



**American Water Works
Association**

The Authoritative Resource on Safe WaterSM

ANSI/AWWA B406-06
(Revision of ANSI/AWWA B406-97)

AWWA Standard

Ferric Sulfate



Effective date: May 1, 2006.

First edition approved by AWWA Board of Directors Jan. 23, 1961.

This edition approved Feb. 12, 2006.

Approved by American National Standards Institute Dec. 22, 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

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 © 2006 by American Water Works Association
Printed in USA

Committee Personnel

The AWWA Subcommittee on Ferric Sulfate–Ferrous Sulfate, which developed this standard, had the following personnel at the time:

Gene Shull, *Chair*

T.A. Barber Jr., Coca-Cola Company, Atlanta, Ga.	(AWWA)
J.E. Brown, Southern Ionics Inc., Whitney, Texas	(AWWA)
D.E. Gordon, QC Corporation, Baltimore, Md.	(AWWA)
M.E. Kenney, Hobart, Ind.	(AWWA)
P.J. Olson, * Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
C.L. Payne, Synergy Production Inc., Reisterstown, Md.	(AWWA)
G. Shull, Kemiron Inc., Houston, Texas	(AWWA)
B.H. Wilder, Daytona Beach, Fla.	(AWWA)

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:

J.P. Corless, *Chair*
Gene Shull, *Vice Chair*

General Interest Members

M.B. Alvarez, CH2M Hill, Orlando, Fla.	(AWWA)
K.K. Au, Greeley & Hansen, Chicago, Ill.	(AWWA)
D.T. Duke, East Liverpool, Ohio	(AWWA)
J.D. Edwards, Burgess & Niple Ltd., Columbus, Ohio	(AWWA)
J.J. Gemin, Earth Tech (Canada) Inc., Kitchener, Ont., Canada	(AWWA)
P.H. Hargette, Black & Veatch Engineers, Greenville, S.C.	(AWWA)
R.D. Harriger, Williamsburg, Va.	(AWWA)
C.B. Lind, Russell-Stanley, Bridgewater, N.J.	(AWWA)

*Liaison, nonvoting

C.L. McLain, * Standards Council Liaison, Moorhead Public Service, Moorhead, Minn.	(AWWA)
P.J. Olson, * Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
J.W. Patterson, J.W. Patterson Environmental Consultants, Silverthorne, Colo.	(AWWA)
L.W. VandeVenter, Metcalf & Eddy Inc., Wakefield, Mass.	(AWWA)
B.H. Wilder, Daytona Beach, Fla.	(AWWA)

Producer Members

J.E. Brown, Southern Ionics Inc., Whitney, Texas	(AWWA)
J.P. Crass, Eaglebrook Inc., Ventura, Calif.	(AWWA)
J.M. Gonzalez, PVS Technologies Inc., South New Berlin, N.Y.	(AWWA)
D.E. Gordon, QC Corporation, Baltimore, Md.	(AWWA)
L.N. Hjersted, † Kemiron Inc., Bartow, Fla.	(AWWA)
B. Keogh, Dundas, Ont., Canada	(AWWA)
K.E. Ruehl, General Chemical Corporation, Ballwin, Mo.	(AWWA)
G. Shull, Kemiron Inc., Houston, Texas	(AWWA)

User Members

B.S. Aptowicz, Philadelphia Water Department, Philadelphia, Pa.	(AWWA)
T.A. Barber Jr., Coca-Cola Company, Atlanta, Ga.	(AWWA)
J.P. Corless, US Naval Reserve, Rockville, Md.	(AWWA)
L.V. Landry, City of Shreveport, Shreveport, La.	(AWWA)
C.A. Owen, Tampa Bay Water, Clearwater, Fla.	(AWWA)
R.S. Schultz, Bloomington, Ill.	(AWWA)
J.S. Trotter, City of Bloomington Utilities, Bloomington, Ind.	(AWWA)
D.P. Wolz, Clean Water Plant, Wyoming, Mich.	(AWWA)

