

## Developing and Validating a Rapid Small-Scale Column Test Procedure for GAC Selection using Reconstituted Lyophilized NOM

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Cost effective design and operation of Granular Activated Carbon (GAC) facilities requires the selection of GAC that is optimal for a specific site. Rapid small-scale column tests (RSSCTs) are widely used for GAC assessment due to several advantages, including the ability to simulate the breakthrough behavior in full-scale adsorbers without requiring complex numerical models, significantly reduced time, and significantly reduced water volume. Moreover, previous research has successfully simulated the breakthrough of NOM in pilot-scale GAC columns using proportional diffusivity (PD) RSSCTs.

The challenge in comparing different GACs with RSSCTs lies in the variability of NOM. Concentration and characteristics of aquatic NOM in source water change over time, depending on organic matter source, biodegradation, and some other factors like temperature, pH and ionic strength. Even with preservation, aqueous samples have a limited holding time. Previous research on NOM and disinfection byproduct formation overcame this issue by further concentrating and preserving NOM via lyophilization. Lyophilization produced a dry material with a long shelf-life, which was validated to be consistent with the source NOM after reconstitution. Therefore, it is desirable to have a shelf-stable NOM standard produced from a site specific source water, which can be reconstituted to generate feed water with consistent quality for RSSCTs. Using such an NOM standard would allow a water utility to benchmark the effectiveness of various GAC samples over long time periods, which could perhaps assist in purchasing decisions.

To develop and verify a method for GAC evaluation using stable NOM standards produced from drinking water sources, this study concentrated NOM from the influent to GAC contactors (GACI) at Greater Cincinnati Water Works (GCWW), while collecting source GACI water at the same time. Subsequently, dry NOM was produced from the NOM concentrate via lyophilization. PD-RSSCTs were conducted simultaneously with the source GACI and with GACI prepared by reconstituting the dry NOM in Milli-Q water (Recon GACI). NOM concentration, hardness, pH and conductivity in Recon GACI were closely matched to those in the source GACI. Both virgin and regenerated GACs provided by GCWW were studied.

TOC and UV-254 breakthrough profiles obtained with GACI and Recon GACI were almost identical, validating that using reconstituted NOM does not introduce significant error to GAC evaluation results. Also, RSSCT simulated TOC breakthrough profiles of both virgin GAC and regenerated GAC were compared to a full-scale breakthrough profile and the virgin GAC yielded a rather accurate estimation. The regenerated GAC comparison resulted in a slightly earlier breakthrough profile, possibly due to the changes in GAC pore structure during regeneration and grinding. The results of this project will be fully discussed and the potential uses for drinking water relevant standardized NOM sources explored.