

American Water Works Association

ANSI/AWWA B407-98

(Revision of ANSI/AWWA B407-93)



AWWA STANDARD
FOR
LIQUID FERRIC CHLORIDE



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AMERICAN WATER WORKS ASSOCIATION

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AWWA Standard

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Foreword

This foreword is for information only and is not a part of AWWA B407.

I. Introduction.

I.A. Background. Ferric chloride is commercially available in two solid forms, hexahydrate and anhydrous, or in liquid form. This standard covers ferric chloride in aqueous (liquid) form for use in the treatment of municipal and industrial water supplies. Ferric chloride can be produced as a coproduct with titanium dioxide from natural ores containing iron and titanium oxides or by the controlled reaction of spent steel pickling solutions, hydrochloric acid, chlorine, and scrap iron. A high-purity product can be manufactured by reacting chlorine gas with iron, ferrous sulfate, or ferrous chloride. Recognizing that the purity of ferric chloride can vary with the manufacturing process, the purchaser may request that the supplier describe the manufacturing process used. The purchaser also may want to ask the supplier about potential impurities relative to the manufacturing process used.

This standard provides methods for the analysis of specific gravity, insoluble matter, total iron, ferrous iron, ferric chloride, and acidity.

I.B. History. In 1977, the AWWA Water Quality Division recommended to the AWWA Standards Council that a standard for ferric chloride be prepared. The Standards Council authorized the development of a ferric chloride standard on May 12, 1977. The first edition of ANSI/AWWA B407 was approved by the AWWA Board of Directors on June 5, 1983. Subsequent revisions were made in 1988 and 1993. This edition was approved on Jan. 25, 1998.

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 all 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 direction of NSF, ANSI†/NSF‡ 60, Drinking Water Treatment Chemicals—Health Effects, and ANSI/NSF 61, Drinking Water System Components—Health Effects.

Various certification organizations may be involved in certifying products in accordance with ANSI/NSF 60 (61). Individual states or local agencies have authority

*Persons in Canada, Mexico, and non-North American countries should contact the appropriate authority having jurisdiction.

†American National Standards Institute, 11 W. 42nd St., New York, NY 10036.

‡NSF International, 3475 Plymouth Rd., Ann Arbor, MI 48106.

to accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Appendix A, "Toxicology Review and Evaluation Procedures," to ANSI/NSF 60 (61) 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 Appendix A procedures may not always be identical, depending on the certifier.

AWWA B407-98 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 greater 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 ANSI/NSF Standard 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. Storage and Handling Precautions. Liquid ferric chloride is an orange-brown aqueous solution that is acidic and corrosive to common metals. Suitable materials for construction of storage and handling facilities include titanium, tantalum, synthetic-rubber-lined steel, corrosion-resistant fiberglass-reinforced plastics (FRP), ceramics, tetrafluoroethylene polymer (PTFE), polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC). Steel, aluminum, or copper, and polyamides such as nylon, are not suitable.

Ferric chloride solution may cause burns to the eyes, and acid-resistant goggles should be worn during handling. Contact with skin may cause irritation. This can be avoided by wearing rubber gloves, boots, jacket, and pants.

For additional safety aspects, refer to material safety data sheets (MSDS) available from the chemical supplier or manufacturer.

II.B. Basis for Payment. The basis for payment shall be the dry weight equivalent of ferric chloride supplied.

III. Use of This Standard. AWWA has no responsibility for the suitability or compatibility of the provisions of this standard to any intended application by any user. Accordingly, each user of this standard is responsible for determining that the standard's provisions are suitable for and compatible with that user's intended application.

III.A. Purchaser Options and Alternatives. This standard for liquid ferric chloride permits a wide range of ferric chloride concentration. The purchaser should be aware of the wide range of water weight relative to the shipping cost.

