



**American Water Works
Association**

ANSI/AWWA B202-13
(Revision of ANSI/AWWA B202-07)

AWWA Standard

Quicklime and Hydrated Lime

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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.

SEC.	PAGE	SEC.	PAGE
<i>Foreword</i>		2	References 2
I Introduction.....	vii	3	Definitions 2
I.A Background.....	vii	4	Requirements
I.B History.....	vii	4.1	Physical Requirements..... 3
I.C Acceptance.....	vii	4.2	Chemical Requirements 4
II Special Issues.....	viii	4.3	Impurities..... 4
II.A Calcium Oxide.....	viii	5	Verification
II.B Lime.....	ix	5.1	Sampling..... 5
II.C Magnesium and Insoluble		5.2	Test Procedures: General 7
Material	ix	5.3	Available Calcium Oxide..... 7
II.D Size and Marking.....	x	5.4	Slaking Rate..... 9
II.E Purchase Basis.....	x	5.5	Objectionable Insoluble Matter 12
II.F Sampling.....	x	5.6	Notice of Nonconformance..... 14
III Use of This Standard.....	xi	6	Delivery
III.A Purchaser Options and		6.1	Marking..... 15
Alternatives	xi	6.2	Packaging and Shipping 15
III.B Modification to Standard	xi	6.3	Affidavit of Compliance 16
IV Major Revisions.....	xii		
V Comments	xii		
<i>Standard</i>		<i>Figures</i>	
1 General		1	Details of Equipment for
1.1 Scope	1		Slaking-Rate Test 10
1.2 Purpose.....	1	2	Assembly of Apparatus for
1.3 Application.....	1		Slaking-Rate Test 11

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA B202.

I. Introduction.

I.A. *Background.* Quicklime results from the calcination of limestone, shell, or equivalent, and consists of calcium oxide in natural association with a lesser amount of magnesium oxide. Hydrated lime is a very finely divided powder resulting from the hydration of quicklime with enough water to satisfy its chemical affinity. Slurry lime contains additional water to create a suspension of hydrated lime. Both quicklime and hydrated lime are commonly used in the treatment and softening of municipal and industrial water supplies.

I.B. *History.* ANSI/AWWA B202 was first approved as tentative Sept. 9, 1952. It was made standard Sept. 28, 1954. Subsequent revisions to ANSI/AWWA B202 were prepared by the AWWA Standards Committee and were approved by the AWWA Board of Directors on Jan. 25, 1965; Jan. 30, 1977; Jan. 30, 1983; June 19, 1988; June 6, 1993; Jan. 20, 2002, and Jan. 21, 2007. This edition of B202 was approved on June 9, 2013.

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, now Water Research Foundation) and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association 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

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

† 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 B202 addresses additives requirements in Sec. 4.3 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, 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. *Calcium Oxide.* The amount of available calcium oxide (CaO) varies in limes. Many methods are available for evaluating the available CaO in lime. Some give consistently low results, some are rather time-consuming, and some do not give reproducible results. The method included in this standard is reasonably rapid and reproducible and gives results that are consistent with the available CaO content obtained in use in water treatment. Other methods may be used.

The method of analysis for available CaO content presented in this standard has been found by many users to be satisfactory as a basis for the purchase of lime for water treatment. Usable results will be obtained by this method only if the acid is carefully

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

standardized according to the instructions in this standard and only if the procedure for the specified test is followed in exact detail.

Some water utility personnel still believe that a better evaluation of lime can be made and that more accurate results can be obtained by determining total CaO. In addition to available CaO, such an analysis determines CaO present as calcium carbonate—a factor of little importance in water treatment. For those who prefer the total CaO method, and for those who wish to make a complete analysis, the methods outlined in ASTM* C25, Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime, are recommended.

The amount of available CaO varies in limes from different geographic regions. Factors such as source of rock, manufacturing conditions, type of kiln, type of fuel, and even personnel have an effect on product quality.

II.B. *Lime.* A lime that slakes at a rate consistent with plant equipment is more economical to use and less difficult to handle. A slaking-rate test to determine the reactivity of lime is included in this standard. This procedure was devised to control the variables that occur in the test, thus improving the reproducibility of results. The results of the slaking-rate test on a given quicklime should be correlated with the performance of the lime in the slaker. The slaking requirement for the lime can then be specified.

Because most modern lime-slaking equipment contains devices for the removal of grit, sand, pebbles, and other coarse inert material and because overloading of the grit-removing devices is undesirable, a test for insoluble matter is provided in this standard.

II.C. *Magnesium and Insoluble Material.* This standard sets no limit on magnesium because keeping the available CaO content within the specified limit should address any excess magnesium problem adequately. No provision is made for high-magnesium lime for the specific reason that such lime is not suited for water treatment. Although insoluble matter (iron and aluminum) can cause turbidity when lime is applied to filtered water or to a water supply not to be filtered, no limit is set for these constituents because turbidity problems can be overcome by adding the lime as a saturated solution. If such a procedure is impractical, individual treatment plants may need to set up limits for total insoluble matter, iron, and aluminum when purchasing lime. This condition occurs so rarely that a provision for it in this standard is unwarranted. The test for insolubles included in this standard determines only those insolubles that are coarse enough to be retained in the slaker or grit remover. Likewise,

* ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

no mention is made of the character of insoluble matter, assuming that its composition will not affect the application of lime if done using a dry-feed machine.

II.D. *Size and Marking.* Sizes of lime are established in the standard to meet the requirements of various types of feed equipment. Alternatively, purchasers may set size requirements to meet specific conditions. A change in size requirements should be made only after consultation with the manufacturer of the feed equipment being used.