* Liaison, nonvoting

† Alternate

Contents

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

SEC.		PAGE	SEC.		PAGE
	Foreword		3	Definitions	2
I	Introduction.....	vii	4	Requirements	
I.A	Background.....	vii	4.1	Physical Requirements	2
I.B	History.....	vii	4.2	Chemical Requirements.....	3
I.C	Acceptance	vii	4.3	Impurities	3
II	Special Issues.....	viii	5	Verification	
II.A	Manufacture and Use of Ferric Sulfate.....	viii	5.1	Sampling.....	4
II.B	Storage and Handling Considerations	ix	5.2	Laboratory Examination	5
II.C	Basis for Payment	ix	5.3	Laboratory Samples.....	5
II.D	Free Acid	ix	5.4	Moisture Content of Dry Ferric Sulfate.....	5
III	Use of This Standard	ix	5.5	Test Procedure for Insoluble Matter.....	6
III.A	Purchaser Options and Alternatives	ix	5.6	Test Procedure for Soluble Ferrous Iron.....	6
III.B	Modification to Standard.....	x	5.7	Test Procedure for Soluble Ferric Iron	7
IV	Major Revisions	x	5.8	Test Procedure for Free Acid in Ferric Sulfate	8
V	Comments	x	5.9	Test Procedure for Chloride	10
	Standard		5.10	Basis for Rejection	11
1	General		6	Delivery	
1.1	Scope	1	6.1	Marking.....	12
1.2	Purpose	1	6.2	Packaging and Shipping.....	12
1.3	Application	1	6.3	Affidavit of Compliance.....	13
2	References	2			

This page intentionally blank.

Foreword

This Foreword is for information only and is not a part of ANSI/AWWA B406.

I. Introduction.

I.A. *Background.* Ferric sulfate is used as an inorganic coagulant for removal of suspended and colloidal particles from water by coagulation and flocculation. It is prepared by oxidizing ferrous sulfate or by dissolving ferric oxide in sulfuric acid. Ferric sulfate is available in dry form as a powdery-granular product, grayish-white to reddish-gray in color, or as a stable solution that is relatively clear and reddish-brown in color. The term *ferric sulfate* as used in this standard refers to the manufactured ferric sulfate product, a partially hydrated dry ferric sulfate having the basic formula $\text{Fe}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$ in which x averages approximately 9. This ferric sulfate dissolves rapidly in water, as contrasted with anhydrous ferric sulfate, which dissolves very slowly in water. Similarly, in this standard the term *liquid ferric sulfate* refers to a solution of ferric sulfate containing between 10 percent and 14 percent ferric iron by weight. This percentage may be varied by agreement between the supplier and purchaser.

I.B. *History.* This standard was first approved as tentative on Jan. 23, 1961, by the AWWA Board of Directors and was approved as a standard on Feb. 11, 1964. Subsequent revisions to ANSI/AWWA B406 were approved by the AWWA Board of Directors in 1987, 1992, and 1997. This fifth edition of B406 was approved by the AWWA Board of Directors on Feb. 12, 2006.

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

*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 B406 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. 4.3.2 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, 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 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. *Manufacture and Use of Ferric Sulfate.* Due to the corrosivity of chlorides on some metals, this edition of ANSI/AWWA B406 includes a limitation on chloride impurity of 10 ppm Cl per 1 percent of contained ferric iron. This limitation is based on a static-test corrosion test using liquid ferric sulfate, which contained 10 percent ferric iron in a solution containing up to 1,000 ppm Cl held at 100°F (38°C), in which no corrosion of 304 or 316 stainless steel resulted during 21 days of contact. Mild steel as a control, however, was consumed in several days, regardless of the presence or absence of chlorides. Because a hot ferric sulfate

*NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48106.

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

solution containing chlorides may increase corrosivity or extraction of metal impurities when loaded, stored, or used at product temperatures exceeding 100°F (38°C), the purchaser may wish to discuss with the supplier the level of chlorides, temperatures, and potential corrosivity, particularly with temperatures exceeding 100°F (38°C).

