2866-94	Test method for total ash content of activated carbon
D 2867-99	Test method for moisture in activated carbon
D 3466-76	Test method for ignition temperature of granular activated carbon
D 3467-99	Test method for carbon tetrachloride activity in activated carbon
D 3802-79	Test method for ball-pan hardness of activated carbon
D 3803-91	Test method for nuclear-grade activated carbon
D 3838-80	Test method for pH of activated carbon
D 3860-98	Practice for determination of adsorptive capacity of activated carbon by aqueous phase isotherms
D 4069-95	Specification for impregnated activated carbon used to remove gaseous radio-iodines from gas streams
D 4607-94	Test method for determination of iodine number of activated carbon
D 5029-98	Test method for water solubles in activated carbon
D 5158-98	Test method for determination of the particle size of powdered activated carbon by air jet sieving
D 5159-91	Test method for dusting attrition of granular activated carbon
D 5160-95	Guide for gas-phase adsorption testing of activated carbon
D 5228-92	Test method for determination of the butane working capacity of activated carbon
D 5742-95	Test method for determination of the butane activity of activated carbon
D 5832-98	Test method for volatile matter content of activated carbon samples
D 5919-96	Practice for determination of adsorptive capacity of activated carbon by a micro-isotherm technique for adsorbates at ppb concentrations
D 6385-99	Test method for determining acid extractable content in activated carbon by ashing

Table 2. Advantages of GRPD for activated carbon manufacturers and users

- Differentiates activated carbons that have the same ASTM iodine number
- Provides Freundlich aqueous- and gas-phase isotherms with three target compounds
- Monitors the degree of reactivation, regeneration and initial activation level of unused activated carbons
- Compares unused and used activated carbons to determine pores used in an application
- Determines cleanliness of activated carbon
- Provides trace-, mid-, and high-capacity information
- Differentiates activated carbon supplies from a single production batch from a supply of combined batches of activated carbons lots
- Provides information about the location of chemical impregnants in the activated carbon structure
- Determines the activity of outside versus inside of individual GAC granules
- Determines the GAC penalty of carbon blocks compared to free-flowing GAC
- Enables the determination of the GAC raw material source: coal, wood, coconut shell or other starting materials
- Allows inventors of new activated carbons to compare their materials against a database of commercial activated carbons, to quickly determine potential markets
- Allows characterization of a family of activated carbons (0.2-0.8 g/cc apparent densities)
- Reveals the total adsorption energy distribution (AED) site(s) in a wide variety of sorbents
- AED determinations help clients to select the best activated carbon for each application.
- Demonstrates knowledge and willingness to use the best test methodology
- Improves data quality and decisions: precision and accuracy are improved, which allows small sorbent mass used for testing and small differences to be meaningful
- Thin GAC beds, of only 3-5 granules, can be evaluated with this advanced test method. Granules against the containing barrier have been compared with granules in the middle of the thin bed.
- Forensic and de-formulation analysis cases: Is it new or used GAC? What is the raw product source; wood, coconut shell, bituminous coal, etc.?
- Shows differences in sorbent performance between thermally cleaned and not cleaned received GAC
- Provides a total thermogravimetric analysis chromatogram from the sorbent cleaning step
- Provides a thermogravimetric analysis of the sorbent's water content
- Provides a simultaneous BET surface area and pore size distribution determination in addition to the characterization of the adsorption energy distribution of the sorbent
- Can obtain adsorption binding site(s) information in a wide variety of materials besides activated carbons
- Determines the location of chemical impregnants of concern: surface, specific areas, overall evenly or not evenly spread in GAC
- The instrument could provide mass spectral analysis of initial off-gases and desorbed gases.

labs is a daunting task. If possible, the carbon user should have a full-time or part-time carbon specialist to help guide decisions on their process systems.

Advanced test methods

In addition to the standard test methods, advanced test methods have become available. Perhaps the best of the new test methods is the Gravimetric Rapid Pore Size Distribution (GRPD) test method,¹ invented by Dr. Mick Greenbank. The GRPD is a modern test method which provides rapid and cost-effective information for aqueous and vapor-trace organic removals.

A Greenbank-developed off-shoot of GRPD technology is the emerging trace capacity test method² based upon a vapor-phase sorbent challenge with tetrafluoromethane (TFM) (which was recently outlined in the June issue of *WC&P*). GRPD uses 1,1,1,2-tetrafluoroethane as the challenge gas.

TFM requires higher adsorption energy binding sites to capture it compared to TFE, which is easier for sorbents to capture. The TFM method is useful for sorbent developers designing new sorbents for adsorption of carbon dioxide, methane and other refractory compounds for which conventional commercial sorbents are not adequate to solve pressing problems.

Winning the business case for advanced test methods requires patience and persistence. People do not understand methods technology and its benefits to their business. Laboratory service providers need to explain testing results in a way that is useful to the client.

Test methods can 'prove' optimum cost per gallon of treated water, air, process liquids, etc. in real-plant operating situations. This will mean dollars and cents in the pocket of the company using the activated carbon for treatment of their process streams.

GRPD enables activated users a way to determine the pores (adsorption specific spaces) needed for their application.³ This information is obtained by comparing the starting unused activated carbon with the used activated carbon GRPD runs. When an activated carbon user or their carbon supplier has obtained information about the needed pores, they are positioned to select the best available application.

To provide the needed level of understanding, you have to be prepared to educate people and prove the business case for them. This education process takes time. Table 2 contains a list of some advantages for using the GRPD method as an aid in your activated carbon decisions.

Activated carbon school

Ideally, activated carbon users should have sufficient knowledge to work effectively with equipment and sorbent media suppliers. Typically, carbon users do not have a complete knowledge base to handle all possible issues. Formal education and training in activated carbon adsorbers is hard to find, as you do not learn it at a university. Professional sources within the industry, such as the Activated Carbon School, remain a best option.

Continuing education is an important tool to obtain third-party advice on professional operations. Having face-to-face discussions with knowledgeable individuals is a benefit and, of course, attendance and participation.

Most conferences have short courses before and after the events. Adding a couple of days of training to your next conference to continue your education is cost effective.

Firms and individuals need the best knowledge, ideas and any possible alternatives to reduce the risk of making bad decisions. Establishing relationships with mentors has been found useful to obtain valuable third-party ideas to avoid making mistakes.

An important need for third-party evaluations often involves legal dispute or purchasing an external firm. In these situations a highly knowledgeable and unbiased expert helps to assure the best decision is obtained.

Working with lawyers is a task with which scientists typically have little experience, especially in the role of an expert witness.⁴ Even when the plaintiff or defendant have staff capable of working with their legal representative, they often choose outside experts.

This is done to avoid bias and disruption of normal business. Lawyers, however, are demanding of an expert's time, often having critical drop-dead dates that require large amounts of time in only a few weeks.

References

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2. Greenbank, Mick. *Using a Gas-Phase Test To Predict Liquid-Phase Activated Carbon Performance at Trace Concentrations*. Presented at the 24th International Activated Carbon Conference, Pittsburgh, PA October 6, 2009.
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4. Nowicki, Henry and Sherman, Barbara. "So You Want To Be An Expert Witness." *Chemical Engineering*, July 2005, pg 48-52.

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About the company

◆ Professional Analytical and Consulting Services Inc. (PACS) is celebrating its 25th year of incorporated business. PACS provides testing, R&D, training and consulting services. To view a typical GRPD report mentioned in this paper, see www.pacslabs.com.

If you are new to a subject it is a good idea to start with the glossary of words used in the industry. PACS has published a glossary of key words and provided a self-administered test to check your word usage and understanding of activated carbon vocabulary.