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(Revision of ANSI/AWWA B453-19)

AWWA Standard

Polyacrylamide

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American Water Works Association

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STANDARD Since 1881

AWWA Standard

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA B453.*

I. Introduction

I.A. *Background*. Chemical clarification methods have been used to improve the quality of drinking water supplies since the late 1880s. In 1967, the first completely synthetic organic polyelectrolyte was accepted by the US Public Health Service for use in treatment of potable water. The responsibility for accepting additives for drinking water treatment was subsequently assumed by the US Environmental Protection Agency (USEPA) and administered by its Office of Drinking Water as an advisory program. USEPA's acceptance was by the specific name of the suppliers' product and not by generic type. Polyacrylamide is one of several types of synthetic organic polyelectrolytes that were accepted for use in potable water treatment under this program, which was discontinued in 1990.

Polyacrylamides (PAMs) belong to a large family of synthetic organic polyelectrolytes (also called polymers or flocculants) used in water and wastewater treatment to improve the performance of some unit operations in the treatment process, most often by increasing the extent or rate of liquid–solids separation. PAMs may have an anionic, nonionic, cationic, or amphoteric charge and always have a high molecular weight relative to most other polymer types. Because their high molecular weight makes relatively dilute solutions of PAMs highly viscous, PAMs cannot be sold as concentrated aqueous solutions. PAMs are manufactured in the following product forms: emulsions, dry, dilute viscous solutions, and aqueous solutions. For potable water supply service, emulsion and dry forms are most frequently used. All product forms are used for wastewater service. A subclass of PAMs, aminomethylated PAMs, also known as Mannich polymers, are only used in wastewater service and are manufactured in dilute, highly viscous solutions.

When used with potable water, the solvents in PAM emulsions can impart unacceptable odor/taste into the product water. For potable water use, a proposed PAM emulsion should be tested for aesthetic impacts on product water prior to its full-scale implementation.

Nonionic PAMs are made by polymerizing acrylamide monomer. Anionic PAMs are made by copolymerizing acrylamide monomer with an anionic monomer or by

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alkaline hydrolysis of nonionic PAM. The anionic monomers most widely used are acrylic acid and acrylic acid salts. Cationic PAMs, with the exception of Mannich polymers, are made by copolymerizing acrylamide monomer with a cationic monomer. Several different cationic monomers are used. Mannich polymers are made by reacting dimethylamine and formaldehyde with solution PAM.

Certain properties of the polymer, such as molecular weight, can be varied by controlling the polymerization reaction. The charge density of PAM copolymers is varied by adjusting the relative amount of anionic or cationic monomer added to the polymerization. Acrylamide monomer is made from acrylonitrile.

Dry PAM that is flake, dry powder, or granular is usually manufactured by first polymerizing the monomer(s) in aqueous solution to form a gel and then drying and grinding the gel. Emulsion PAM is usually manufactured by first emulsifying droplets of monomer(s) and water in a hydrocarbon solvent before polymerization is initiated. Emulsion PAMs contain some surfactants to keep the emulsion from separating and to aid in the dissolution of the PAM after mixture with water at a specified ratio. The liquid polymerized emulsion is sold as manufactured or further modified to remove water or hydrocarbon solvent. Solution PAM can be manufactured by aqueous polymerization of the monomer(s) or by dissolving emulsion-form or dry-form PAM in water. Aqueous dispersions are manufactured by first emulsifying droplets of monomer(s) in water containing inorganic salt(s) before polymerization is initiated.

Important concepts to remember regarding PAMs include the following:

1. PAMs differ from polyDADMAC polymers (ANSI/AWWA B451, Poly [Diallyldimethylammonium Chloride]) and epichlorohydrin-DMA polymers (ANSI/AWWA B452, EPI-DMA Polyamines) in their use, handling, storage, and solution preparation.

2. PAMs are not one polymer but instead a large family of polymers that differ in product form, charge type, charge density, molecular weight, and other properties.

3. The nomenclature used to describe the four forms in which PAMs are supplied follows:

    a. Dry (also called flake, powder, granular, or bead).
    b. Emulsions (also called liquids, dispersions, or inverse emulsions).
    c. Solutions (also called liquids, aqueous solutions, or viscous solutions).
    d. Aqueous dispersions (also called oil-free emulsions, water dispersions, or brine dispersions).

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4. The physical properties of a PAM cannot be used to judge product performance; only laboratory testing, pilot-plant studies, or full-scale plant trials can discern product efficacy.

