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American Water Works Association

The Authoritative Resource on Safe Water®

AWWA Standard

Reactivation of Granular Activated Carbon

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Contents

All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

Foreword

This foreword is for information only and is not a part of ANSI/AWWA B605.

I. Introduction.

I.A. *Background.* A number of municipal water utilities employ granular activated carbon (GAC) to remove organic impurities from potable water sources.

These impurities include compounds imparting taste and odors, algal toxins, synthetic organic compounds, endocrine disruptors, pharmaceutically active compounds, and disinfection by-product precursors. As the water treatment service time of a GAC increases, its capacity to adsorb impurities decreases. When the GAC filter no longer produces water of the desired quality, a potable water utility faces the decision either to replace the GAC with virgin (new) carbon or to reactivate the used GAC and use it again. The following document offers guidelines regarding the latter choice. This document is intended to provide standards for use by the potable water utilities that use granular activated carbon and to the suppliers who provide a thermal reactivation service.

I.B. *History.* The Standards Council authorized the development of this standard in 1993. The standard was developed by the AWWA Reactivation of Granular Activated Carbon Subcommittee, and the first edition was approved by the AWWA Board of Directors Jan. 24, 1999. This edition was approved on Feb. 15, 2007.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the American Water Works Association Research Foundation (AwwaRF) and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (AWWA) and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.* Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health

*Persons outside the United States should contact the appropriate authority having jurisdiction.

effects of products and drinking water additives from such products, state and local agencies may use various references, including

1. An advisory program formerly administered by USEPA, Office of Drinking Water, discontinued on Apr. 7, 1990.
2. Specific policies of the state or local agency.
3. Two standards developed under the direction of NSF, NSF*/ANSI† 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.
4. Other references, including AWWA standards, *Food Chemicals Codex, Water Chemicals Codex*,‡ and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of "unregulated contaminants" are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

ANSI/AWWA B605 does not address additives requirements. Users of this standard should also consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.
2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

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* NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.

† American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

‡ Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20418.

II. Special Issues.

II.A. *General.* A description of virgin GAC and its production is provided in ANSI/AWWA B604, Standard for Granular Activated Carbon.

GAC is used to remove a broad spectrum of impurities from water. At some point in the service life of a GAC, the GAC adsorption capacity decreases to the point that the GAC no longer produces the desired effluent water quality. At this time, the GAC is characterized as *spent,* and it must be replaced. The spent GAC can be disposed of and replaced with virgin GAC, or the spent GAC can be reactivated and reinstalled for additional use.

During reactivation, GAC is typically exposed to the following conditions: drying, desorption/devolatization, pyrolysis, and oxidation. This process requires high temperature conditions. Reactivation is a form of regeneration. Regeneration can also include low-temperature processes that may not be as effective as reactivation.

Varying conditions within a water treatment plant, such as process upsets, length of GAC service, or widely fluctuating influent water quality will affect how efficiently a specific spent GAC may be reactivated. Because of this, characterizing a representative sample of the spent GAC and determining its reactivation characteristics (possibly by laboratory reactivation testing) are the most reliable means for projecting how the GAC will behave in a commercial reactivation system (appendix B discusses collecting representative samples).

For generic classification purposes, lightly loaded GACs are those that have been subjected to low loadings of total organic carbon (TOC), calcium, and disinfectants/oxidants over a short time. At the other extreme are highly loaded GACs that have experienced high loadings of TOC and calcium and have been exposed to higher levels of disinfectants/oxidants over a long time. The relationship between loading and reactivation will vary by GAC type and water quality, but in general, lightly loaded GACs will recover a higher percentage of adsorptive capacity than heavily loaded GACs.

There will be some loss of GAC during reactivation. Causes for this loss include transportation and handling and reactivation losses. Therefore, makeup GAC is added to the reactivated GAC to bring the total GAC volume back to the original level. The makeup GAC should be virgin GAC or other reactivated GAC from the same potable water facility, exclusively. Use of virgin GAC as makeup avoids the

potential liability of introducing leachable foreign material from reactivated GAC from sources other than the purchaser's own water.

II.B. *Source of Supply and Services.* GAC and carbon reactivation services should be obtained from sources regularly used to produce and supply these materials and services for water utilities.

II.C. *GAC Size Distribution.* The reactivated GAC should possess a particle size distribution, effective size (ES), and uniformity coefficient (UC) comparable to the virgin product to ensure proper physical filtration performance and adsorption behavior. The makeup GAC can be either virgin or reactivated GAC. Because the makeup GAC can contribute significantly to the overall GAC volume, the acceptability of placing the entire makeup GAC shipment in a filter should be determined by considering the impact and effect of the makeup GAC on the particle size distribution, effective size, and uniformity coefficient. More information on the definition and significance of GAC size distribution is provided in ANSI/AWWA B604.

II.D. *Adsorptive Capacity.* To accurately assess the effectiveness of reactivated GAC, testwork should be completed using water from the particular plant in question. Evaluating the removal of a specific challenge compound, such as geosmin or 2-methylisoborneol (MIB) may be included in the testwork. It is strongly recommended that users of reactivated GAC follow this approach, as it will reflect the actual conditions under which the GAC will be used.