When purchasing liquid ferric chloride under the provisions of this standard, the purchaser must provide specifications that should include the following:

1. Standard used—that is, AWWA B407, Standard for Liquid Ferric Chloride, of latest revision.
2. Affidavit of compliance, certified analysis, or both, if required (Sec. 6.3).

3. If specific gravity of the solution is stipulated (Sec. 4.1).
4. Percentage of ferrous iron permitted. If ferrous iron in excess of 2.5 percent is permitted, the purchaser should state the maximum allowable ferrous iron concentration (Sec. 4.2).

5. Size and type of container to be used (Sec. 6.2.1).

6. If weight certificates are required (Sec. 6.2.2).

7. Net weight to be supplied (Sec. II.B).

8. Whether the recommended compliance with ANSI/NSF Standard 60, *Drinking Water Treatment Chemicals—Health Effects*, is to be required. If this certification is to be required, the purchaser's specifications shall read, "This material shall be certified as suitable for contact with or treatment of drinking water by an accredited certification organization in accordance with ANSI/NSF Standard 60, *Drinking Water Treatment Chemicals—Health Effects*."

9. In the event that an analysis by a referee laboratory is required, the assignment of testing costs should be addressed (Sec. 5.12.1).

III.B. *Modification to Standard.* Any modification of the provisions, definitions, or terminology in this standard must be provided in the purchaser's specifications.

IV. *Major Revisions.* Major revisions to the standard in this edition include the following:

1. The acceptance clause (Sec. I.C) has been changed to approved wording.

2. Section 4.3.2, Product certification, has been added.

3. Alternative testing methods for iron, ferrous iron, and ferric iron have been added (Sec. 5.9, 5.10, and 5.11).

V. *Comments.* If you have any comments or questions about this standard, please call the AWWA Standards and Materials Development Department, (303) 794-7711 ext. 6283, FAX (303) 795-1440, or write to the department at 6666 W. Quincy Ave., Denver, CO 80235.

American Water Works Association



ANSI/AWWA B407-98
(Revision of ANSI/AWWA B407-93)

AWWA STANDARD FOR

LIQUID FERRIC CHLORIDE

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard covers ferric chloride in aqueous (liquid) form for use in the treatment of municipal and industrial water supplies. Applications of the chemical include (1) water softening with lime or a combination of lime and soda ash to improve hardness reduction and coagulation, and (2) water clarification, as a coagulant, followed by settling or filtration.

Sec. 1.2 Purpose

The purpose of this standard is to provide liquid ferric chloride purchasers, manufacturers, and suppliers with the minimum requirements for liquid ferric chloride, including physical, chemical, packaging, shipping, and testing requirements.

Sec. 1.3 Application

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

SECTION 2: REFERENCES

This standard references the following document. In its latest edition, it forms a part of this standard to the extent specified in this standard. In any case of conflict, the requirements of this standard shall prevail.

Standard Methods for the Examination of Water and Wastewater, APHA,* AWWA, and WEF.† AWWA, Denver, Colo. (19th ed., 1995).

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Manufacturer*: The party that manufactures, fabricates, or produces materials or products.
2. *Purchaser*: The person, company, or organization that purchases any materials or work to be performed.
3. *Supplier*: The party that supplies material or services. A supplier may or may not be the manufacturer.

SECTION 4: REQUIREMENTS

Sec. 4.1 Physical Requirements

Liquid ferric chloride (FeCl_3) is an orange-brown, acidic, corrosive, aqueous solution. The specific gravity of the solution shall be in the range of 1.3 to 1.5. The specific gravity will vary with the FeCl_3 concentration. Concentration may be varied with the season and point of destination to prevent crystallization during cold weather.

Sec. 4.2 Chemical Requirements

Liquid ferric chloride shall contain from 28 to 47 percent FeCl_3 by weight, which is 9.6 to 16.2 percent total iron as Fe. Not more than 2.5 percent of the total iron shall be in the ferrous state; however, the purchaser may establish higher allowable ferrous-iron concentration in supplemental specifications. The free acid, expressed as HCl, shall not exceed 1.0 percent. The solution shall not contain more than 0.5 percent total insoluble matter by weight.