The standard also does not require the date of manufacture to be stamped on the bags in which the hydrated lime is shipped; it is assumed that the material will be delivered to the point of use in a condition to be handled readily in a dry-feed machine.

II.E. *Purchase Basis.* This standard describes only limes composed mainly of calcium oxide or calcium hydroxide. Special limes, such as dolomitic limes for the removal of silica, are not included. Thus, for the purchase of lime of a different chemical composition, the purchaser must provide specifications describing the kind of material desired. For lime of any type, the purchaser may specify the method of manufacture to be used in making the lime.

Lime should be purchased according to the following industry-recommended guidelines:

1. Quicklime. In general, quicklime contains about 90 percent available CaO in the material provided, although greater or lower percentages of available CaO can be used. The quicklime should slake satisfactorily, based on the system's design.

Satisfactory "quick-slaking" lime will usually produce a temperature rise of 40°C (72°F) in 3 min, and the slaking reaction will be complete in 10 min or less when the lime is tested according to Sec. 5.4 of this standard.

Satisfactory quicklime for water treatment will slake without production of objectionable amounts of insoluble material.

2. Hydrated lime. In general, hydrated lime contains 68 percent available CaO (which is equivalent to 89.8 percent calcium hydroxide) content in the material provided, although higher or lower percentages of available CaO can be used.

II.F. *Sampling.* Production-statistical process control testing is being used increasingly as a substitute for per-load sampling and testing and may be used as an alternative.

Current good laboratory practices require documentation of the handling of all samples from the time they are first collected until they are introduced as evidence in possible legal proceedings. Chain-of-custody procedures are followed to maintain and document control of sample possession. An in-depth discussion of chain-of-custody

procedures is discussed in *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA-600/4-82-029). At a minimum, the chain-of-custody records should show the location, date, and time the sample was taken, along with the name of the individual who took the sample. Each time possession of the samples is transferred, the person relinquishing and the person receiving the samples should sign, date, and note the transfer of the chain-of-custody record form.

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 B202, Quicklime and Hydrated Lime, of latest revision.
2. Whether compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.
3. Quantity and whether quicklime or hydrated lime is being purchased (Section 3).
4. Details of other federal, state or provincial, and local requirements (Section 4).
5. Size required (Sec. 4.1), depending on the type of feeding equipment used.
6. Limit on insoluble matter (Sec. 4.2.1) if other than 5 percent.
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. 5.1 through Sec. 5.5, demonstrate that the product meets the standard. Failure to meet the standard or absence of, or irregularities in, seals may be sufficient cause to reject a shipment.
8. Marking information (Sec. 6.1).
9. Method of packaging and shipping (Sec. 6.2).
10. Weight certificates (Sec. 6.2.4).
11. Whether alternative security measures have been adopted to replace or augment the security measures set out in Sec. 6.2.5 and 6.2.6.
12. An affidavit of compliance or certified analysis, or both, if required (Sec. 6.3).

III.B. *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 revision include the following:

1. Inclusion of the use of this material for wastewater and reclaimed water as well as definitions of these terms (Sections 1 and 3).
2. Inclusion of a requirement for compliance with the Safe Drinking Water Act and other federal regulations (Section 4).
3. Inclusion of guidance for rejection of the material and concentration variation (Sec. 5.6, Notice of Nonconformance).

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



**American Water Works
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(Revision of ANSI/AWWA B202-07)

AWWA Standard



Quicklime and Hydrated Lime

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes pebble, lump, and ground quicklime and hydrated lime for use in the treatment of potable water, wastewater, or reclaimed water supply service.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for quicklime and hydrated lime, including physical, chemical, sampling, packaging, shipping, and testing requirements.

Sec. 1.3 Application

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

ASTM* C25—Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime.

ASTM C110—Standard Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone.

NSF†/ANSI‡ 60—Drinking Water System Chemicals—Health Effects.

NSF/ANSI 61—Drinking Water System Components—Health Effects.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Day*: A day is defined as a 24-hr period.
2. *Hydrated lime*: A very finely divided powder or slurry resulting from the hydration of quicklime with enough water to satisfy its chemical affinity. It consists essentially of calcium hydroxide or a mixture of calcium hydroxide and magnesium hydroxide, depending on the type of quicklime used in slaking.
3. *Manufacturer*: The party that manufactures, fabricates, or produces materials or products.
4. *Potable water*: Water that is safe and satisfactory for drinking and cooking.
5. *Purchaser*: The person, company, or organization that purchases any materials or work to be performed.
6. *Reclaimed water*: Wastewater that becomes suitable for beneficial use as a result of treatment.
7. *Quicklime*: The product resulting from the calcination of limestone, shell, or equivalent (such as dried sludge from lime-softening processes of suitable analysis). It consists essentially of calcium oxide (CaO) in natural association with a lesser amount of magnesium oxide.

* ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

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

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

8. *Supplier:* The party that supplies materials or services. A supplier may or may not be the manufacturer.

9. *Tamper-evident packaging:* Packaging having one or more indicators or barriers to entry which, if breached or missing, can reasonably be expected to provide visible evidence to the purchaser that tampering has occurred. The tamper-evident features of the packaging shall be designed to and shall remain intact when handled in a reasonable manner during manufacture, storage, shipment, and delivery to the purchaser. Properly constructed, labeled, and closed, and sealed multiwall paper bags and super sacks constitute effective forms of tamper-evident packaging.

10. *Wastewater:* A combination of the liquid and water-carried waste from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and stormwater that may be present.

