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ANSI/AWWA B507-16
(First Edition)

AWWA Standard

Phosphoric Acid

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AWWA Standard

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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.

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA B507.*

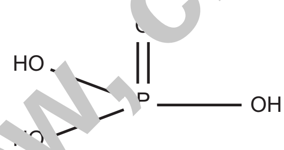
I. Introduction.

I.A. *Background.* Phosphate chemicals are among the few recognized chemical substances that can be safely and effectively used as a corrosion inhibitor in potable water. Several forms of phosphate inhibitors are available, one of which is phosphoric acid (H_3PO_4, ortho-phosphoric acid, white phosphoric acid). Commercial or technical-grade phosphoric acid is a manufactured product principally obtained by the addition of sulfuric acid to phosphate rock that is mostly mined in Florida, Tennessee, and the West in the United States. Food-grade phosphoric acid is generally produced by the electric-furnace method.

The reaction:

$$\underset{\text{Phosphate Rock}}{Ca_3(PO_4)_2} + \underset{\text{Sulfuric Acid}}{3H_2SO_4} + \underset{\text{Water}}{H_2O} \rightarrow \underset{\text{Phosphoric Acid}}{2H_3PO_4} + \underset{\text{Gypsum}}{3CaSO_4} + \underset{\text{Water of Hydration}}{2H_2O}$$

This typically produces a phosphoric acid concentration in the range of 28–32 percent with a pH of less than 1.5. Gypsum ($CaSO_4$) is precipitated and removed from solution leaving phosphoric acid, which has the molecular structure:



Pure anhydrous phosphoric acid is a white solid that melts at 42.35°C (108.23°F) to form a viscous liquid. The phosphoric acid concentration can either be diluted to 10 percent or less, or concentrated by evaporation to concentrations that generally range from 35 to 75 percent, up to 85 percent. The normal application concentration of phosphoric acid is 50 to 75 percent by weight in water.

Currently, there are over 25 chemical manufacturers and suppliers of phosphoric acid that have certification under NSF†/ANSI 60 Drinking Water Treatment Chemicals—Health Effects, and it is widely available throughout North America.

Its action as a corrosion inhibitor is often the reaction with the metal on the surface forming a metal phosphate film deposit as follows:

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.
† NSF International, 789 Dixboro Road, Ann Arbor, MI 48105.

Metal	Chemical Formula	Mineral Name
Iron	$Fe_3(PO_4)_2$	Vivianite
Copper	$Cu_3(PO_4)_2 \cdot 2H_2O$	Cupric orthophosphate
Lead	$Pb_5(PO_4)_3 \cdot OH$	Hydroxypyromorphite

The metal phosphate film can also have calcium and/or magnesium phosphate precipitates.

Typically, these films are not absolute barriers to corrosion but frequently can reduce corrosion and metal release rates significantly by reducing metal solubility.

The NSF/ANSI 60–certified maximum concentrations are a function of the phosphoric acid solution concentration.

Acid Concentration	Maximum H_3PO_4 Dosage
30–35%	25–27 mg/L
50% ±5%	17 mg/L
70–75%	13–14 mg/L
80–85%	12 mg/L

These maximum acid feed concentrations translate to a maximum phosphorus (P) dosage of approximately 3 mg/L. That is the maximum concentration that is common, and the minimum effective dose can be as low as 0.15 mg/L P.

It is often necessary to initiate a phosphate corrosion control dosage at relatively high concentrations (e.g., 2 to 3 mg/L as P) to form an initial passivation film in the first month of application, then to decrease the feed in stages of about 25 percent of the maximum in sequential stages every two weeks to a maintenance dosage more in the order of 0.5 to 1 mg/L P.

The maintenance dosage may need to be increased during warmer water temperatures of summer and decreased in the cooler water temperatures of winter by as much as a 2:1 factor.

The corrosion rate may be measured and the phosphate dosage increased or decreased by insertion and periodic testing of metal coupons and/or metal release. Linear polarization probes are available for continuous real-time measurement of corrosion rates. Adjusting inhibitor dosage rates is system specific as there is a wide variation between corrosion rate and metal release.

I.B. *History.* This first edition of ANSI/AWWA B507, Standard for Phosphoric Acid, was approved by the AWWA Board of Directors on Jan. 16, 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 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 B507 addresses additives requirements in Sec. 4.3.2 of the standard. The transfer of contaminants from chemicals to processed water or to residual solids is becoming a problem of great concern. The language in Sec. 4.3.2 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. 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.

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

2. Determine the status of certifications by all 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. *Storage and Handling Precautions.* Phosphoric acid is often available from a supplier in food-grade and technical-grade purities, both of which may be NSF/ANSI 60–certified or equivalent for potable water use. The food-grade chemical usually contains fewer impurities than the technical grade. Phosphoric acid should be stored and handled as any typical acid and should be considered hazardous as a corrosive. Protect containers from physical damage. Store in a cool, dry area in closed containers. Refer to the safety data sheet (SDS) available from the manufacturer or supplier for additional information.

Phosphoric acid purchased for nonpotable water application does not need to be certified to NSF/ANSI 60 or equivalent.

The user also may wish to obtain price quotations from vendors at different acid concentrations. There is often an advantage in hauling and storage volume costs of utilizing higher-strength acids in the 70–75 percent range of concentration. However, it is usually more costly for a producer to provide a more elevated acid concentration so that it may be almost a trade-off in chemical costs.