Sec. 4.3 Impurities

4.3.1 *General impurities*. The liquid ferric chloride supplied according to this standard shall contain no substances in quantities capable of producing deleterious or injurious effects on the health of those consuming water that has been properly treated with liquid ferric chloride. This standard applies to liquid ferric chloride produced by currently recognized methods of manufacture. If other methods or raw materials are used, impurities could be present that might be inconsistent with accepted water treatment practices. In such cases, additional tests by the manufacturer may be required to demonstrate that the product is suitable for water treatment purposes.

*American Public Health Association, 1015 15th St. N.W., Washington, DC 20005.

†Water Environment Federation, 601 Wythe St., Alexandria, VA 22314-1994.

4.3.2 *Product certifications.* Liquid ferric chloride is a direct additive used in the treatment of potable water. This material should be certified as suitable for contact with or treatment of drinking water by an accredited certification organization in accordance with ANSI/NSF Standard 60, Drinking Water Treatment Chemicals—Health Effects. Evaluation shall be accomplished in accordance with requirements that are no less restrictive than those listed in ANSI/NSF Standard 60. Certification shall be accomplished by a certification organization accredited by the American National Standards Institute.

SECTION 5: VERIFICATION

Sec. 5.1 Sampling

5.1.1 *Sampling point.* Samples shall be taken at the point of destination.

5.1.2 *Amount of shipment to be sampled.* Five percent of the containers shall be sampled, but a minimum of 5 and a maximum of 15 containers in any one shipment shall be sampled. No sample shall be taken from a leaking container. In the case of bulk shipments, a composite sample should be taken from the tank truck or barge at five equally spaced intervals during unloading of the bulk container.

5.1.3 *Sampling method, sample size, and handling.* The contents of each container to be sampled shall be mixed thoroughly, and a portion shall be taken of such size that the total gross sample shall consist of at least 10 qt (10 L). After thorough mixing of the gross sample, three 0.5-qt (0.5-L) samples shall be sealed in airtight bottles. Care must be taken during sampling not to introduce large quantities of air into the product. A chain-of-custody form shall accompany all samples and shall be properly completed by the individuals collecting samples. Each sample container shall be labeled to identify it and shall be signed by the sampler.

5.1.4 *Distribution of samples.* One of the three sealed samples is for immediate use by the purchaser for testing of the shipment according to Sec. 5.2. The two remaining samples shall be retained for possible future use according to Sec. 5.12.

5.1.5 *Sample retention.* Samples shall be retained for at least 30 days after the date of receipt of the shipment before they are discarded.

5.1.6 *Test samples.* Test samples shall be obtained from sealed material samples delivered to the laboratory. Material samples shall be unsealed only when it is necessary to remove quantities of the material for testing. This shall be accomplished quickly, and the material samples shall then be resealed for future reference. Liquid ferric chloride shall be mixed thoroughly before a portion is withdrawn for examination. The bottle shall be kept sealed after the sample has been removed.

Sec. 5.2 Test Procedures—General

Sampling shall be conducted according to Sec. 5.1. The laboratory examination of the sample shall be completed within five working days after receipt of the shipment.

Methods of testing ferric chloride for specific gravity, insoluble matter, total iron, ferrous iron, ferric iron, acidity, and impurities shall conform to the procedures presented in the following sections. Alternative procedures may be used only with the written approval of the purchaser. In any case of conflict, the methods described in this standard shall prevail.

Sec. 5.3 Specific Gravity

The approximate amount of ferric chloride present in the sample can be determined by measuring the specific gravity with an accurate hydrometer at a known temperature. The supplier shall furnish a table showing the percentage of ferric chloride for different specific-gravity readings.

