ANSI/AWWA B403-16
(Revision of ANSI/AWWA B403-09)

American Water Works Association

Dedicated to the World's Most Important Resource®

AWWA Standard

Aluminum Sulfate—Liquid, Ground, or Lump

Effective date: Nov. 1, 2016.
First edition approved by AWWA June 25, 1942.
This edition approved June 19, 2016.
Approved by American National Standards Institute March 31, 2016.

Copyright © 2016 American Water Works Association. All Rights Reserved.

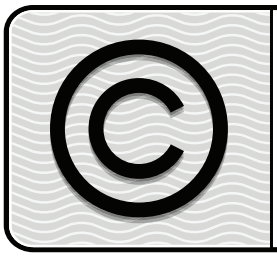
AWWA Standard

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. This standard does not supersede or take precedence over or displace any applicable law, regulation, or code of any governmental authority. AWWA standards are intended to represent a consensus of the water 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 Official Notice section of *Journal – American Water Works Association*. The action becomes effective on the first day of the month following the month of *Journal – American Water Works Association* 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; or emailing info@ansi.org.



This AWWA content is the product of thousands of hours of work by your fellow water professionals. Revenue from the sales of this AWWA material supports ongoing product development. Unauthorized distribution, either electronic or photocopied, is illegal and hinders AWWA's mission to support the water community.

ISBN-13, print: 978-1-62576-178-1 eISBN-13, electronic: 978-1-61300-389-3
DOI: http://dx.doi.org/10.12999/AWWA.B403.16

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 © 2016 by American Water Works Association
Printed in USA

Copyright © 2016 American Water Works Association. All Rights Reserved.

Committee Personnel

The AWWA Standards Committee on Iron Salts, Aluminum Salts, and Related Coagulant Aids, which reviewed and approved this standard, had the following personnel at the time of approval:

Glenn R. Evers, *Chair*
Jan J. Pavlicek, *Vice-Chair*

General Interest Members

M.B. Alvarez, CH2M, Coral Gables, Fla.	(AWWA)
K-K Au, FMC Global Peroxygens, Naperville, Ill.	(AWWA)
J.D. Edwards, Westerville, Ohio	(AWWA)
G.R. Evers, IS2 LLC, Hockessin, Del.	(AWWA)
J.J. Gemin, AECOM, Kitchener, Ont., Canada	(AWWA)
P.H. Hargette, Black & Veatch Corporation, Greenville, S.C.	(AWWA)
S. Heidary-Monfared, EIT, Edmonton, Alta., Canada	(AWWA)
G.A. Iversen, Hazen and Sawyer, Raleigh, N.C.	(AWWA)
D. Larson,* St. Louis, Mo.	(AWWA)
C.B. Lind, Mauser USA LLC, East Brunswick, N.J.	(AWWA)
J.W. Patterson, J.W. Patterson Environmental Consultants, Chicago, Ill.	(AWWA)
S.J. Posavec,* Standards Group Liaison, AWWA, Denver, Colo.	(AWWA)
B.H. Wilder, Daytona Beach, Fla.	(AWWA)

Producer Members

T.A. Badwak, USALCO LLC, Baltimore, Md.	(AWWA)
J.P. Crass, Ventura, Calif.	(AWWA)
D.E. Gordon, QC Corporation, Baltimore, Md.	(AWWA)
L.N. Hjersted,† Agro Iron, Lakeland, Fla.	(AWWA)
B. Keogh, B.I.K. Water Technologies, Dundas, Ont., Canada	(AWWA)
J.J. Pavlicek, Detroit, Mich.	(AWWA)
K.E. Ruehl, Chemtrade Logistics, Ballwin, Mo.	(AWWA)
G. Shull, Yantis, Texas	(AWWA)
B. Wodetzki, PVS Chemicals Inc., Valparaiso, Ind.	(AWWA)

* Liaison, nonvoting
†Alternate

Copyright © 2016 American Water Works Association. All Rights Reserved.

User Members

J.M. Carroll, East Lansing-Meridian Water, East Lansing, Mich. (AWWA)
L.V. Landry, Consolidated Waterworks/Sewerage District Number 1, Princeton, La. (AWWA)
C.A. Owen, Tampa Bay Water, Clearwater, Fla. (AWWA)
B.K. Parsons, City of Greensboro, Greensboro, N.C. (AWWA)
R.S. Smith, Louisville Water Co., Louisville, Ky. (AWWA)
J.S. Trotter, City of Bloomington Utilities, Bloomington, Ind. (AWWA)

Copyright © 2016 American Water Works Association. All Rights Reserved.