Phosphoric acid is typically the least expensive form of phosphate inhibitor chemical because other inhibitors, including mono- and disodium phosphate, zinc orthophosphate, and sodium hexametaphosphate, are prepared from the chemical reaction of heating and crystallization of phosphoric acid, which by itself is an orthophosphate compound.

Phosphoric acid, even at a 1 percent concentration, has a pH less than 1.5 and is a hazardous chemical that must be handled with necessary safety precautions to meet building and fire code requirements in the United States. Refer to safety data sheets (SDSs), available from the supplier or manufacturer, on safe handling and storage. SDS may be replaced with globally harmonized system (GHS) of classification and labeling of chemicals by OSHA in the United States.

There is a range of suitable storage materials for various concentrations of phosphoric acid, which may be obtained in quantities of 5-gal, 30-gal, 55-gal, or 250-gal (19-L, 133-L, 208-L, or 946-L) containers, or by bulk delivery in the range of 500 to 3,500 gal.

Suitable corrosion-resistant metals depend on acid concentration and are Type 304 or 316 stainless steel or Hastelloy C. Many plastics are also suitable for storage to ambient temperatures to 40°C (100°F), which include polyvinyl chloride (PVC) or polyethylene (PE). Higher temperature resistance can be provided by chlorinated polyvinyl chloride (CPVC) or polypropylene (PP) up to 80°C (175°F). Neoprene or Viton® elastomers are also resistant to deterioration by phosphoric acid to 175°F for intermittent use, but to 120°F (49°C) for continuous use.

It often may be necessary to elevate the pH of water treated by phosphoric acid for further corrosion control based on individual water chemistry and the buffer capacities of the source and treated water. Neutralized phosphoric acid is also commercially available and is provided at a pH of above 6. It is not classified as a hazardous chemical nor does it require double containment, isolation, or as much ventilation. Additional chemicals may also be required for pH control.

Phosphoric acid vapors are corrosive and toxic. Provision should be made upon storage of this chemical to have adequate ventilation in an interior room. It often is desirable to provide a scrubber on the vent piping with exterior discharge to avoid excessive fumes while filling or refilling the storage tank, or when the temperature in the storage room exceeds 20°C (70°F). Vent piping is typically sized for 1.5 times the diameter of the fill-pipe to prevent overpressurization of the storage vessel or scrubber. Phosphoric acid density and viscosity increase with solution concentration.

Acid Solution Concentration	Density	Viscosity
10%	1.033	Low
50%	1.334	Low
85%	1.685	Syrupy
100%	1.874	Almost solid

The dosage of phosphoric acid can be measured by analysis of the orthophosphate concentration in the water. There may be some natural phosphate in the source water, typically less than 1 mg/L, and that must be accounted for in the analysis of the phosphate dosage.

The effectiveness of phosphoric acid for corrosion control at low concentration may be less than some of the other phosphate inhibitors when applied at low concentration. It may be necessary to dose two to three times or more with phosphoric acid to achieve the same corrosion reduction results as with other phosphate inhibitors.

Phosphate corrosion inhibitors are typically effective in suppression of iron or steel corrosion in a pH range of 7 to 8, with reduced effectiveness for stagnant conditions. Typically, near neutral pH is better for corrosion reduction of copper, and slightly alkaline pH is best for lead. Their effectiveness at higher or lower pH values can be dependent on water quality and may be more satisfactory.

II.B. *Wastewater Discharge.* There is substantial environmental concern about phosphate nutrient loads that can cause eutrophication in bodies of water that receive wastewater streams and effluent discharge, or irrigation tail water discharges to freshwater and estuary water. Typically, domestic wastewater phosphorus concentrations are in the range of 5–10 mg/L. The addition of a maintenance dose of phosphate can increase these concentrations by 10 to 20 percent. Effluent phosphate discharges to water bodies are often regulated below 0.5 mg/L. However, phosphates are often a benefit to reclaimed water use for irrigation or cooling. The benefits of a phosphate for corrosion control should be evaluated to consider effectiveness and costs of phosphate treatment.

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 information should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA B507, Phosphoric Acid, of latest revision.
2. Quantity of phosphoric acid required.
3. Whether compliance with NSF/ANSI Standard 60, Drinking Water Treatment Chemicals—Health Effects, is required.
4. Details of other federal, state or provincial, and local requirements (Section 4).
5. Type of material—liquid (Sec. 4.1).
6. Form of shipment—bulk or package and the type and size of container (Sec. 6.2).
7. Whether alternative security measures have been adopted to replace or augment the security measures set out in Sec. 6.2.3 and Sec. 6.2.4.
8. 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. 5.2, 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.
9. An affidavit of compliance or certified analysis, or both, if 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. This is the first edition of this standard.

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

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Phosphoric Acid

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes phosphoric acid (H_3PO_4) corrosion inhibitor in liquid form used 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 phosphoric acid, including physical, chemical, sampling, packaging, shipping, and testing requirements.

Sec. 1.3 Application

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

SECTION 2: REFERENCES

This standard references the following documents. In their latest editions, they form a part of this standard to the extent specified in this standard. In any case of conflict, the requirements of this standard shall prevail.