SECTION 4: REQUIREMENTS

Materials shall comply with the requirements of the Safe Drinking Water Act and other federal regulations for potable water, wastewater, and reclaimed water systems as applicable.

Sec. 4.1 Physical Requirements

Sizes of lime are established to meet the requirements of various types of equipment. Point-of-shipment tests to verify gradation may be required by the purchaser.

4.1.1 *Dry-feed equipment.*

4.1.1.1 If quicklime is to be fed by a dry-feed machine, the quicklime shall, if necessary, be crushed and screened so that none is retained on a $\frac{3}{4}$ -in. (19-mm) sieve and not more than 5 percent shall pass through a No. 100 US standard sieve on shipment at the supplier's plant. (Soft limes may generate some fines during vigorous screening. To minimize this possibility, use an intermediate $\frac{3}{8}$ -in. [10-mm] sieve, which will reduce the load on the 100-mesh sieve and thus partly eliminate the pulverizing action of lime against lime.)

4.1.1.2 If provided in a dry form, the hydrated lime shall be white, finely powdered, and free from lumps or any foreign material that might interfere with the operation of dry-feed equipment. Uniformity of particle size is desirable.

4.1.2 *Pneumatic equipment.* If quicklime is to be handled by pneumatic conveying equipment, the quicklime shall, if necessary, be crushed and screened so that none shall be retained on a 1-in. (25-mm) sieve and not more than 5 percent shall pass through a No. 100 US standard sieve on shipment at the supplier's or manufacturer's plant.

4.1.3 *Mechanical equipment.* If quicklime is to be handled by mechanical conveying equipment, the pieces of quicklime shall be no larger than 2 in. (51 mm), except that an occasional slablike piece may be up to 3 in. (76 mm) in length.

Sec. 4.2 Chemical Requirements

4.2.1 *Quicklime.* Quicklime shall not have less than 80 percent available CaO (see Sec. II.E in the Foreword and Sec. 5.6). Quicklime shall produce more than a 10°C (18°F) rise in temperature in 3 min and shall reach the maximum temperature, as a minimum, in 20 min on slaking according to Sec. 5.4. Quicklime supplied according to the provisions of this standard shall be freshly burned and shall be substantially free from carbonate solids and siliceous residue. Not more than 5.0 percent of the quicklime shall be insoluble material when tested according to Sec. 5.5, unless modified by the purchaser.

4.2.2 *Hydrated lime.* Hydrated lime shall not have less than 62 percent available CaO, which is equivalent to 81.9 percent calcium hydroxide.

Sec. 4.3 Impurities*

4.3.1 *General impurities.* The quicklime and hydrated lime supplied in accordance with this standard shall contain no soluble inorganic or organic substances in quantities capable of producing deleterious or injurious effects on the health of those consuming water that has been treated properly with the lime products.

4.3.2 *Product certifications.* Quicklime and hydrated lime are direct additives used in the treatment of potable water. These materials should be certified as suitable for contact with or treatment of drinking water by an accredited certification organization in accordance with NSF/ANSI 60. Evaluation shall be accomplished in accordance with requirements that are no less restrictive than those listed in NSF/ANSI 60. Certification shall be accomplished by a certification organization accredited by the American National Standards Institute.

* See Sec. I.C of the foreword.

SECTION 5: VERIFICATION

Sec. 5.1 Sampling

To minimize contact with air, samples shall be taken quickly at the point of destination and shall be placed immediately into an airtight, moisture-proof container.

5.1.1 *Size.* Sample size shall be as follows:

5.1.1.1 For lump material or finely divided bulk material, a minimum sample of 50 lb (22.7 kg) shall be taken for each 30 tons (27.2 metric tons) of material.

5.1.1.2 If delivery is in the range of 25–50 tons (22.7–45.4 metric tons) per week, a composite sample shall be composed of a week's sampling and kept in an airtight container. When appropriate, a composite sample may be made of a day's shipment.

5.1.1.3 If delivery is less than 25 tons (22.7 metric tons) per week, a sufficient sample—32 lb (14.5 kg)—shall be obtained from each shipment to perform an analysis.

5.1.2 *Method.* Sampling method shall be as follows:

5.1.2.1 For packaged materials in railcars or trucks, at least 2 percent of the packages, but no fewer than five packages, shall be sampled. Individual packages shall be taken from various locations on the railcar or truck being sampled. No sample shall be taken from a broken package.

5.1.2.2 For packaged powdered material, a sampling tube, such as a grain-sampling tube that takes a core not less than ½ in. (13 mm) in diameter shall be used. The tube shall be inserted sidewise into the package so that it will take a core of the material from substantially the entire width of the package. Three samples shall be taken from each package, evenly spaced over the length of the package.

5.1.2.3 If the material is handled by conveyor or elevator, a mechanical sampling arrangement may be used. Carefully adjust the location and timing of sampling to secure a representative sample.

5.1.2.4 Finely divided bulk material shall be sampled using a sampling tube, such as a grain-sampling tube, that takes a core of at least 1 in. (25 mm) in diameter. Cores shall be taken from at least eight separate areas of the mass to secure a representative sample. A tube 5 ft (1.52 m) long should be satisfactory.* Access for sampling

* Sampling tubes for this purpose can be obtained from laboratory supply houses.

purposes is not uniformly available in transports. The sampler's best judgment must be used when collecting a representative sample. Adequate documentation of sampling location and method is essential.

5.1.3 *Handling.* Samples shall be selected and stored for analyses according to Sec. 5.1.3.1–5.1.3.3.