5. PAMs may or may not contain inactive ingredients such as hydrocarbon solvents, surfactants, and salts, depending on the product form, manufacturing method, and formulation. The typical primary components of each form can be described generically as follows:

a. Dry (PAM, moisture [water]; may contain inert inorganic salts or inert organic compounds).

b. Emulsions (PAM, hydrocarbon oil, water, surfactants). The amount of hydrocarbon oil is typically, but not limited to, 20–50 percent by weight of the emulsion.

c. Solution (usually a dilute, viscous, aqueous solution of dry or emulsion form PAM; refer to the aforementioned primary components).

d. Aqueous dispersions (PAM, water, salts) in which the PAM is suspended in aqueous solution of inorganic salts. Aqueous dispersion PAMs are currently used for wastewater treatment and may be introduced in the future for potable water supply treatment if they meet appropriate approvals. These products contain no hydrocarbon oil or surfactants.

6. The storage, dissolution, and feeding of PAMs may require specific procedures, considerations, and equipment that are unique for each product form. Failure to use the proper storage equipment and conditions, dissolution procedure and equipment, and feeding equipment and design can result in loss of activity, the formation of insoluble gels, loss of feeding, and increased maintenance problems.

7. The user should consult both the product technical data sheet and the safety data sheet (SDS, formerly known as material safety data sheet [MSDS]) for the specific PAM product being used for information on the product's composition, physical properties, safety procedures, feeding and storage guidelines, and other important information. The supplier must provide to the user of the product copies of the technical data sheet, along with the SDS in some circumstances, in accordance with this standard.

I.B. *History*. The AWWA Standards Council authorized the development of this standard in 1979. The standard was developed by the AWWA Standards Committee on Polyelectrolytes and was approved by the AWWA Board of Directors on Feb. 4, 1996. The AWWA Board of Directors approved subsequent editions of this standard on June 17, 2001; Feb. 12, 2006; June 9, 2013, and June 7, 2019. This edition of this standard was approved by the AWWA Board of Directors on Oct. 14, 2024.

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I.C. *Acceptance (Water Supply Service Applications)*. In May 1985, the 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). 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 four standards developed under the direction of NSF: NSF/ANSI/CAN[§] 60, Drinking Water Treatment Chemicals—Health Effects; NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects; NSF/ANSI 372—Drinking Water System Components—Lead Content; and NSF/ANSI/CAN 600, Health Effects Evaluation and Criteria for Chemicals in Drinking Water.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI/CAN 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. NSF/ANSI/CAN 60 does not address aesthetic issues such as odor.

NSF/ANSI/CAN 600 (which formerly appeared in NSF/ANSI/CAN 60 and 61 as Annex A, "Toxicology Review and Evaluation Procedures") 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 NSF/ANSI/CAN 600 procedures may not always be identical, depending on the certifier.

ANSI/AWWA B453 addresses additives requirements in Sec. 4.6 Additives Requirements (Water) and Sec. 4.8 Additives Requirements (Wastewater) of the standard. The transfer of contaminants from chemicals to processed water or to residual solids is becoming a problem of greater concern. The language in Sec. 4.6.1. is

[†] NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

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

[§] Standards Council of Canada, 55 Metcalfe Street, Suite 600, Ottawa, ON K1P 6L5 Canada.

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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/CAN 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 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.

I.D. *Acceptance (Wastewater Service Applications)*. In 2008, the AWWA Standards Council directed standards committees to incorporate wastewater applications into its standards. This edition is the second revision of ANSI/AWWA B453 that addresses wastewater service applications and standards.

II. Special Issues

II.A. *Safety*. PAMs are not considered to be as toxic as some household products nor are they considered to be primary skin or eye irritants as defined by the Consumer Product Safety Commission (US Federal Hazardous Substances Act). Good housekeeping procedures and personal cleanliness are recommended when handling polyacrylamides. The products may contain trace amounts of acrylamide monomer, which has been shown to be toxic. The MCL for acrylamide of 0.05 percent in polyacrylamide products is lower than that which would require labeling under the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard.

Safety glasses should be worn when handling emulsion or solution forms of PAM and, although not required, when handling the dry form. Appropriate first-aid practices should be followed in all cases of exposure. In case of eye contact, flush with plenty of water for at least 15 min and call a physician. Emulsion-form PAMs contain hydrocarbon solvents whose vapors can cause nausea, headaches, and other symptoms. Consult the SDS for the specific product for safety information and procedures before handling any PAM product.

II.B. *Spill Control*. Dispose of PAMs according to federal, state or provincial, and local regulations. Solutions of PAMs make floors and other surfaces extremely slippery. A dike should be formed around the spill area to contain as much spilled material as possible, and the contained material should be shoveled, scooped, or pumped, as appropriate, into suitable disposal containers. Any remaining material

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should be adsorbed on vermiculite or other suitable adsorbing material and placed in a sealed metal container for disposal. The spill area should be thoroughly washed with water only after all possible polymer has been scooped up, absorbed, or wiped up. Use of warm water is beneficial.

