ANSI/AWWA B600-05
(Revision of ANSI/AWWA B600-96)

American Water Works Association

The Authoritative Resource on Safe Water℠

AWWA Standard

Powdered Activated Carbon

American National Standards Institute

Effective date: Oct. 1, 2005.
First edition approved by AWWA Board of Directors May 15, 1953.
This edition approved Jan. 16, 2005.
Approved by American National Standards Institute Aug. 11, 2005.

6666 West Quincy Avenue
Denver, CO 80235-3098
T 800.926.7337
www.awwa.org

Advocacy
Communications
Conferences
Education and Training
▶ ***Science and Technology***
Sections

Documents
Document Sharing Hub

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Full document details: AWWA B600 2005

AWWA Standard

This document is an American Water Works Association (AWWA) standard. It is not a specification. AWWA standards describe minimum requirements and do not contain all of the engineering and administrative information normally contained in specifications. The AWWA standards usually contain options that must be evaluated by the user of the standard. Until each optional feature is specified by the user, the product or service is not fully defined. AWWA publication of a standard does not constitute endorsement of any product or product type, nor does AWWA test, certify, or approve any product. The use of AWWA standards is entirely voluntary. AWWA standards are intended to represent a consensus of the water supply industry that the product described will provide satisfactory service. When AWWA revises or withdraws this standard, an official notice of action will be placed on the first page of the classified advertising section of *Journal AWWA*. The action becomes effective on the first day of the month following the month of *Journal AWWA* publication of the official notice.

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether that person has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review, and users are cautioned to obtain the latest editions. Producers of goods made in conformity with an American National Standard are encouraged to state on their own responsibility in advertising and promotional materials or on tags or labels that the goods are produced in conformity with particular American National Standards.

CAUTION NOTICE: The American National Standards Institute (ANSI) approval date on the front cover of this standard indicates completion of the ANSI approval process. This American National Standard may be revised or withdrawn at any time. ANSI procedures require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036; (212) 642-4900.

Science and Technology

AWWA unites the entire water community by developing and distributing authoritative scientific and technological knowledge. Through its members, AWWA develops industry standards for products and processes that advance public health and safety. AWWA also provides quality improvement programs for water and wastewater utilities.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information or retrieval system, except in the form of brief excerpts or quotations for review purposes, without the written permission of the publisher.

Copyright © 2005 by American Water Works Association
Printed in USA

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

Committee Personnel

The AWWA Standards Committee on Activated Carbon, which reviewed and approved this standard, had the following personnel at the time of approval:

Mark A. Waer, *Chair*

General Interest Members

D.R.U. Knappe, North Carolina State University, Raleigh, N.C.	(AWWA)
D.W. Mazyck, University of Florida, Gainesville, Fla.	(AWWA)
T.J. McCandless,* Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
S.J. Medlar, Camp Dresser & McKee Inc., Edison, N.J.	(NEWWA)
R.G. Saterdal, Englewood, Colo.	(AWWA)
P.L. Schorr, New Jersey Department of Environmental Protection, Princeton, N.J.	(AWWA)
T.F. Speth, USEPA, Cincinnati, Ohio	(AWWA)
I.H. Suffet, UCLA School of Public Health, Los Angeles, Calif.	(AWWA)
R.S. Summers, University of Colorado at Boulder, Boulder, Colo.	(AWWA)
M.A. Waer, Black & Veatch, Phoenix, Ariz.	(AWWA)

Producer Members

D.A. Ainsworth, Cameron Carbon Inc., Baltimore, Md.	(AWWA)
S.L. Butterworth, Calgon Carbon Corporation, Pittsburgh, Pa.	(AWWA)
H.R. Johnson,† MeadWestvaco Corporation, Covington, Va.	(AWWA)
David Jordan, San Francisco, Calif.	(AWWA)
R.G. MacLean, Azurix, Livingston, N.J.	(AWWA)
W.F. Naylor, NORIT Americas Inc., Marshall, Texas	(AWWA)
D.O. Rester,† NORIT Americas Inc., Marshall, Texas	(AWWA)
R.G. Roodman, Envirotrol Inc., Sewickley, Pa.	(AWWA)
B.A. Smith, MeadWestvaco Corporation, Kenner, La.	(AWWA)

