EFFICIENT CARBON AND ION EXCHANGE MEDIA EXCHANGE: A PROVEN PROCESS FOR OPTIMAL PERFORMANCE

Water and wastewater treatment systems rely on the timely exchange of filtration media to maintain efficiency and treatment compliance. This document outlines the essential steps required to exchange spent media, including disposal of spent media.

Filtration media removes contaminants via adsorption or ion exchange mechanisms, depending on the media used. Once treatment media runs out of adsorption or ion exchange sites, contaminants are no longer removed and begin to breakthrough to the effluent. An effective media exchange program ensures that every pound of media is used prior to being exchanged while preventing breakthrough above compliance or performance targets.

Performance Monitoring

Performance monitoring is a critical part of a media exchange program. Media filtration systems are designed to operate in lead-lag configuration, as shown in Figure 1, wherein two treatment vessels work in series to remove the selected contaminant. The lead vessel does the bulk of contaminant removal, and the lag vessel acts as a polishing step.

Over time, the media in the lead vessel becomes saturated as shown in Figure 2. Once contaminants break through the lead vessel, it is swapped with the lag vessel and the media is exchanged. Monitoring for breakthrough is done by taking samples at the 25% and 75% sampling ports of the lead vessel, and at the sampling port between two vessels. In the early phases of treatment, samples taken between the lead and lag vessels will return results below instrument detection levels for most contaminants. As such, samples are taken from the 25% and 75% ports to validate the kinetic models used to predict breakthrough. Sampling at the effluent may be required for compliance purposes.

Figure 1*: A treatment system with two vessels in lead-lag configuration.*

If the contaminant is detected at the 25% level but not the other levels, saturation of the upper bed has occurred. If the contaminant is detected at the 75% level, the media is nearing exhaustion and breakthrough at the outlet is imminent, and operators should prepare for an exchange. Sampling is typically done at a monthly or bi-monthly frequency, depending on the expected media lifetime.