II.B. *Storage and Handling Considerations.* Dry ferric sulfate is mildly hygroscopic and should, therefore, be stored in a dry place. When feeding ferric sulfate, the correct water ratio (quantity of water to weight of material in the dissolving tank) should be maintained. The feeding equipment manufacturer's directions for feeding should be followed.

Liquid ferric sulfate should be stored in corrosion-resistant tanks and metered into the water as required with appropriate metering equipment. While liquid ferric sulfate remains a stable liquid for at least 72 hr at 32°F (0°C) without freezing or crystallizing, with only a slight increase in viscosity, it is recommended that tanks be insulated or heated if prolonged periods of temperature below 32°F (0°C) are normally expected.

Human exposure to either dry or liquid ferric sulfate should be minimized by adequate ventilation, protective clothing, good hygiene, and careful "housekeeping" practices. Personnel handling dry ferric sulfate should wear goggles, a dust mask, gloves, and other protective clothing. Those handling liquid ferric sulfate should wear goggles, gloves, and an acid-resistant apron. Splashing or misting of the liquid should be avoided. A respirator with an activated carbon filter suitable for a weak sulfuric acid mist should be worn when handling liquid ferric sulfate.

II.C. *Basis for Payment.* The basis for payment shall be the net weight of ferric sulfate supplied, excluding the weight of the shipping container.

II.D. *Free Acid.* Liquid ferric sulfate can be manufactured with free sulfuric acid levels from 0 percent to over 3.5 percent. The purchaser and supplier may agree on a free acid level in excess of or lower than the standard maximum depending on the application.

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 ferric sulfate under the provisions of this standard, the following items should be specified by the purchaser:

1. Standard used—that is, ANSI/AWWA B406, Ferric Sulfate, of latest revision.
2. Type of ferric sulfate to be supplied.

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

4. If requesting impurity information, the purchaser must state maximum impurity content limits and the analytical methods to be used to determine compliance with the limits (Sec. 4.3).

5. Quantity of ferric sulfate required and method of packaging and shipping (Sec. 5 and Sec. 6).

6. If an analysis by a referee laboratory is required, the assignment of testing costs should be addressed (Sec. 5.10.1).

7. Whether weight certificates are required (Sec. 6.2.5).

8. An affidavit of compliance, 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.** Major revisions made to the standard in this edition include the following:

1. The minimum water-soluble ferric iron (Fe^{3+}) in liquid ferric sulfate has been changed from 9.0 percent to 10.0 percent (Sec. 4.2.1).

2. The allowable water-soluble ferrous iron (Fe^{2+}) has been reduced from 3.0 percent to 1.5 percent in dry ferric sulfate and from 1.5 percent to 0.75 percent in liquid ferric sulfate (Sec. 4.2.2).

3. The allowable free acidity as H_2SO_4 in liquid ferric sulfate has been updated (Sec. 4.2.4).

4. The test procedure for insoluble matter in dry ferric sulfate has been updated (Sec. 5.5.1).

5. A test procedure for free acid in liquid ferric sulfate has been added (Sec. 5.8.3).

6. The test procedure for chloride in liquid ferric sulfate has been updated (Sec. 5.9.3).

V. **Comments.** If you have any comments or questions about this standard, please call the AWWA Volunteer & Technical Support Group, 303.794.7711, FAX 303.795.7603, write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.



American Water Works
Association

ANSI/AWWA B406-06
(Revision of ANSI/AWWA B406-97)

AWWA Standard

Ferric Sulfate

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes dry form ferric sulfate and liquid ferric sulfate for use in water treatment.

Sec. 1.2 Purpose

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

Sec. 1.3 Application

This standard can be referenced in specifications for purchasing and receiving ferric sulfate and can be used as a guide for testing the physical and chemical properties of ferric sulfate samples. The stipulations of this standard apply when this document has been referenced and then only to ferric sulfate used in water supply service.