5.1.3.1 The gross sample shall be thoroughly mixed, and at least 32 lb (14.5 kg) of the material, representative of the gross sample, shall be quartered. If the test for objectionable insolubles is to be made, crush one 8-lb (3.6-kg) sample to $\frac{3}{8}$ -in. (10-mm) sieve size, mix well, and quarter. If the test for objectionable insoluble matter is not to be made, crush the 8-lb (3.6-kg) sample to 6-mesh sieve size, mix well, and quarter. Store the four 2-lb (0.9-kg) samples in sealed containers as required in Sec. 5.1.3.2.

5.1.3.2 Four 2-lb (0.9-kg) samples shall be sealed in airtight, moisture-proof containers. One sample is for the immediate use of the purchaser for testing of the shipment. The other three samples shall be kept until the results of all testing are complete.

5.1.3.3 Another sample of approximately 2.5 lb (1.1 kg) of the gross sample shall be taken and placed in an airtight container for the purpose of a screen analysis by the purchaser.

5.1.4 *Sieve analysis.* The 2.5-lb (1.1-kg) sample taken for sieve analysis (Sec. 5.1.3.3) needs no further preparation. The screen analysis should be made as quickly as possible after the sample is taken.

5.1.5 *Quicklime.* The sample of quicklime for the laboratory shall be prepared from the 2-lb (0.9-kg) sample that has been set aside for the purchaser as described in Sec. 5.1.3.2. The following procedure shall be used:

1. Crush approximately one half of the 2-lb (0.9-kg) sample so that it passes through a No. 6 US standard sieve using a nonmetallic mechanical crusher, preferably, or using a glass mortar and pestle. Mix the crushed sample thoroughly and place in an airtight, moisture-proof glass container.

2. Mechanically pulverize a 50-g portion of the crushed sample until it passes through a No. 100 US standard sieve. If mechanical equipment is not available, a mortar and pestle may be used. Mix thoroughly and store the pulverized sample in an airtight, moisture-proof container.*

* A 2-oz (60-mL) wide-mouthed bottle, similar to that used for bacteriologic water samples, is convenient for storing the pulverized sample, preferably if it is rubber stoppered or has a metal cap with a suitable airtight liner. Corks and ground-glass stoppers are not recommended. Corks are porous and ground-glass stoppers frequently become separated from their original bottles and do not properly fit in the bottles with which they are used.

5.1.6 *Hydrated lime.* The sample of hydrated lime for the laboratory shall be prepared from the 2-lb (0.9-kg) sample that has been set aside for the purchaser as described in Sec. 5.1.3.2. As described in Sec. 5.1.5(2), a 50-g portion of sample shall be mechanically pulverized so that it passes through a No. 100 US sieve. The sample shall then be mixed and placed in an airtight, moisture-proof container.

5.1.7 *Composite sample.* For a composite sample, the test sample shall be worked up from the container (Sec. 5.1.1.2).

5.1.8 *Weighing.* Weigh each sample from the sample container as rapidly as possible to avoid excessive contact with air.

Sec. 5.2 Test Procedures: General

Laboratory examination of the sample shall be completed within five days after receipt of shipment.

Sec. 5.3 Available Calcium Oxide*

Available CaO content in quicklime and hydrated lime is that constituent that enters into the reaction under the conditions of the rapid sugar method (Sec. 5.3.2, step 2). The method adopted for this standard is used widely and will give satisfactory and reproducible results if the procedure is carefully followed. In this procedure, the term *lime sample* shall mean a sample that has been ground so that all of it passes through a 100-mesh sieve, and the temperature at titration shall be room temperature, 20°–25°C (68°–77°F).

Other test procedures may be used if approved by the purchaser.

5.3.1 Reagents.

1. 0.1782*N* Hydrochloric acid solution. Prepare a solution containing 15.7 mL HCl (specific gravity 1.19) per liter. This solution will be slightly stronger than necessary. Standardize the HCl solution against 0.85 g of pure, dry sodium carbonate, using methyl orange as an indicator. Titrate to a salmon-pink end point. Adjust the solution either by the addition of CO₂-free distilled water if too strong or by the addition of HCl if too weak, so that 0.85 g of sodium carbonate exactly neutralizes 90 mL of the standard HCl solution. One milliliter of the standard HCl solution is equivalent to 1.0 percent CaO when 0.5 g of the sample is tested.

2. Phenolphthalein indicator, 4 percent solution. Dissolve 4 g dry phenolphthalein in 100 mL of 95 percent ethanol.

3. CO₂-free distilled water.

4. Cane sugar.

* Adapted from ASTM C25.

5.3.2 Procedure: Available CaO.

1. Weigh 0.5 g of the pulverized sample and brush into a 250-mL Erlenmeyer flask containing about 10 mL of CO₂-free distilled water, and immediately stopper the flask loosely with a rubber stopper. (IMPORTANT: Have a small amount of water in the flask before adding the sample. This is especially necessary for quicklime, because when water is added on top of a dry charge in a flask, the material tends to cake and form lumps that are difficult to dissolve completely in the sugar solution used later. On the other hand, if the lime is added to a small amount of water, conditions are favorable for a thorough dispersion of fine particles to produce a more rapid solution. With quicklime, some slaking action probably occurs to facilitate the dispersion and solution.)

