



# Standard Specification for Quicklime, Hydrated Lime, and Limestone for Chemical Uses<sup>1</sup>

This standard is issued under the fixed designation C 911; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE—Note 9, Note 10, and Note 11 were editorially re-inserted February 2002.

## 1. Scope

1.1 This specification covers lime and limestone products suitable for chemical uses as shown in Table 1. The type designations signify the following:

Limestone, high-calcium—CL  
Limestone, dolomitic—DL  
Limestone, magnesian—ML  
Quicklime, high-calcium—CQ  
Quicklime, dolomitic—DQ  
Quicklime, magnesian—MQ  
Hydrated lime, high-calcium—CH  
Hydrated lime, dolomitic—DH  
Hydrated lime, magnesian—MH  
Hydrated lime, by-product—BH

NOTE 1—Lime is used in environmental systems when the control of factors influencing the environment such as gases, liquids and solids is required.

1.2 The buyer shall designate the use, as listed in Table 1, and may specify one or more of the type designations in 1.1.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- C 25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime<sup>2</sup>
- C 50 Methods of Sampling, Inspection, Packing, and Marking of Lime and Limestone Products<sup>2</sup>
- C 51 Terminology Relating to Lime and Limestone (as Used by the Industry)<sup>2</sup>
- C 110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone<sup>2</sup>
- C 400 Test Method for Quicklime and Hydrated Lime for Neutralization of Waste Acid<sup>2</sup>

## 3. Chemical Composition and Physical Properties

3.1 The requirements for quicklime, hydrated lime, and limestone for the designated end uses are as shown in Table 1,

and are on the basis of the weight of sample taken at the place of manufacture, except as noted in footnote B after the requirement. In this case, the requirement is on a moisture and carbon dioxide-free basis.

## 4. General Requirements

4.1 Quicklime shall be reasonably free of unslakable residues and shall be capable of disintegrating in water to form a suspension of finely divided material. Rapidity of slaking is generally a desirable quality.

4.2 The amount of residue shall not exceed that stated in the physical requirements of Table 1 or as agreed upon between the manufacturer and the purchaser (the residue is the amount of material retained on the screen).

## 5. Sampling and Inspection

5.1 Conduct the sampling, inspection, rejection, retesting, packing, and marking in accordance with Methods C 50.

NOTE 2—Rags are cooked for the manufacture of paper in a digester under steam pressure with lime or with lime and soda ash. They are then washed to eliminate as much of the noncellulose material as possible. A standard composition without rejection limits is specified for the reason that lime of either higher or lower total oxides, available lime, calcium oxide, or calcium hydroxide than the standard, may safely be used under suitable conditions for the purpose herein specified, depending primarily upon economic considerations. In the present state of the art, it is believed that the more serviceable type of specification for the product herein specified is that which defines a reasonable standard rather than one that fixes actual rejection limits. It is generally recognized that, other things being equal, lime meeting this standard is preferable to lime that does not, and lime surpassing the standard should be considered of premium quality.

NOTE 3—Lime is used in the “milk of lime” or “tank” system of sulfite pulp manufacture for making the cooking liquor. The milk of lime is held in solution or suspension in a series of tanks equipped with suitable agitators. The sulfur dioxide (SO<sub>2</sub>) is forced or drawn through these tanks successively. In some cases, the tanks are built on top of each other in the form of a tower. The contents of the first tank are drawn off when the liquor has reached a certain strength (3.5 to 6 % total SO<sub>2</sub>) and the contents of the second and third tanks progress to the first and second tanks respectively. The third tank is again charged with fresh milk of lime. There are other systems of absorption that provide for continuous instead of intermittent operation. The function of the lime is to furnish the base for the formation of the bisulfites of calcium and magnesium.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C07 on Lime and is the direct responsibility of Subcommittee C07.03 on Industrial Uses.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.01.