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	viii
I.C	Acceptance	viii
II	Special Issues	ix
II.A	Safety and Spill Control	ix
II.B	Protective Equipment	x
II.C	First Aid	x
II.D	Spill-Control Considerations	x
III	Use of This Standard	x
III.A	Purchaser Options and Alternatives	x
III.B	Modification to Standard	xi
IV	Major Revisions	xi
V	Comments	xi
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	Physical Requirements	3
4.2	Chemical Requirements	4
4.3	Impurities	4
5	**Verification**	
5.1	Sampling	5
5.2	Test Procedures—General	6
5.3	Specific Gravity	6
5.4	Water-Insoluble Matter	6
5.5	Total Soluble Alumina and Aluminum	7
5.6	Total Water-Soluble Iron	10
5.7	Ferric Iron	12
5.8	Ferrous Iron	12
5.9	Basicity or Free Acid	13
5.10	Total Alumina Alternative Method	14
5.11	Notice of Nonconformance	16
6	**Delivery**	
6.1	Marking	16
6.2	Packaging and Shipping	17
6.3	Affidavit of Compliance	18

Copyright © 2016 American Water Works Association. All Rights Reserved.

This page intentionally blank.

Copyright © 2016 American Water Works Association. All Rights Reserved.

Foreword

This foreword is for information only and is not a part of ANSI/AWWA B403.*

I. Introduction.

I.A. *Background.* Coagulation of suspended and colloidal particles in water using various forms of aluminum sulfate has been known since the seventeenth century. Although historical details are lacking, in the early days of water purification by coagulation, lump or slab forms of aluminum sulfate were dissolved and added to the water in solution form. Sommerville, N.J., was probably the first utility in the United States serving potable water to use this treatment method on a more or less continuous basis. Shortly thereafter, numerous plants adopted this method, including the Hackensack (N.J.) Water Company and those of the former American Water Works and Electric Company.

The terms *filter alum*, *papermakers alum*, and *commercial alum* all refer to the same chemical: aluminum sulfate. Aluminum sulfate, as produced in tonnage quantities, has the formula $Al_2 (SO_4)_3 \cdot nH_2O$, where *n* is approximately 14 waters of crystallization instead of 18, which is the true crystalline form. The purpose of producing a form of aluminum sulfate that has 14 waters of crystallization is twofold. First, it is stable and gains or loses water slowly under adverse storage conditions. Second, aluminum sulfate having 14 waters of crystallization is approximately 12 percent stronger than aluminum sulfate having 18 waters of crystallization. Using the more concentrated form of the chemical reduces the tonnage to be handled, reduces chemical storage requirements, and saves the consumer transportation costs.

Several other "dry alums" are used in treating swimming pool water and certain industrial waters. These products are "true alums," which are double salts containing 24 waters of crystallization, such as ammonia alum $Al_2 (SO_4)_3 (NH_4)_2SO_4 \cdot 24H_2O$ and potash alum $Al_2 (SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$. These specialty alums are excellent coagulants but have a lower Al_2O_3 content and are not widely used compared with aluminum sulfate. Commercial liquid alum is shipped as a relatively clear, stable solution that contains up to 48.5 percent by weight dry product. In recent years, manufacturers have built production plants in areas of high consumption, and now the United States has many alum-producing plants.

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

Copyright © 2016 American Water Works Association. All Rights Reserved.

Aluminum sulfate is prepared from aluminum hydroxide, alumina trihydrate, or alumina-bearing ores, such as clay and bauxite. The aluminum ore is ground to a required fineness and digested with sulfuric acid at elevated temperatures. Insoluble materials are removed by sedimentation. The supernatant solution is either decanted and sold in liquid form or concentrated and allowed to crystallize into a solid, dry hydrated product. The aluminum oxide content of the liquid is limited to about 8 percent Al_2O_3 to avoid crystallization in transit and storage. The solid, dry hydrated product usually contains 17 percent Al_2O_3.

Liquid alum may be received and stored in corrosion-resistant tanks and transferred through appropriate liquid-metering devices directly into the water at the desired point of application.

I.B. *History.* A specification for Sulphate of Alumina was published in 1925 by the American Water Works Association (AWWA) in its *Water Works Practice Manual*.* On June 25, 1942, AWWA adopted the Emergency Alternate Specifications for Sulphate of Alumina, which relaxed some provisions and allowed the chemical to be made from lower-quality raw materials. (As a wartime measure, higher-quality bauxite had been diverted to the aluminum-metals industry.) In 1952, AWWA's committee upgraded the standard under the guidance of J.E. Kerslake, with Paul Tamer acting as referee for the comments from producers and consumers. The standard was revised in 1958 to include liquid aluminum sulfate. Other revisions were made in 1964, 1969, 1970, 1982, 1988, 1993, 1998, 2003, and 2009. This edition was approved by the AWWA Board of Directors on June 19, 2016.

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 Water Research Foundation (formerly 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

* *Water Works Practice Manual*. AWWA, New York (1925).

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

Copyright © 2016 American Water Works Association. All Rights Reserved.