2. For quicklime, remove the stopper, place the flask on a hot plate, and immediately add 50 mL of boiling CO₂-free distilled water. Swirl the flask and boil actively for 1 min for complete slaking. Remove from the hot plate, stopper the flask loosely, and place in a cold-water bath to cool to room temperature. For hydrated lime, use 50 mL of CO₂-free water and do not boil. Add about 50 mL of CO₂-free distilled water, and then add approximately 15–17 g of pure cane sugar. Stopper the flask, swirl, and let stand for 15 min to react. Reaction time should be 10 to 20 min. Swirl at 5-min intervals during reaction. Remove stopper, add 4–5 drops of 4 percent phenolphthalein indicator, wash the stopper and sides of the flask with CO₂-free distilled water, and titrate, in the original flask, with the standard HCl solution.

3. A mechanical stirrer may be used during the titration if desired. Put a clean mechanical stirrer bar, approximately $\frac{3}{8}$ in. \times 1½ in. (10 mm \times 38 mm), into the flask and place the flask on the mechanical stirrer. Adjust to stir as rapidly as possible without incurring loss by spattering.

4. When titrating, first add, without shaking, about 90 percent of the acid requirement from a 100-mL burette. Then shake the flask as vigorously as possible and finish the titration more carefully, to the first complete disappearance of pink color. Note the reading and ignore the return of color. If the operator is not familiar with previous analyses of the lime under test and if the available lime content varies to extremes, it is good practice to run a preliminary test by slow titration to determine the proper amount to add without first shaking the flask.

5.3.3 Calculation: Available CaO. The number of milliliters of standard acid solution used in step 4 (Sec. 5.3.2) equals the percentage of available calcium oxide in the quicklime or hydrated lime sample.

Sec. 5.4 Slaking Rate

The slaking rate of quicklime is a measure of its reactivity, a quality that is a function of the purity of the lime and the process by which it is manufactured. When tested by the following method, the reactivity may be classified as follows:

1. A high-reactive lime will show a temperature rise of 40°C (72°F) in 3 min or less, and the reaction will be complete within 10 min.
2. A medium-reactive lime will show a temperature rise of 40°C (72°F) in 3–6 min, and the reaction will be complete within 10–20 min.
3. A low-reactive lime will require more than 6 min to show a temperature rise of 40°C (72°F) and will require more than 20 min for the reaction to be completed.

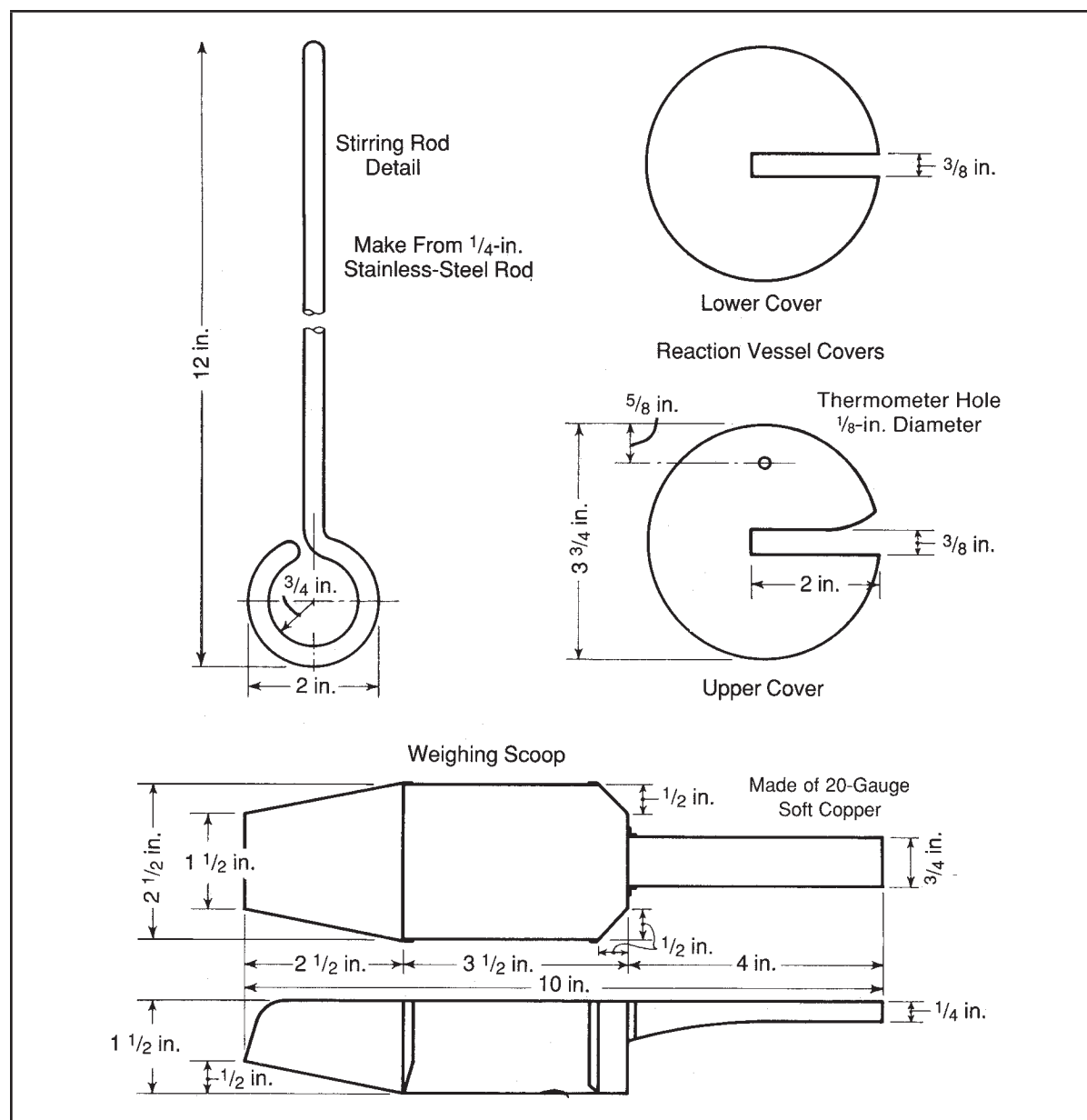
5.4.1 *Principle.* Samples of quicklime may be slaked under controlled conditions with reproducible results (to the extent that the temperatures attained after any time intervals are concerned). Because some slight variations in temperature at the various time intervals can occur, three consecutive slaking-rate tests should be made on each sample, and an average temperature at each time interval should be used. The conditions to be controlled are (1) speed of stirring, (2) ratio of water to lime, (3) heat loss, (4) size of reaction vessel, (5) size and shape of stirring rod, (6) position of stirring rod in the reaction vessel, (7) particle size of the lime sample, and (8) amount of lime used for the test.