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*. This AWWA standard can be used to prepare a purchase specification but is not itself a specification because it cannot address requirements unique to the purchaser's specific situation, nor does it establish business relationships or set additive requirements (MCL or maximum-use dosage). In addition, this PAM standard does not establish physical and chemical property specifications for any one PAM product for two reasons: (1) PAMs are a broad family of products differing widely in properties and product form, and (2) physical and chemical properties of PAMs do not always relate to their performance as a flocculant in specific applications.

Following are requirements that the user might consider when developing a PAM polymer purchase specification. This standard requires the supplier to provide a product technical data sheet in addition to an SDS for each product and also requires specific information to be included in the product technical data sheet. The information in a product technical data sheet may be used to establish or comply with purchase specifications.

1. Standard used—that is, ANSI/AWWA B453, Polyacrylamide, of latest revision.

2. Compliance with the latest revision of ANSI/AWWA B453, Polyacrylamide, for potable water supply service applications (water) or wastewater service applications (wastewater), as applicable.

3. Whether compliance with NSF/ANSI/CAN 60, Drinking Water Treatment Chemicals—Health Effects, is required.

4. Description of application.

5. Estimation of annual purchase requirements (pounds/kilograms).

6. Typical order quantity (number of containers and pounds/kilograms of product).

7. Shipping address (destination).

8. Special delivery requirements (need for a truck with a lift gate; length and coupling sizes of hoses needed for bulk delivery; transfer pump; allowed times of

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delivery; limitations on truck size or weight; sampling protocol; other). Are there any product physical property limitations such as a maximum viscosity that cannot be handled by the storage or feed equipment?

9. Order lead time (the number of days between order placement and delivery necessary if typical lead times are insufficient).

10. Billing address.

11. Financial terms.

12. Insurance/performance bond requirements.

13. Details of federal, state, provincial, territorial, and local requirements (Section 4).

14. For potable water applications, whether compliance with NSF/ANSI/CAN 60, Drinking Water Treatment Chemicals—Health Effects, is required (Sec. 4.6.4).

15. Active polymer concentration in the product expressed as a weight percent (Sec. 4.9.2).

16. Specific physical and chemical properties for quality control. Minimum specifications should include visual inspection, total solids, Brookfield viscosity range, and pH of product's solution. Verification of physical and chemical properties should be by the methods specified in Section 5, Verification, or by other methods acceptable to both purchaser and supplier.

17. Sampling requirements (Sec. 5.2).

18. Requirement for supplier to provide manufacturing location contact information for quality-control inquiries (Sec. 5.9).

19. Marking requirements (Sec. 6.1).

20. Packaging and shipping requirements (Sec. 6.2). State any alternative security measures desired that have been adopted to replace or augment the security measures set out in Sec. 6.2.1 and Sec. 6.2.2.

21. Whether the purchaser will reject product from tank trucks (bulk), containers, or packaging with missing or damaged seals. The purchaser may reject product if it fails to meet specifications determined by testing from bulk containers or packages with missing or damaged seals unless the purchaser's tests of representative samples, conducted in accordance with Sec. 5.2 through 5.5, demonstrate that the product meets the standard. Failure to meet the standard or the absence of, or irregularities in, seals may be sufficient cause to reject the shipment. State whether a chain of custody is desired (Sec. 6.2.2.2).

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22. Whether alternative security measures have been adopted to replace or augment the security measures set out in Sec. 6.2.1 and Sec. 6.2.2.

23. Affidavit of compliance or certified analysis, or both, if required (Sec. 6.4).

III.B. *Product Performance*. Performance evaluation via a laboratory test or pilot plant or plant trial or other performance test is essential for confirming PAM activity (Section 5.6).

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

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

1. Minor boilerplate updates to the following sections:
    - I.C. Acceptance (Water Supply Service Applications)
    - I.D. Acceptance (Wastewater Service Applications)
    - III.A. Purchaser Options and Alternatives
    - Section 2: References
    - Section 4: Requirements
    - Sec. 4.7.4 Product Certifications
    - Section 6: Delivery
2. Minor text revisions to the following sections:
    - I.A. Background
    - Sec. 5.6 Product Performance

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

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American Water Works Association

ANSI/AWWA B453-24
(Revision of ANSI/AWWA B453-19)

AWWA Standard

Polyacrylamide

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes polyacrylamide (PAM) for use in the treatment of potable water, wastewater, and reclaimed water.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for PAM products, including physical, chemical, packaging, shipping, and testing requirements and to provide the means of developing requirements for PAM products.

Sec. 1.3 Application

This standard can be referenced in documents for purchasing and receiving PAM products and can be used as a guide for testing the physical and chemical properties of PAM product samples. The stipulations of this standard apply when this document has been referenced and then only to PAM products used in the treatment of potable water, wastewater, and reclaimed water. Each section or subsection of this standard shall apply to both water supply service applications and wastewater service applications, unless the section or subsection states that it applies only to water supply service applications or the word *water* is stated in the title, or the section or subsection states that it applies only to wastewater service applications or the word *wastewater* is stated in the title.

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