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

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 60. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 60 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 B403 addresses additives requirements in Sec. 4.3 of the standard. The transfer of contaminants from chemicals to processed water or the residual solids is becoming a problem of great concern. The language in Sec. 4.3.3 is a recommendation only for direct additives used in the treatment of potable water to be certified by an accredited certification organization in accordance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects (http://www.nsf.org/newsroom_pdf/NSF-ANSI_60_watemarked.pdf). However, users of the standard may opt to make this certification a requirement for the product. 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. *Safety and Spill Control.* Aluminum sulfate is a buffered acidic solution that causes irritation when it comes in contact with the eyes, skin, or mucous membranes. Protective clothing and equipment should be used when handling liquid alum. Good ventilation, good housekeeping procedures, and personal cleanliness are also recommended.

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

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

Copyright © 2016 American Water Works Association. All Rights Reserved.

II.B. *Protective Equipment.* Dry aluminum sulfate dust can cause irritations to the respiratory system and eyes. Dust masks, goggles, and gloves are recommended for persons working in the presence of dry aluminum sulfate dust.

Normal precautions should be used to prevent spraying or splashing liquid alum. Face shields should be worn to protect the eyes. Outer coverings, such as vinyl or rubber rain jackets and pants, may be used to protect clothing from liquid alum.

II.C. *First Aid.* Aluminum sulfate should be flushed from the eyes using copious amounts of water. If irritation persists, a physician should be consulted promptly. Aluminum sulfate should be washed from the skin with copious amounts of water.

For additional safety information, refer to material safety data sheets available from the chemical supplier or manufacturer.

II.D. *Spill-Control Considerations.* Outdoor storage tanks should be suitably diked or otherwise provided with an adequate means of secondary containment. Appropriate secondary containment measures should be taken to prevent spills or leaks from indoor storage tanks and tank-car or tank-truck unloading stations from entering sewers or other channels that discharge directly to a water body or a municipal sewage system.

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.* When purchasing aluminum sulfate under the provisions of this standard, the following information should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA B403, Aluminum Sulfate—Liquid, Ground, or Lump, of latest revision.
2. Whether compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.
3. Details of other federal, state or provincial, and local requirements (Section 4).
4. Type of aluminum sulfate required—liquid, ground, or lump (Sec. 4.1). Standard practice is to order liquid alum on a "dry basis" by specifying the quantity of aluminum sulfate as weight of dry chemical in a water solution.
5. If other than the listed percent of water-soluble aluminum is required (Sec. 4.2.1.2).
6. If basic or acidic alum is required (Sec. 4.2.2).

Copyright © 2016 American Water Works Association. All Rights Reserved.

7. Whether the purchaser will reject product from containers or packaging with missing or damaged seals. The purchaser may reject product from bulk containers or packages with missing or damaged seals unless the purchaser's tests of representative samples, conducted in accordance with Sec. 5.3 through 5.10, demonstrate that the product meets specifications. Failure to meet specifications or the absence of, or irregularities in, seals may be sufficient cause to reject the shipment.

8. Quantity required and method of packaging and shipping (Section 6).

9. If less-than-carload quantities of liquid alum are ordered, the type and size of container required (Sec. 6.2.2.2).

10. If bulk shipments are to be accompanied by weight certificates or certificates issued by certified weighers (Sec. 6.2.4).

11. Whether alternative security measures have been adopted to replace or augment the security measures set out in Sec. 6.2.5 and 6.2.6.

12. Affidavit of compliance, if required (Sec. 6.3).

III.B. *Modification to Standard.* Any modification of 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. Inclusion of definitions for potable water, reclaimed water, and wastewater (Section 3).

2. Revisions to the Notice of Nonconformance (Sec. 5.11).

V. Comments. If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services at 303.794.7711, FAX at 303.795.7603; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email standards@awwa.org.

Copyright © 2016 American Water Works Association. All Rights Reserved.

This page intentionally blank.

Copyright © 2016 American Water Works Association. All Rights Reserved.

ANSI/AWWA B403-16
(Revision of ANSI/AWWA B403-09)

American Water Works Association

Dedicated to the World's Most Important Resource®

AWWA Standard

Aluminum Sulfate—Liquid, Ground, or Lump

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes purified aluminum sulfate in liquid, ground, or lump form for use in the treatment of potable water, wastewater, or reclaimed water.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for aluminum sulfate, including physical, chemical, sampling, testing, packaging, and shipping requirements.

Sec. 1.3 Application

This standard can be referenced in specifications for purchasing and receiving aluminum sulfate and can be used as a guide for testing the physical and chemical properties of aluminum sulfate samples. The stipulations of this standard apply when this document has been referenced and then only to aluminum sulfate used in the treatment of potable water, wastewater, or reclaimed water.

Copyright © 2016 American Water Works Association. All Rights Reserved.