Other test procedures may be used if approved by the purchaser.*

5.4.2 *Apparatus.*

1. Mechanical stirrer, with a speed of 400 rpm \pm 50 rpm fitted with a special stainless-steel stirring rod. A rheostat or high-voltage transformer may be necessary for controlling the stirring speed.
2. A 665-mL, heat-resistant glass Dewar flask that is fitted with special gasket-rubber covers.
3. Ring stand or support for holding the stirrer, fitted with a large clamp to hold the Dewar flask firmly in place.
4. Thermometer, dial type, range 0°–100°C in increments of 1°C (32°–212°F in increments of 2°F).
5. Analytical balance.
6. US No. 6 sieve, 8 in. (200 mm) in diameter, with pan and cover.
7. Jaw crusher or an iron mortar and pestle.

* See ASTM C110.



NOTE: Specifications for stirring rod, reaction-vessel covers, and recommended weighing scoop are given.

Figure 1 Details of equipment for slaking-rate test

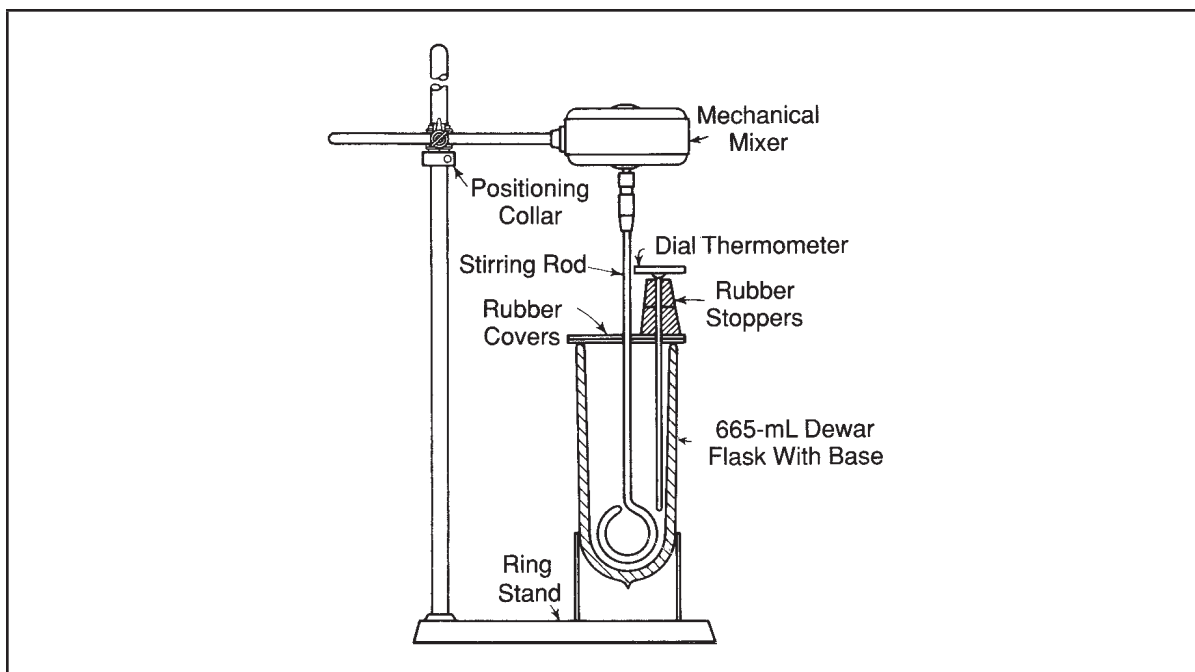
8. Stopwatch.

9. Speed indicator or tachometer.

10. Weighing scoop large enough to hold 100 g of sample.

5.4.3 *Assembled apparatus.* An apparatus as detailed in Figures 1 and 2 shall be used.

5.4.3.1 The apparatus consists of a covered reaction vessel fitted with a mechanical stirrer and thermometer. The quicklime charge shall be stirred with



NOTE: Shown is the assembled apparatus for performing the slaking-rate test on samples of quicklime. Further details are given in the text.

Figure 2 Assembly of apparatus for slaking-rate test

a mechanical stirrer fitted with a stainless-steel stirring rod, the end of which is formed into a loop to follow the contour of the bottom of the reaction vessel. A means for controlling the stirring speed and a means for measuring that speed shall be provided.