Sec. 5.4 Total Insoluble Matter**5.4.1 Apparatus.**

1. Membrane filter holder—47 mm (or 110 mm).
2. Glass-fiber filters—Whatman GF/C (Whatman Inc., Clifton, N.J.) or equivalent.
3. Filter flask—1,000 mL.

5.4.2 Procedure.

1. Dry a filter at 103°C (217°F) for ½ h. Cool in a desiccator and weigh to the nearest milligram. This is the tare weight.
2. Place the filter, wrinkled surface up, in a filter holder. Apply a vacuum and wet with a small amount of distilled water.
3. Mix the sample thoroughly, and immediately pipette 25 mL into a tared 250-mL beaker. Rapidly determine the weight of the sample to the nearest 0.01 g. This weight will be used in the calculation for percent total insoluble matter (Sec. 5.4.3).
4. Add approximately 150 mL of distilled water and filter.
5. Wash the residue in the beaker onto the filter.
6. Wash the filter repeatedly with distilled water until it is free of any yellow ferric chloride color. Perform at least six washings.
7. Remove the filter, dry 1 h at 103°C (217°F), cool in a desiccator, and weigh to the nearest milligram. Subtract the tare weight (from Sec. 5.4.2[1]); this is the weight of the residue to be used in the calculation for percent total insoluble matter (Sec. 5.4.3).

5.4.3 Calculation.

$$\% \text{ total insolubles} = \frac{\text{weight of residue} \times 100}{\text{weight of sample}} \quad (\text{Eq 1})$$

Sec. 5.5 Iron**5.5.1 Reagents.**

1. Concentrated sulfuric acid.
2. Concentrated hydrochloric acid.
3. Stannous chloride solution. Dissolve 100 g stannous chloride in 30 percent-by-volume hydrochloric acid solution (HCl/H₂O). Store over clean metallic tin. Discard if the solution becomes cloudy. The stannous chloride solution is not stable, and a fresh solution should be prepared each month.
4. Saturated mercuric chloride solution—poison. Dissolve mercuric chloride in 500 mL distilled water until no additional mercuric chloride will dissolve.
5. Sulfuric acid/phosphoric acid solution. Make 150 mL H₂SO₄ and 150 mL of 85 percent H₃PO₄ up to 1 L with distilled water. (Pour acids into water.)
6. Potassium dichromate solution. Dissolve 4.902 g of reagent-grade potassium dichromate in distilled water and dilute to 1 L; this is a 0.1N solution.
7. Barium-diphenylamine sulfonate indicator. Dissolve 0.32 g of barium diphenylamine sulfonate in 100 mL of distilled water.

5.5.2 *Procedure.*

1. Mix the sample thoroughly. Quickly transfer approximately 10 mL of sample to a previously tared stoppered weigh bottle. Weigh the sample to the nearest 0.01 g. The weight of the sample will be used in calculating percent total iron (Sec. 5.5.3). Transfer the sample to a 250-mL volumetric flask and dilute to the mark with distilled water. Invert 10 times and quickly pipette 50 mL of sample from the 250-mL volumetric flask into a 500-mL Erlenmeyer flask.

2. Add 15 mL of concentrated sulfuric acid and 10 mL of concentrated hydrochloric acid to the contents of the flask and bring to a boil.

3. Stannous chloride reduction. When the solution has been heated to near the boiling point, 95°C–100°C (203°F–212°F), add stannous chloride solution, drop by drop, while gently swirling the flask with heat-resistant tongs until the yellow iron color in the solution is discharged. Add no more than one drop stannous chloride in excess. Allow solution to cool to room temperature, and add 10 mL of saturated mercuric chloride solution. A gray or black precipitate indicates an excessive amount of stannous chloride. A white, silky precipitate should form; if it does not, discard and start over. Dilute to 150 mL with distilled water. Add 15 mL of the sulfuric acid/phosphoric acid solution and 0.3 mL of barium diphenylamine sulfonate indicator solution. Titrate at once with 0.1N potassium dichromate solution to a violet-blue end point.