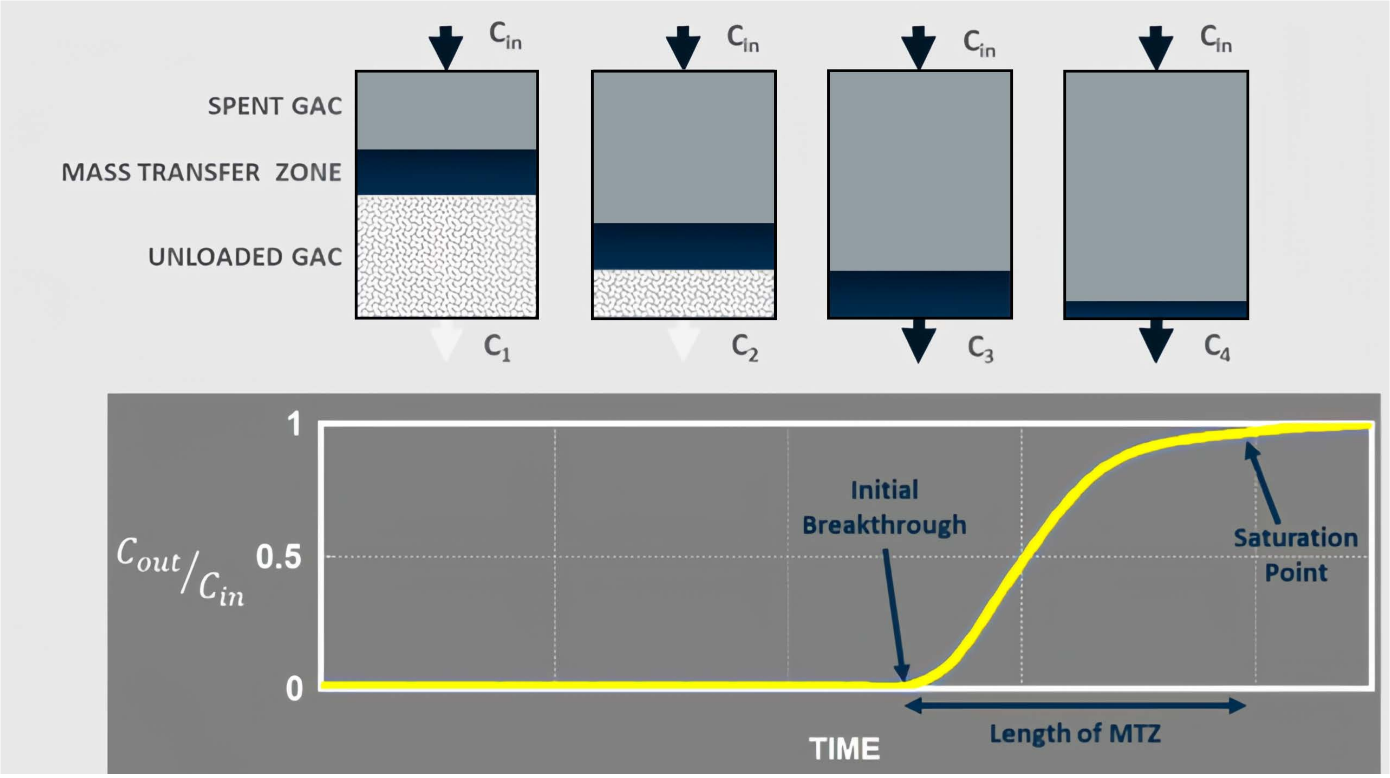

Figure 2: Example of media saturation over time for a carbon bed.

Media Exchange

Once exhausted, spent media must be exchanged. The exchange process involves six steps: removing spent materials, system disinfection, pre-fill sampling and system checks, fresh media fill, and soaking, backwashing, and flushing.

In a typical exchange process, spent media is displaced by pressurizing the treatment system. Spent media is pneumatically displaced to a slurry trailer where it can easily be transported for disposal (see Figure 3). If the vessel was opened to perform an inspection or to conduct repairs, then a thorough disinfection process following AWWA standards is required before new media is installed.

Using a chlorine-based solution, all piping, vessels, and associated components are sanitized to eliminate biological contaminants that, if not properly removed, will foul new media. With the spent media removed, new media is transferred into the system, typically via a slurry transfer method wherein media is fluidized to ensure even distribution and optimal bed structure.

Testing is conducted to ensure the disinfection step is carried out properly. The influent, effluent, and source water are tested for bacteria before and after new media is installed. New media is transferred into the system, typically via a slurry transfer method wherein media is fluidized to ensure even distribution and optimal bed structure.

Figure 3: *AqueoUS Vets' state of the art slurry trailer.*

After the media is installed, further steps are taken to ensure proper performance. Activated carbon must be soaked overnight for 12 to 24 hours to eliminate trapped air and to open the carbon pores to maximize adsorption capacity. Following this, the system must be backwashed to ensure the bed is properly stratified and pressure drop is minimized (see Figure 4). After flushing, the system undergoes a final bacterial testing to ensure readiness, where influent, effluent, and source water are all tested.