Various surrogate tests have been developed that give an indication of a granular activated carbon's performance under specific conditions. These tests use a specific adsorbate at a high concentration to reduce the amount of time required to run the test. They are of limited versatility and are not necessarily indicative of the performance of reactivated GAC for a given application. Examples of these tests are the iodine number, tannin value, and acetoxime number adsorption tests. Iodine number is indicative of the total surface area of a GAC. Acetoxime number is used as an index of a GAC's ability to remove some low-molecular-weight compounds, such as volatile organic compounds (VOCs). Tannin value is used as an index of a GAC's ability to remove high-molecular-weight compounds, such as disinfection by-product precursors. ASTM D4607 describes the test method for determining a GAC's iodine number. Information on determining tannin value and acetoxime number is

presented in appendix B of ANSI/AWWA B604 (Granular Activated Carbon) and AWWA guidance documents *Standardized Protocol for the Evaluation of GAC*.*

II.E. *Caution in Handling and Storage.* Wet GAC will readily adsorb oxygen from the air, creating an acute oxygen depletion hazard in confined areas. Appropriate safety measures for oxygen-deficient atmospheres should be strictly adhered to when entering enclosed or partially enclosed areas containing GAC.

In storing dry, reactivated GAC, users should take precautions to avoid direct contact with strong oxidizing agents, such as chlorine, hypochlorite, potassium permanganate, ozone, chlorite, and peroxide. Contact with these agents can produce significant exothermic reactions or the rapid production of gaseous decomposition products. GAC can ignite or explode if it is overpressurized.

Mixing of GAC with hydrocarbons (oils, gasoline, diesel fuel, grease, paint thinners, etc.) may cause spontaneous combustion. Therefore, GAC must be kept separate from hydrocarbon storage or spills.

GAC dusts are classified as "nuisance particulates," and the applicable threshold limit values (TLVs) should be followed.

III. Use of This Standard. It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* The following items should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA B605, Reactivation of Granular Activated Carbon, of latest revision.

2. Whether compliance with NSF/ANSI 61 Drinking Water System Components—Health Effects, is required, in addition to the requirements of the Safe Drinking Water Act.

3. Quantity of spent GAC to be reactivated. Reactivated GAC, including makeup, intended for immediate placement in an adsorption bed is typically purchased by the volume that remains following in-place backwashing and draining, per ANSI/AWWA B604.

4. Physical requirements (Sec. 4.1).

5. Details of other federal, state, or provincial and local requirements (Sec. 4.1.1).

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*R.S. Summers, et al. 1992 *Standardized Protocol for the Evaluation of GAC* (Denver, CO) AwwaRF and AWWA.

6. Performance criteria (Sec. 4.2).

7. Product lot analysis and/or representative sample of prior cycle startup GAC (virgin or reactivated GAC) (Sec. 4.3).

8. Representative sample and history of spent GAC to be reactivated (this includes data pertaining to the original, virgin GAC(s) that became spent) (Sec. 4.3).

9. If the material does not meet the requirements of this standard and the purchase documents, payment or removal should be covered in the purchase documents (Sec. 5.3).

10. Provisions for failing to reactivate GAC to specified conditions (Sec. 5.3.6).

11. Method of shipping and packaging (Sec. 4.4 and 6.2).

12. Additional adsorptive capacity tests (Sec. 4.2.2).

13. Provisions for reaching agreement on sampling technique (Sec. 5.1) for in-place spent GAC product and reactivated product (Sec. 5.3.3).

14. Reference sample and acceptance method (Sec. 5.3.1 and 5.3.5).

15. If shipment is to be in bulk, the type of railcar or truck/trailer (Sec. 6.2.4); the type of bulk bag (Sec. 6.2); and whether the bulk shipments are to be accompanied by weight certificates by certified weighers (Sec. 6.2.5).

16. Whether an affidavit of compliance is required (Sec. 6.3).

III.B. *Modification to Standard.* Any modification to the provisions, definitions, or terminology in this standard must be provided by the purchaser.

IV. Major Revisions. Major revisions made to the standard in this edition include the following:

1. The minimum allowable apparent density was changed from 0.25 g/cc to 0.20 g/cc.

2. The foreword was revised to address AWWA format requirements.

3. Expanded definition section.

4. Information in appendix B was removed and replaced with an existing test from appendix C.

V. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer and Technical Support Group at 303.794.7711, FAX 303.795.7603, write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

American Water Works Association

ANSI/AWWA B605-07
(Revision of ANSI/AWWA B605-99)

AWWA Standard

Reactivation of Granular Activated Carbon

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes the procurement of granular activated carbon (GAC) reactivation services and the use of reactivated GAC for water treatment. This standard does not cover the design of activated carbon handling facilities, reactivation facilities, or adsorption processes. Background information on GAC reactivation can be found in references listed in the bibliography to this standard (appendix A).

Sec. 1.2 Purpose

The purpose of this standard is to provide a standard for use in preparing purchase documents for the procurement of GAC reactivation services where GAC is used as an adsorptive medium to produce potable water.

Sec. 1.3 Application

This standard can be referenced in purchase documents for the reactivation of granular activated carbon. The stipulations of this standard apply when this