5.5.3 *Calculation.*

$$\% \text{ total iron} = \frac{\text{mL } 0.1N \text{ K}_2\text{Cr}_2\text{O}_7 \times 0.5585}{\text{grams of sample} \times 50/250} \quad (\text{Eq } 2)$$

Sec. 5.6 Ferrous Iron5.6.1 *Reagents.*

1. Concentrated sulfuric acid.
2. Sulfuric acid/phosphoric acid solution. Dilute 150 mL of concentrated H₂SO₄ and 150 mL of 85 percent H₃PO₄ to 1 L with distilled water. (Pour acids into water.)
3. Barium diphenylamine sulfonate indicator. Dissolve 0.32 g of barium diphenylamine sulfonate in 100 mL of distilled water.
4. Potassium dichromate solution. Dissolve 4.902 g of reagent-grade potassium dichromate in distilled water and dilute to 1 L. This is a 0.1N solution.

5.6.2 *Procedure.*

1. Pipette a 100-mL portion of the sample from the 250-mL volumetric flask (see Sec. 5.5.2[1]) and transfer to a 500-mL Erlenmeyer flask.
2. Add 15 mL of concentrated sulfuric acid.
3. Dilute to 200 mL with distilled water.
4. Allow to cool to room temperature.
5. Add 15 mL of the sulfuric acid/phosphoric acid solution and 12 drops of barium diphenylamine sulfonate indicator solution.
6. Titrate at once with 0.1N potassium dichromate solution to a violet-blue end point.

5.6.3 *Calculations.*

$$\% \text{ ferrous iron} = \frac{\text{mL } 0.1N \text{ K}_2\text{Cr}_2\text{O}_7 \times 0.5585}{\text{grams of sample} \times 100/250} \quad (\text{Eq } 3)$$

$$\% \text{ total iron as ferrous} = \frac{\% \text{ ferrous iron}}{\% \text{ total iron}} \quad (\text{Eq 4})$$

Sec. 5.7 Percent Ferric Chloride

5.7.1 *Procedure.* The percent ferric chloride is determined by subtracting the percent ferrous iron from the percent total iron and then converting the percent ferric iron to percent ferric chloride.

5.7.2 *Calculations.*

$$\% \text{ ferric iron} = \% \text{ total iron} - \% \text{ ferrous iron} \quad (\text{Eq 5})$$

$$\% \text{ ferric chloride} = \% \text{ ferric iron} \times 2.905 \quad (\text{Eq 6})$$

Sec. 5.8 Acidity

5.8.1 *Reagents.*

1. Potassium fluoride ($\text{KF} \cdot 2\text{H}_2\text{O}$)—analytical reagent grade.
2. Phenolphthalein indicator solution. Dissolve 5 g phenolphthalein in 1 L of 50 percent alcohol. Neutralize with sodium hydroxide.
3. Sodium hydroxide. To prepare a 1N solution, weigh out 40 g of sodium hydroxide pellets and dissolve in approximately 200 mL of CO_2 -free distilled water. Dilute to 1 L in a volumetric flask. Standardize against benzoic acid or potassium acid phthalate of known normality. Use modified methyl orange as an indicator. To prepare a 0.05N solution, dilute 50 mL of 1N NaOH to 1 L with CO_2 -free distilled water.
4. Sulfuric acid. To prepare 0.05N sulfuric acid, dilute 50 mL of concentrated sulfuric acid (36N) to 1 L. This solution is 1.8N. Take 28.0 mL of the 1.8N sulfuric acid and dilute to 1 L, thereby producing a 0.05N sulfuric acid. Standardize the 0.05N sulfuric acid against a known base before using.