*Liaison, nonvoting

†Alternate

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

AVA Documents Document Sharing Hub

Full document details: AWWA B600 2005

User Members

J.A. Bella, Passaic Valley Water Commission, Clifton, N.J.	(AWWA)
D.J. Hartman, Greater Cincinnati Water Works, Cincinnati, Ohio	(AWWA)
M.J. Pickel, Philadelphia Water Department, Philadelphia, Pa.	(AWWA)
H.L. Plowman Jr., Philadelphia Suburban Water Company, Media, Pa.	(AWWA)
C.E. Stringer, Dallas Water Utilities, Dallas, Texas	(AWWA)
K.T. Walsh, The Connecticut Water Company, Clinton, Conn.	(NEWWA)

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

Contents

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

SEC. PAGE

Foreword

I Introduction vii
I.A Background vii
I.B History vii
I.C Acceptance viii
II Special Issues ix
II.A Handling and Storage ix
II.B Activated Carbon Dust x
II.C Adsorptive Performance Tests x
III Use of This Standard xi
III.A Purchaser Options and Alternatives xi
III.B Modification to Standard xii
IV Major Revisions xii
V Comments xiii

Standard

1 General
1.1 Scope 1
1.2 Purpose 1
1.3 Application 1

2 References 2

3 Definitions 2

4 Requirements
4.1 Materials 3
4.2 Characteristics 3
4.3 Chemical Requirements 4
4.4 Impurities 4

5 Verification
5.1 Sampling 4
5.2 Test Procedures 5
5.3 Rejection 12

6 Delivery
6.1 Marking 12
6.2 Packaging and Shipping 13
6.3 Affidavit of Compliance 13

Appendixes

A Bibliography 15

B MIB/Geosmin and Tannin Values Tests
B.1 MIB/Geosmin Test 17
B.2 Tannin Value Test 21

Figures

1 Parallel Threshold Dilution Chart 8
B.1 Example of Calculation of PAC Dose-Equivalent Performance Factors 20
B.2 Sample Determination of Tannin Extract by Carbon Adsorption 24

Tables

1 Parallel Threshold Dilution Chart 11
B.1 Example Weighted Cost Determined by Performance Factors 21

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

AVA Documents Document Sharing Hub

Full document details: AWWA B600 2005

This page intentionally blank.

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

Foreword

This Foreword is for information only and is not a part of ANSI/AWWA B600.

I. Introduction.

I.A. *Background.* Activated carbon is a crude form of graphite that is produced by a carefully controlled oxidation process to develop a porous carbon structure with an internal surface area greater than 500 m^2/g. This surface area gives the activated carbon the capacity to adsorb dissolved organic chemicals, many of which are taste- and odor-causing substances in water.

The major raw materials used in the manufacture of powdered activated carbon (PAC) include, but are not limited to, peat, bituminous coal, coconut shells, wood, and lignite coal. During activation, the raw materials are either reacted at high temperatures in the presence of steam or at moderate temperatures in the presence of activation chemicals. The activation process first drives off volatile components from the raw material, creating a fine porous structure, and then enlarges the pores, which creates the extensive internal pore structure required to obtain appreciable adsorption of organic chemicals. Subsequent processing may include crushing, screening, grading, and packaging.

PAC is applied by mixing it with water to form a slurry that is metered into the water at a suitable point in the treatment process. The activated carbon, along with adsorbed contaminants, is removed by settling or filtration.

I.A.1. Source of supply. Activated carbon used for water treatment should be obtained from manufacturers that are regularly engaged in the production of activated carbon that is found to be satisfactory for service in the water treatment field.