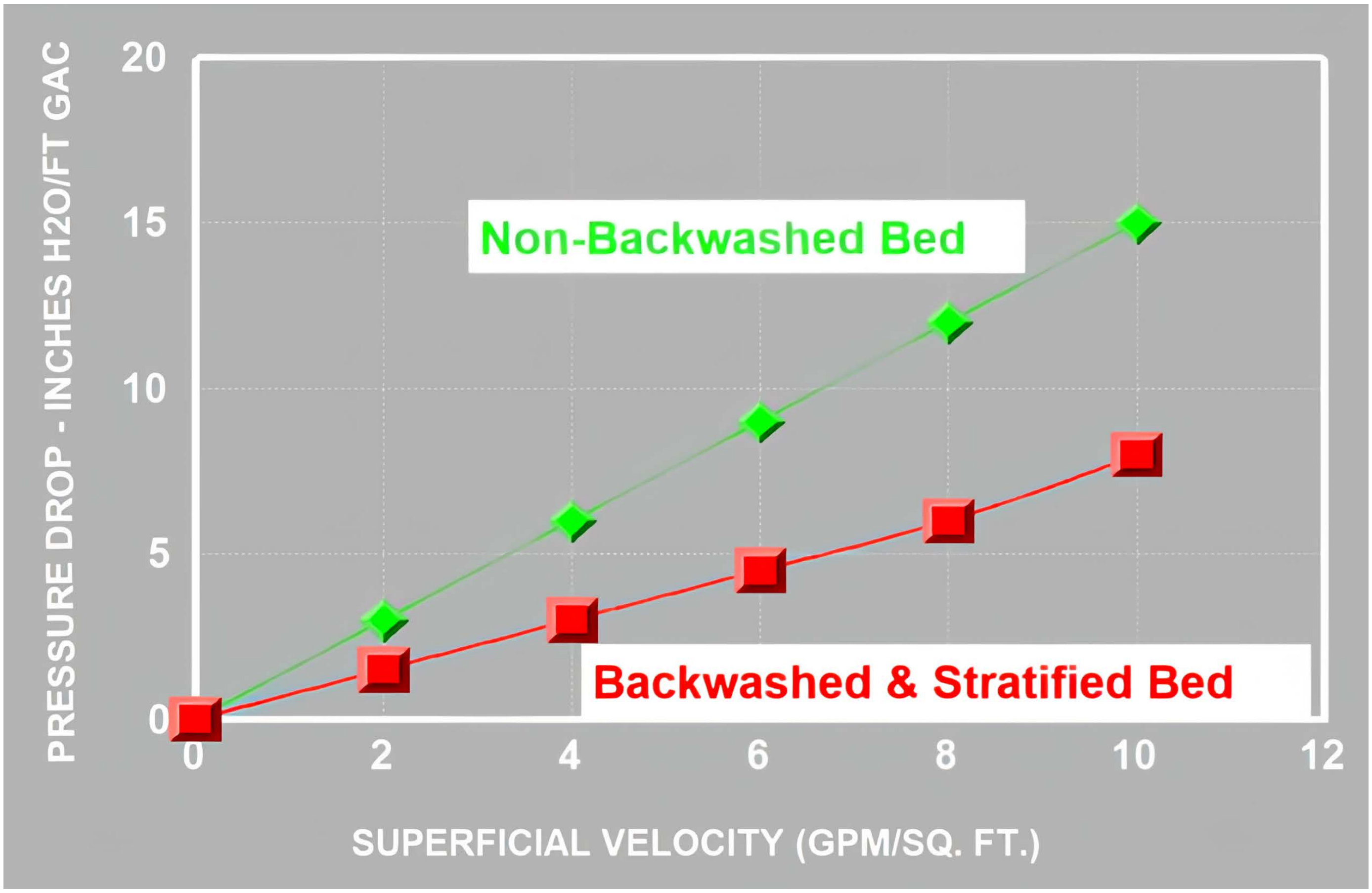

Figure 4: *Pressure drop for stratified vs. non-stratified carbon beds.*

Spent Media Disposal

Proper care must be taken when disposing of spent media. The type of media used, contaminants removed, and proximity to disposal infrastructure dictate where spent media is sent. Typical disposal routes include landfills or thermal treatment facilities. Determining the most appropriate disposal route starts with generating a profile of the spent material. A small sample of material is collected and analyzed for any hazardous compounds, as classified by the Resource Conservation & Recovery Act (RCRA)[1]. The presence of such compounds subjects the waste to additional control measures during transportation and disposal.