5.8.2 *Procedure.*

1. Dissolve 20 g of potassium fluoride in 40 mL of boiled distilled water. Add 0.2 mL of phenolphthalein indicator solution and adjust to a faint pink color with 0.05N sodium hydroxide or sulfuric acid to obtain neutralized potassium fluoride.
2. Weigh 1 to 2 g (1 mL) of ferric chloride solution and record weight to within 0.001 g. Wash into a 150-mL beaker with 50 mL of boiled distilled water.
3. Add 25 mL of neutralized potassium fluoride and mix.
4. Add 0.2 mL of phenolphthalein indicator solution and titrate to a faint pink color with 0.05N sodium hydroxide.

5.8.3 *Calculation.*

$$\% \text{ free acidity (as HCl)} = \frac{\text{mL } 0.05\text{N NaOH} \times 0.001825 \times 100}{\text{grams of sample}} \quad (\text{Eq 7})$$

Sec. 5.9 Iron Alternative Method

5.9.1 *Procedure.* The percent ferrous chloride and percent ferric chloride results are converted to percent iron and then added together. The calculation is performed with results from Sec. 5.10 and 5.11.

5.9.2 *Calculation.*

$$\% \text{ total iron} = \frac{\% \text{FeCl}_2}{2.2696} + \frac{\% \text{FeCl}_3}{2.905} \quad (\text{Eq 8})$$

Sec. 5.10 Ferrous Iron Alternative Method5.10.1 *Reagents.*

1. Sulfuric acid/phosphoric acid solution. Use an ice bath to cool 600 mL of distilled water in a beaker to <10°C. Add slowly, with stirring, 150 mL of concentrated H₂SO₄ (95 to 98 percent by weight) and 250 mL of 85 percent H₃PO₄.

2. Diphenylamine sulfonate indicator. Dissolve 1.356 g of diphenylamine sulfonic acid, sodium salt in 500 mL of distilled water.

3. Ceric sulfate solution. Cautiously add 30 mL of concentrated H₂SO₄ (95 to 98 percent by weight) to 500 mL of distilled water in a 1-L volumetric flask. Dissolve 63.255 g of ceric ammonium sulfate dihydrate (Ce[NH₄]₄[SO₄]₄ · 2H₂O) in this acid solution. Cool to room temperature and dilute to the 1-L mark with distilled water. For best results, allow to stand two or more weeks and filter before use. This is a 0.1N solution. Ceric sulfate solution can also be purchased at a supplier-certified 0.1N concentration.

5.10.2 *Procedure.*

1. Pipette a 10-mL portion of sample into a previously tared weighing cup. Record the weight to the nearest 0.001 g. Transfer into a 500-mL Erlenmeyer flask, with weighing cup rinses.

2. Dilute the sample to about 300 mL with distilled water. Add 15 mL of sulfuric acid/phosphoric acid mixture and then 2 mL of diphenylamine sulfonate indicator solution.

3. Titrate at once with 0.1N ceric sulfate solution from light green-gray to a purple-violet end point. It is useful to have a lighted magnetic stirrer under the flask.

5.10.3 *Calculations.*

$$\% \text{ ferrous chloride} = \frac{\text{mL } 0.1N \text{ Ce}(\text{NH}_4)_4(\text{SO}_4) \cdot 2\text{H}_2\text{O} \times 1.2675}{\text{grams of sample}} \quad (\text{Eq 9})$$

$$\% \text{ ferrous iron} = \frac{\% \text{ ferrous chloride}}{2.2696} \quad (\text{Eq 10})$$

Sec. 5.11 Ferric Iron Alternative Method5.11.1 *Reagents.*

1. 1.0N hydrochloric acid (HCl)

2. Potassium thiocyanate (KCNS) indicator solution. Dissolve 20 g of KCNS in 100 mL of distilled water.

3. Disodium ethylene diamine tetraacetic acid (Na₂EDTA) solution. Dissolve 37.224 g of Na₂EDTA · 2H₂O, in distilled water and dilute to the mark in a 1-L volumetric flask. This is approximately a 0.1M solution, which should be standardized for accurate work. An appropriate iron reference for standardization is 1,000 ± 10 ppm Fe in acidic solution. Na₂EDTA solutions can also be purchased at a supplier-certified 0.1M concentration.