I.B. *History.* The first edition of ANSI/AWWA B600, Powdered Activated Carbon, was approved as tentative by the AWWA Board of Directors on July 11, 1949, and later as a standard on May 15, 1953. Subsequent revisions to ANSI/AWWA B600 were approved by the AWWA Board of Directors on Jan. 23, 1966, Jan. 28, 1978, June 17, 1990, and Feb. 4, 1996. This sixth edition of B600 was approved by the AWWA Board of Directors on Jan. 16, 2005.

ANSI/AWWA B600 provides information on preparing purchase documents for the purchase of PAC to be used as an adsorption medium for the treatment of

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

AVA Documents
Document Sharing Hub

Full document details: AWWA B600 2005

municipal and industrial water supplies. Granular activated carbon is covered in ANSI/AWWA B604, Granular Activated Carbon.

This standard does not cover the design of activated carbon handling facilities or adsorption processes. Design information may be found in *Journal AWWA* and in other publications, some of which are listed in the bibliography (Appendix A) of this standard.

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 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.

---

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

† 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, N.W., Washington, DC 20001.

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

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 B600 does not address additives requirements. Thus, 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.

II. Special Issues.

II.A. *Handling and storage.* The following safety precautions should be exercised to minimize or eliminate hazards when handling and storing PAC. Wet activated carbon 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 activated carbon.

PAC should be stored in a building or compartment that is as fire resistant as possible. Bags of PAC should be stacked in rows with aisles between them so that each bag may be easily removed in case of fire. Nothing else should be stored in the same building or compartment with activated carbon. Strict precautions must be taken to avoid PAC contacting strong oxidizing agents such as chlorine, hypochlorites, potassium permanganate, ozone, and peroxide. Mixing activated carbon with hydrocarbons (such as oils, gasoline, diesel fuel, grease, paint thinners, and so forth) may cause spontaneous combustion. Therefore, activated carbon must be kept separate from hydrocarbon storage or spills.

In case of an activated carbon fire, the safest procedure, if possible, is to place the smoldering material in a metal container and remove it from the building. An

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

activated carbon fire may also be smothered by means of a very fine spray or mist of water from a hose or by a foam-type chemical extinguisher. A direct stream of water should not be used, as it will cause the smoldering particles to fly into the air and spread the fire.

II.B. *Activated carbon dust.* Respiratory protection shall be worn when bags of activated carbon or dry bulk material are unloaded, sampled, prepared for analysis, or otherwise handled. Excessive dusting and inhalation of activated carbon dust should be avoided. Activated carbon dusts are classified as "nuisance particulates," and the applicable threshold limit values (TLVs) should be followed.

Activated carbon is an electrical conductor and should not be allowed to accumulate as dust near or on open electrical circuits. Electrical outlets, lights, and motors in dry–activated-carbon feed and storage rooms should be watertight to preclude the entrance of activated carbon dust.

II.C. *Adsorptive performance tests.* Performance-based evaluation tests include the tannin value and 2-methylisoborneol (MIB)/geosmin test listed in Appendix B. Tannin value is used as an index of a carbon's ability to remove high molecular weight impurities such as organic compounds added to water by decayed vegetation. The MIB/geosmin test is used to assist the user in choosing the most effective PAC for taste and odor removal and the lowest necessary dosage required to meet treatment objectives. These activated carbon tests should be completed using water from the particular plant in question. It is strongly recommended that users do this, as tests will reflect the actual conditions under which the activated carbon will be used. Additional information on the MIB/geosmin test can be found in the AwwaRF research report *Optimization of Powdered Activated Carbon Application for geosmin and MIB Removal.*[*]

Surrogate tests have been developed to give an indication of PAC's general performance under specific conditions. Please note that the use of these surrogates may not model adsorption of actual water contaminants. Examples of these tests are the iodine, number, and threshold odor tests. These tests use a specific adsorbate at a high concentration to reduce the amount of test time required. These tests are of limited versatility and are not necessarily indicative of an activated carbon's performance for a given application. Iodine number is used as an index of the

[*]Watson, M. 1999. *Optimization of Powdered Activated Carbon Application for Geosmin and MIB Removal.* Denver, Colo.: AwwaRF.