5.4.3.2 The vacuum reaction vessel shall be provided with a cover consisting of two circular pieces of gasket-rubber sheet approximately $\frac{1}{8}$ in. (3 mm) thick. The first piece is provided with a single radial slot so that the piece slides over the stirring rod and thermometer. The second (top) piece has a similar slot, plus a hole to provide for the dial thermometer. When the two cover pieces are in place, the slot in the lower piece is at right angles to the slot in the upper piece, with the thermometer stem extending through the lower slot.

5.4.3.3 Although not shown in Figure 2, a large clamp should be used to hold the reaction vessel firmly in place. Any convenient supporting equipment may be used, but a support stand with a large C-shaped base is particularly stable. The positioning collar shown ensures the distance between the bottom of the stirring rod and the bottom of the reaction vessel is the same for each test. The distance should be $\frac{1}{4}$ – $\frac{3}{8}$ in. (6–10 mm).

A scoop, approximately the size shown in Figure 1, will hold 100 g of the crushed lime, and the sample will slide smoothly from the scoop into the reaction vessel.

5.4.4 Procedure.

1. Warm up the stirring mechanism by running at $400 \text{ rpm} \pm 50 \text{ rpm}$ for at least 5 min.
2. Adjust the temperature of approximately 500 mL of distilled water to 25°C (77°F) and add 400 mL to the Dewar flask. The temperature of the water in the flask must be within $\pm 0.5^{\circ}\text{C}$ of 25°C ($\pm 1^{\circ}\text{F}$ of 77°F). Start the stirring mechanism.
3. Weigh out 100 g of the 6-mesh size sample (Sec. 5.1.5[1]) in the weighing scoop and add it to the flask as quickly as possible by letting it slide smoothly into the flask. No more than 10 sec should be required for adding the lime to the flask.*
4. Start the stopwatch.
5. Put the covers and thermometer in place.
6. Take a temperature reading 30 sec after the addition of the lime and at each additional 30-sec interval up to 5 min and then at 1-min intervals up to 10 min, or until there is less than 0.5°C of temperature change in three consecutive readings. Temperatures should be read to the nearest 0.5°C . Record all readings.
7. Make three consecutive tests and average the readings at each time interval.
8. The total active slaking time will be the time at which the first of the last three consecutive readings was taken. The temperature at this time shall be considered the final reaction temperature. Subtract the initial temperature from the average temperature at 3 min to obtain the temperature rise in 3 min. Subtract the initial temperature from the average final reaction temperature to obtain the total temperature rise.
9. Plot a time-temperature curve showing the slaking temperature as ordinates and the time in minutes as abscissas. The results may also be reported as
 - a. temperature rise in 3 min,
 - b. total temperature rise, or
 - c. total active slaking time.

Sec. 5.5 Objectionable Insoluble Matter

5.5.1 *Principle.* The intent of the following procedure for objectionable insoluble material in quicklime is to determine the amount of coarse, gritty materials consisting of sand, pebbles, and core, which in large amounts would overload

* Add 500 mL distilled water to the Dewar flask in step 2 if a paste forms, when using 400 mL distilled water.

grit removers or necessitate excessive cleaning of slakers or basins. The procedure does not determine the total amount of insoluble material, because this would include a large amount of relatively insoluble calcium hydroxide in the slurry. There is no distinct separation between the size of particles held by a grit remover and the size that will pass out of the grit remover and into the reaction basins. This distinction depends not only on the particle size but also on its specific gravity, the viscosity of the slurry, the rate of lime feed, and the amount of agitation in the slaker. The size of sieve recommended for screening out insoluble matter is that which will pass nearly all of the insolubles in the lime slurry as it leaves the grit remover but will retain most of the larger particles that would be held in the grit remover.

5.5.2 *Apparatus.*

1. Mechanical stirrer, variable speed of 250–600 rpm fitted with a stainless-steel stirring rod. (The stirring mechanism used in the slaking-rate test serves very well for this test if the range of speed is as previously specified. See Sec. 5.4.2.)
2. Stainless-steel, 600-mL beaker.
3. Ring stand or support for holding the stirrer. (This should be fitted with a large clamp to hold the stainless-steel beaker firmly in place.)
4. Analytical balance.
5. Scoop capable of holding at least 125 g of quicklime.
6. Jaw crusher or a mortar and pestle.
7. US No. 30 sieve, 3 in. (76 mm) in diameter, with pan.

5.5.3 *Procedure.* Three tests should be made and the results averaged.

1. The stirring apparatus is essentially the same (it may be the same one) as that used in the slaking-rate test. Because the size of the material to be slaked is greater than that used for the slaking-rate test, a stainless-steel beaker is used because it is more shock resistant. Adjust the stirrer so that the distance from the rod to the bottom of the beaker is about $\frac{1}{2}$ in. (13 mm).

2. Crush the remaining 1 lb (0.4536 kg) of the sample delivered to the laboratory so that all of it just passes through a $\frac{3}{8}$ -in. sieve. Replace in the sample container and mix thoroughly.

3. Place the 3-in. (76-mm), 30-mesh sieve and pan in the drying oven and dry at 105°C (221°F) for 1 hr. Remove to desiccator, cool, and weigh to the nearest decigram.

4. Adjust the temperature of approximately 500 mL of water to 25°C (77°F) and add 375 mL to the stainless-steel beaker. Start the stirring mechanism at 250 rpm.

5. Weigh out 125 g of the crushed quicklime and add it to the water in the beaker.

6. As soon as the lime begins to slake well and the lumps disintegrate, slowly increase the stirring speed to 550–600 rpm. A temperature increase of 40°–50°C (72°–90°F) indicates that the sample is slaking satisfactorily. Continue to stir for 20 min, then stop the stirrer and remove from the beaker. If the lime tends to cake up in the corner between the side and bottom of the beaker, it should be dislodged using a long stirring rod, without stopping the stirrer.

