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Date: December 12, 2023

Subject: **Reactivation of Activated Carbon for Per– and Polyfluoroalkyl Substances (PFAS) Removal**

Calgon Carbon recently received a number of questions regarding the fate of PFAS after carbon adsorption, including whether reactivation/regeneration is sufficient for removing PFAS from activated carbon, and if incineration is necessary for complete destruction of these compounds. The purpose of this letter is to explain the difference between reactivation and regeneration and to clarify any misconceptions associated with the process of reactivating spent activated carbon used for PFAS removal.

The reactivation of spent activated carbon is a well established, high temperature process for the thermal destruction of adsorbed chemicals, after which the reactivated carbon can be reused. The desorbed chemical constituents are thermally destroyed in the process and the reactivation of spent carbon containing PFOS, PFOA, and other PFAS has been practiced for over 15 years.

While our reactivation furnaces are called “Carbon Regeneration Units” (CRU’s) by the EPA, the reactivation process is highly engineered and drastically different from typical regeneration processes. Though CRU's are not considered incinerators from a regulatory perspective, Calgon Carbon's reactivation furnaces are designed with emissions abatement systems that meet the waste incinerator performance standards of 40 CFR 264 Subpart O (Section 264.343).

Here is some additional information on the difference between the reactivation process and regeneration process:

- Reactivation[1]: spent carbon is reactivated in a multi-hearth furnace or rotary kiln by volatilizing and destroying the adsorbed contaminants and restoring the activated carbon to a virgin-like state. Reactivation temperature and feed throughput requirements may vary depending upon the adsorbate loading characteristics of the spent carbon being processed; Industrial Reactivation furnace temperatures are generally around 1700-1800ºF, similar to incineration conditions but in low oxygen environment. The standard operating procedure for Custom Municipal Reactivation of spent activated carbon used for PFAS applications is currently under additional evaluation to confirm the complete destruction of adsorbates.
    - The destruction of adsorbates on spent activated carbon is a two step process. First, the adsorbates are volatilized or desorbed from the carbon surface. Some of the desorbed contaminants are destroyed in the reactivation furnace. Adsorbates that are removed and not destroyed in the furnace are drawn through an abatement system, which consists of a thermal oxidizer/afterburner, a scrubber, and a baghouse. The abatement system is designed to destroy organics to at least 99.99% efficiency, to neutralize acid gases formed during the process, and to capture particulates. Efficiency and functionality of the abatement system is verified by agency approved and verified stack testing.
- Regeneration: our reactivation process differs greatly from the “regeneration” process. Carbon regeneration does not have the same temperature requirements as Calgon Carbon’s reactivation process and could be performed with steam or hot N_2 that rarely gets above 212°F. As a result, regeneration produces a partially spent carbon containing some, and potentially all, of the original

[1] Calgon Carbon offers two different types of reactivation services – Custom Municipal Reactivation (CMR) and Industrial Reactivation.

adsorbates. Unlike reactivation, a typical regeneration process would not ensure the complete destruction of any and all PFAS.

There are a number of literature references and third party data that support the destruction of PFAS at temperatures similar to our reactivation conditions. Here are some examples for your reference:

- A study of spent carbon used in drinking water treatment that contained PFAS found that no PFAS remained on the carbon at temperatures above 1292°F in nitrogen.[i]
- A number of studies indicate that PFAS and fluoropolymers are effectively destroyed under conditions similar to reactivation.[ii,iii, iv,v]
- A study on the thermal stability of PFAS on spent GAC concluded, "…effective thermal destruction of PFAS during GAC reactivation in CO_2/N_2 or during incineration / combustion of materials laden with PFAS (e.g., municipal solid wastes) is very likely provided high temperatures (≥ 700°C) are used."[viii]
- Greater than 99.999% destruction of five PFAS compounds was demonstrated in a field study examining the performance of a newly installed thermal oxidizer at a Chemours production facility.[ix]
- A study of the thermal destruction of PFOS found that the presence of oxygen and moisture can facilitate complete mineralization to HF, CO_2 and SO_2 such that they were the only products observable at temperatures greater than 850°C.

Based on significant R&D work completed both internally, by third parties, and various literature references, we are confident that PFAS are desorbed and destroyed through Calgon Carbon's reactivation process. In fact, Calgon Carbon very recently published its own findings that the total of targeted PFAS measured during a full scale reactivation campaign at one of its facilities was reduced by greater than 99.99%.[xi] If you have any questions or concerns, please do not hesitate to contact us at pfcsolutions@calgoncarbon.com.

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[iv] Office of Pollution Prevention & Toxics, Docket AR226-1366, ed. Laboratory-Scale Thermal Degradation of Perfluorooctanyl Sulfonate and Related Substances. Washington DC: US Environmental Protection Agency, **2003**, 13

[v] Office of Pollution Prevention & Toxics, Docket AR226-1367, ed. Final Report: Laboratory-Scale Thermal Degradation of Perfluoro-Octanyl Sulfonate and Related Substances. Washington DC: US Environmental Protection Agency, **2003**, 142

[viii] Xiao, F., Sasi, P. C., Yao, B., Kubatova, A., Golovko, S. A., Golovko, M. Y., Soli, D. Thermal stability and decomposition of perfluoroalkyl substances on spent granular activated carbon. *Environmental Science & Technology Letters*, **2020**, *7*, 343-350.

[ix] Chemours. Thermal oxidizer performance test report: Chemours Company Fayetteville Works (Focus Project P-001393), **2020**. https://www.chemours.com/en/-/media/files/corporate/fayetteville-works/2020-03-thermal-oxidizer-test-report.pdf.

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