



**American Water Works
Association**

The Authoritative Resource on Safe Water®

ANSI/AWWA B403-09
(Revision of ANSI/AWWA B403-03)

AWWA Standard

Aluminum Sulfate—Liquid, Ground, or Lump



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AWWA Standard

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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 17th 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 $\text{Al}_2(\text{SO}_4)_3 \cdot n\text{H}_2\text{O}$, 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 $\text{Al}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$ and potash alum $\text{Al}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4 \cdot 24\text{H}_2\text{O}$. 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.

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, the 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, and 2003. This edition was approved by the Board of Directors on Jan. 25, 2009.

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 two standards developed under the

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

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

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 jurisdiction. 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. 4.4 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. 4.4.3 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. 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.

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.

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

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

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 items should be covered 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. Type of aluminum sulfate required—liquid, ground, or lump (Sec. 4.2). 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.
4. Details of other federal, state or provincial, and local requirements (Sec. 4.1).
5. If other than the listed percent of water-soluble aluminum is required (Sec. 4.3.1.2).
6. If basic or acidic alum is required (Sec. 4.3.2).
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