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

acceptable surface area of a carbon and its ability to remove some types of chemical tastes and odors in addition to low molecular weight impurities. An iodine number of 500 mg/g is considered a minimum required value for any PAC. This value was determined by considering test performances for most of the manufactured activated carbons that are used successfully for water treatment.

The threshold odor test may be used to determine an activated carbon's performance in removing tastes and odors from a particular water. The threshold odor test procedure is found in Sec. 5.2.7. This test is often used to determine the optimum dosage needed to remove taste- and odor-causing substances at a particular treatment facility. Because of the subjective nature of the test and the variance in water quality at a treatment facility, the threshold odor test may be difficult to use as a reproducible indicator of activated carbon quality and performance.

The purchaser may find it advisable to modify the figure specified for a minimum iodine number or to include the tannin, value, MIB/geosmin, or threshold odor tests as dictated by the relationship of these parameters to the actual treatment performance.

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 B600, Powdered 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 PAC to be purchased, in lb (kg).

4. When requested, a representative sample of the PAC shall be submitted to the purchaser for acceptance before shipment. The sample must be submitted in clean, vapor-proof containers, clearly marked with the address of the supplier, and identified with the lot number of the contents. A duplicate sample shall be tested by the supplier, and a certified test report shall be submitted to the purchaser with the purchaser's sample, showing compliance with the requirements of the purchase documents, along with a statement certifying that the material for shipment is equal in quality to the sample submitted.

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

Documents
Document Sharing Hub

Full document details: AWWA B600 2005

5. Name of the manufacturer whose product will be provided by the supplier.

6. The purchaser may authorize shipment on the basis of the supplier's certification of quality or may test the reference sample submitted by the supplier to confirm compliance before shipment is authorized.

7. Details and requirements of state, local, and provincial requirements (Sec. 4.1).

8. Particle-size distribution, if other than that specified (Sec. 4.2.3).

9. Minimum iodine number, if other than that specified (Sec. 4.2.4).

10. Additional tests (Sec. 4.2.5).

11. Provisions for reaching agreement on sampling technique (Sec. 5.1).

12. The purchaser may elect to collect a representative sample of the material after delivery. The procedure used shall be in accordance with Sec. 5.1. One of the three sample portions taken may be tested to determine compliance with the purchase documents.

13. Marking (Sec. 6.1).

14. Method of packaging and shipping (Sec. 6.2).

15. If shipment is to be in bulk: type of railcar or hopper truck (Sec. 6.2.4), and whether bulk shipments are to be accompanied by weight certificates of certified weighers (Sec. 6.2.5).

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

17. The purchaser may elect to accept the PAC on the basis of (1) the supplier's certified test report and an accompanying affidavit of compliance (Sec. 6.3) indicating that the product proposed for use complies with this standard and with the purchase documents with no exceptions; (2) the supplier's certified test report completed by a qualified third-party testing laboratory approved by the purchaser and an accompanying affidavit of compliance; (3) the purchaser's own testing of the reference sample submitted by the supplier and the required affidavit of compliance; or (4) the purchaser's own testing of the representative sample, collected according to Sec. 5.1 after receipt of shipment, showing compliance with this standard and the purchase documents.

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 revision include the following:

1. Sec. I.A of the Foreword was changed to include a description of the raw materials used in the manufacture of PAC.

Copyrighted material licensed to University of Iowa by Thomson Reuters (Scientific), Inc., subscriptions.techstreet.com, downloaded on Jan-26-2015 by Susan Duerr. No further reproduction or distribution is permitted. Unco

AVA Documents
Document Sharing Hub

Full document details: AWWA B600 2005