Landfilling

Depending on its characteristics, spent media may be disposed of at municipal solid waste landfills. If landfilling is the preferred route and the spent media is classified as hazardous waste, it must be sent to a landfill governed under RCRA Subtitle C. These landfills are subject to additional controls around lining and leachate treatment that are designed to minimize environmental exposure. As landfills do not destroy contaminants, thermal treatments are often preferred to landfilling.

Thermal Treatment

Thermal treatment methods have long been used for disposing of spent media that are not easily amendable to landfilling. By subjecting spent media to high temperatures, thermal processes aim to mineralize contaminants, effectively breaking them down into inert forms. Common treatment options include reactivation and incineration; however, lightweight aggregate kilns and cement kilns — generally used to process clay, shale, slate, or limestone — may also be used.

Reactivation is the preferred method for disposing of spent Granular Activated Carbon (GAC). Reactivation furnaces have been used to reactivate carbon contaminated with organic compounds such that reactivated material can be reused for decades. The reactivated material is typically reused for non-potable applications; however, potable reactivation and return is not uncommon. The reactivation process consists of four stages that effectively mineralize organic compounds: drying (100-110°C), desorption (315-400°C), pyrolysis (800°C), and oxidation or controlled gasification (800°C).

[1]The EPA has designated PFOA and PFOS as a hazardous *substance* under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This is distinct from a designation as a hazardous waste under RCRA. At the time of writing, PFAS is *not* designated as a hazardous waste under Subtitle D of RCRA. As such, transporters of PFAS-laden waste do not need to have a manifest system, an emergency response plan, nor does waste have the be sent to permitted Treatment, Storage, and Disposal Facilities (TSDFs).

Incineration is the preferred method for disposing of spent ion exchange resin or organoclay materials. Incineration is an effective and permitted method for destroying certain halogenated organic chemicals including chlorinated solvents, PCBs, dioxin-laden wastes, brominated flame retardants, refrigerants, and ozone-depleting substances. Most incinerators pass waste through two stages: combustion in a rotary kiln (650 - 1,370oC) and processing in an after burner / secondary chamber (1,100 - 1,370o C). Unlike reactivation, incinerated media cannot be reused.

For both reactivation and incineration, bottom ash generated from the process is removed from the kiln and is typically sent to hazardous waste landfills. Thermal facilities subject to Clean Air Act and RCRA permitting with off-gas incineration and additional temperature controls are subject to standards and safeguards more conducive to destroying hazardous wastes, and are deemed as the best available technologies for PFAS-laden materials per the EPA's latest guidelines.[2]

Innovative Offerings

AqueoUS Vets recognizes the rapidly evolving landscape of technologies for media regeneration and disposal. Accordingly, we collaborate with innovative technology partners on the development of emerging disposal technologies, with the hopes of proving / disproving the commercial viability of these emerging options for our customers.

The Changing Regulatory Environment for the Disposal of PFAS Laden Materials

The EPA's latest Interim Guidance for the disposal of PFAS-laden materials highlights the complexity of PFAS disposal and underscores the need for continued research and technological innovation. Thermal treatment holds significant promise but requires further validation to address uncertainties around byproducts of incomplete combustion. As this field evolves, AqueoUS Vets will follow EPA's guidance and remain flexible to best in class disposal options.

Learn more about media exchange and disposal at https://www.aqueousvets.com/media-exchange

[2] Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing PFAS (April 2024). Available at: https://www.epa.gov/pfas/interim-guidance-destruction-and-disposal-pfas-and-materials-containing-pfas

About the Author:

Conrad Hopp is the Manager of Strategic Initiatives at AqueoUS Vets®, where he focuses on planning and alignment, strategic partnerships and corporate development, and strategic projects. Conrad brings a deep understanding of the emerging contaminants, with a proven track record of success leading the Advisory Services team at BlueTech Research, a global provider of water technology market intelligence.

(925) 331-0573

aqueousvets.com
info@aqueousvets.com

16761 Clear Creek Road
Redding, CA 96001

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