5.11.2 *Procedure.*

1. Weigh 0.70 ± 0.05 g of sample into a previously tared weighing cup. Record the weight to the nearest 0.0001 g.
2. Transfer contents into a 250-mL Erlenmeyer flask with rinses and add 135 mL of distilled water.
3. While stirring, adjust solution pH to 1.7 ± 0.1 by dropwise addition of 1N HCl if the pH > 1.7 or 1N NaOH if the pH < 1.7 .
4. Add 2 mL of KCNS indicator solution.
5. Titrate with 0.1M Na₂EDTA solution from blood-red to a yellow end point. There is an intermediate orange color to the solution during this titration, but the actual end point is bright yellow. Best results are obtained using an automatic titrator with photometric end point detection.

5.11.3 *Calculations.*

$$\% \text{ ferric chloride} = \frac{\text{mL of } 0.1M \text{ Na}_2\text{EDTA} \times M \text{ Na}_2\text{EDTA} \times 16.22}{\text{grams of sample}} \quad (\text{Eq 11})$$

$$\% \text{ ferric iron} = \frac{\% \text{ ferric chloride}}{2.905} \quad (\text{Eq 12})$$

NOTE: The use of Na₂EDTA in this method may allow other impurities such as Mn, Cu, Zn, and possibly other metals to titrate as iron.

Sec. 5.12 Basis for Rejection

5.12.1 *Notice of nonconformance.* If the liquid ferric chloride delivered to the purchaser does not meet the requirements of this standard, the purchaser shall provide a notice of nonconformance to the supplier within 10 days after receipt of the shipment at the point of destination. The results of the purchaser's tests shall prevail unless the supplier notifies the purchaser within five working days after receipt of the notice of nonconformance that a retest is desired. On receipt of the request for a retest, the purchaser shall forward to the supplier one of the sealed samples taken according to Sec. 5.1 of this standard. If the results obtained by the supplier on retesting do not agree with the test results obtained by the purchaser, the other sealed sample shall be forwarded, unopened, for analysis to a referee laboratory agreed on by both parties. The results of the referee analysis shall be accepted as final.

SECTION 6: DELIVERY*

Sec. 6.1 Marking

6.1.1 *Required.* Each shipment of material shall carry with it some means of identification. The net weight of the contents, the weight-percent ferric chloride, the

*Governmental packaging and marking references reflect United States requirements. Users of B407 from Canada, Mexico, and non-North American countries should verify applicable local and national regulatory requirements.

name of the manufacturer, a brand name if any, and other markings as required by applicable laws and regulations shall be marked legibly on each package. When shipped in bulk, this information shall be provided according to applicable regulations.

6.1.2 *Optional.* The container may also bear the statement, "This material meets the requirements of AWWA B407, Standard for Liquid Ferric Chloride," provided that the requirements of this standard are met and the material is not of a different quality as defined in a separate agreement between the supplier and purchaser.

Sec. 6.2 Packaging and Shipping

Packaging and shipping of liquid ferric chloride shall conform to current federal, state, provincial, and local regulations.

6.2.1 *Shipping containers.* Liquid ferric chloride shall be shipped in carboys, drums, cars, tank trucks, or barges, as specified by the purchaser.

6.2.2 *Weight certificates.* The purchaser may require that bulk shipments be accompanied by weight certificates from certified weighers, or that the weights be checked by the purchaser on delivery.

Sec. 6.3 Affidavit of Compliance

The purchaser may require the manufacturer or supplier to furnish either an affidavit attesting that the liquid ferric chloride furnished according to the purchaser's specifications complies with all applicable requirements of this standard, or a certified analysis of the liquid ferric chloride, or both. The purchaser may also elect to use in-house analytical equipment to assure compliance with this standard.