7. Pour the lime slurry in small portions into the tared 30-mesh sieve, washing each portion through with a spray of tap water. Rinse the beaker into the sieve and wash the residue on the sieve with tap water. Remove the excess water below the sieve by blotting with a towel. Place the sieve on the pan and dry for 1 hr at 105°C (221°F). Remove to desiccator, cool, and weigh.*

5.5.4 Calculation.

$$\frac{\text{grams of residue}}{125} \times 100 = \text{percentage of objectionable insoluble material} \quad (\text{Eq 1})$$

Sec. 5.6 Notice of Nonconformance

If the quicklime or hydrated lime delivered to the purchaser does not meet the chemical, physical, safety, or security requirements of this standard, a notice of nonconformance shall be provided by the purchaser to the supplier within 10 days after receipt of the shipment at the point of destination. The results of the purchaser's test shall prevail unless the supplier notifies the purchaser within five 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. 5.1.3.2. In the event the results obtained by the supplier 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

* Some limes that disintegrate completely in a slaker will not disintegrate well when slaked in the laboratory under the conditions of this test. Large, soft particles of slaked lime may be broken up with a soft bristle brush and washed through the sieve. Hard particles of sand or core will not be affected by this treatment. A metal wire brush must not be used for this purpose. Any particles adhering to the brush must be washed into the sieve. A 5-in. or 8-in. (127-mm or 203.2-mm) diameter, 30-mesh sieve may be substituted for the 3-in. (76.2-mm) sieve. In this case, the sieve and pan do not have to be dried and tared. Simply collect and wash the insolubles as previously described. Dry the sieve and pan over a piece of glazed paper and brush the underside of the sieve with a soft bristle brush to dislodge any particles caught in the wire mesh. Add any particles that have passed through the sieve into the pan on handling or drying. Transfer to a small tared porcelain dish and weigh.

agreed on by both parties. The results of the referee analysis shall be accepted as final.

Material not complying with the requirements of this standard and the purchaser's documents may be rejected. Replacement and retesting shall be accomplished in accordance with the purchaser's documents.

Because the exact concentration of the active ingredient in specific shipments of some materials can vary within an acceptable range (thereby conforming to standard), the purchase documents between purchaser and supplier should address treatment of concentration variation.

SECTION 6: DELIVERY*

Sec. 6.1 Marking

6.1.1 *Required.* Each shipment of material shall be identified as to product, grade, net weight, name and address of the manufacturer, and brand name. Packages or containers shall show a lot number and identification of manufacturer. All markings on packaged, containerized, or bulk shipments shall conform to applicable laws and regulations, including requirements established by the US Occupational Safety and Health Administration (OSHA).

6.1.2 *Optional.* Packages may also bear the statement "Guaranteed by (name of manufacturer) to meet the requirements of ANSI/AWWA B202, Quicklime and Hydrated Lime," provided that the requirements of this standard are met.

Sec. 6.2 Packaging and Shipping

6.2.1 *Quicklime.* Quicklime, whether pebble, ground, or lump, may be shipped in bulk in railcars or trucks, super sacks, or in 80-, 90-, or 100-lb (36.3-, 40.8-, or 45.4-kg) net-weight multiwall paper bags.

6.2.2 *Pulverized lime.* Pulverized lime may be shipped in bulk in railcars or trucks, in super sacks, or in 50- or 80-lb (22.7- or 36.3-kg) net-weight multiwall paper bags.

6.2.3 *Hydrated lime.* Hydrated lime may be shipped in bulk in railcars or trucks, in super sacks, or in 50-lb (22.7-kg) net-weight multiwall paper bags.

* Governmental packaging and marking references reflect US requirements. Users of ANSI/AWWA B202 outside the United States should verify applicable local and national regulatory requirements. Because of frequent changes in these regulations, all parties should remain informed of possible revisions. Provisions of the purchaser's documents should not preclude compliance with applicable regulations.

6.2.4 *Net weight.* The net weight of all packages shipped shall not deviate from the recorded weight by more than ± 1.5 percent. If exception is taken to the weight of the material received, it shall be based on a certified unit weight of not less than 10 percent of all packages shipped and selected at random from the entire shipment.

6.2.5 *Security requirements for nonbulk shipments.* Packaged product shall be stored, shipped, and delivered in tamper-evident packaging as defined in Section 3[7], or an alternative method or methods may be agreed on by the manufacturer and purchaser that provide a reasonable assurance of protection against tampering.

6.2.6 *Security requirements for bulk shipments.* Bulk quantities of product shall be secured by employing one of the following security measures or a combination of measures:

6.2.6.1 *Seals.* Bulk quantities of product may be sealed with a uniquely numbered tamper-evident seal(s). The seal numbers shall be recorded and disclosed on shipping documents such as the bill of lading. Seals shall be inspected upon receipt of product by the purchaser and evidence of tampering or removal should be reported to the carrier and supplier.

6.2.6.2 *Chain of custody.* A continuous chain of custody may be maintained between the manufacturer and the purchaser during storage and shipment if so specified by the purchaser.

6.2.6.3 *Alternative methods.* An alternative method or methods may be agreed on by the manufacturer and purchaser that provide reasonable assurance of protection against tampering.

Sec. 6.3 Affidavit of Compliance

The purchaser may require either (1) an affidavit from the manufacturer that the quicklime or hydrated lime provided complies with applicable requirements of this standard, or (2) a certified analysis of the material at the time of delivery detailing the desired items.

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