**TABLE 1 Limes and Limestones for Chemical Uses**

Use	ASTM Specification <sup>A</sup>	Notes Referenced	Approved Types of Lime or Stone	Chemical Requirements, %									
				CaO min	CaO, +MgO min	SiO <sub>2</sub> +Fe <sub>2</sub> O <sub>3</sub> , +Al <sub>2</sub> O <sub>3</sub> , max	MgO, max	CO <sub>2</sub> , max	SiO <sub>2</sub> + insoluble matter, max	Al <sub>2</sub> O <sub>3</sub> + Fe <sub>2</sub> O <sub>3</sub> , max	Available CaO, min	Fe <sub>2</sub> O <sub>3</sub> , max	Chemical Other
Cooking rags	C 45	2	CH	...	...	...	...	...	...	...	64.3 <sup>B</sup>	...	...
Cooking rags	C 45	2	CQ	...	...	...	...	...	...	...	90.0 <sup>B</sup>	...	...
Sulfite pulp	C 46	3	CQ, MQ	...	95.0 <sup>C</sup>	3.0 <sup>C</sup>	...	...	...	...	...	...	...
Sulfite pulp	C 46	3	CL, ML	...	95.0 <sup>C</sup>	3.0 <sup>C</sup>	...	...	...	...	...	...	...
Silica brick	C 49	4	CH	90 <sup>C</sup>	...	...	2.5 <sup>C</sup>	2.5	3.0 <sup>C</sup>	1.5 <sup>C</sup>	...	...	{ Free CaO ≤1.5
Silica brick	C 49	4	CQ	90 <sup>C</sup>	...	...	2.5 <sup>C</sup>	2.5	3.0 <sup>C</sup>	1.5 <sup>C</sup>	...	...	...
Water softening	C 53	5	CQ	...	...	...	...	...	...	...	90	...	...
Water softening	C 53	5	CH	...	...	...	...	...	...	...	68.1	...	...
Other water treatment uses	C 53	6	CQ, DQ, MQ	...	93.0	...	...	...	...	...	...	...	...
Other water treatment uses	C 53	6	CH, DH, MH	...	93.0 <sup>C</sup>	...	...	...	...	...	...	...	...
Carbide	C 258		CQ	92 <sup>C</sup>	...	...	1.75 <sup>C</sup>	4.0	2.0 <sup>C</sup>	1.0 <sup>C</sup>	...	0.5	P ≤ 0.02 <sup>C</sup> { S 0.2 <sup>C</sup> available { Ca (OH) <sub>2</sub> ≥90
Grease	C 259		CH	...	...	...	1.5	...	1.0	...	...	0.5	...
Calcium silicate product	C 415		CH	90 <sup>C</sup>	...	...	1.3 <sup>C</sup>	2.5	3.0 <sup>C</sup>	1.5 <sup>C</sup>	...	...	...
Calcium silicate product	C 415		CQ	90 <sup>C</sup>	...	...	1.3 <sup>C</sup>	2.5	3.0 <sup>C</sup>	1.5 <sup>C</sup>	...	...	...
Hypochlorite (bleach)	C 433	7	CH	...	...	...	...	...	...	...	68	0.3 <sup>C</sup>	...
Hypochlorite (bleach)	C 433	7	CQ	...	...	...	...	...	...	...	90	...	...
Industrial waste treatment	C 826	8	CH DH MH	...	{95.0 <sup>C</sup>	...	...	{5.0	...	...	...	...	BF > 0.72 <sup>D</sup> BF > 0.81 <sup>D</sup> BF > 0.74 <sup>D</sup>
Industrial waste treatment	C 826	8, 9	BH	...	90.0 <sup>C</sup>	...	...	...	...	...	...	...	...
Industrial waste treatment	C 826	8	CQ DQ MQ	...	{90.0	...	...	...	...	...	...	...	BF > 0.93 <sup>D</sup> BF > 1.06 <sup>D</sup> BF > 0.93 <sup>D</sup>
Industrial waste treatment	C 826	8, 10	CL DL ML	...	{90 <sup>C</sup>	...	...	...	...	...	...	...	BF > 0.45 <sup>D</sup> BF > 0.56 <sup>D</sup> BF > 0.48 <sup>D</sup>

<sup>A</sup> These specifications have all been incorporated into the current issue of this specification and are now discontinued. The discontinued specifications are available through Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704.

C 45 Specification for Quicklime and Hydrated Lime for Cooking of Rags in Paper Manufacture

C 46 Specification for Quicklime and Limestone for Sulfite Brick Manufacture

C 49 Specification for Quicklime and Hydrated Lime for Silica Brick Manufacture

C 53 Specification for Quicklime and Hydrated Lime for Water Treatment

C 258 Specification for Quicklime for Calcium Carbide Manufacture

C 259 Specification for Hydrated Lime for Grease Manufacture

C 415 Specification for Quicklime and Hydrated Lime for Calcium Silicate Products

C 433 Specification for Quicklime and Hydrated Lime for Hypochlorite Bleach Manufacture

C 826 Specification for Lime and Limestone Products for Industrial Waste Treatment

<sup>B</sup> Standard composition.

<sup>C</sup> On a nonvolatile basis.

<sup>D</sup> BF means Basicity Factor.

NOTE 4—In the manufacture of silica brick, silica in the form of massive quartzite or quartz conglomerate is ground until the particles are less than ¼ in. (6 mm) in size. Lime in the form of either slaked or hydrated lime is then added in quantities varying from 1.5 to 3.0 % calcium oxide (CaO), with sufficient water to produce about 5 to 7 % moisture content, and the shapes are molded and dried. They are then burned in downdraft or tunnel kilns until most of the quartzite has been converted into tridymite or cristobalite.

NOTE 5—In the softening of water for municipal and industrial supplies, lime is used alone or with coagulant aids to produce a precipitate that assists in the clarification of water, removal of bacteria, and removal of hardness. Lime and soda ash may be used together for softening water. The lime serves as a chemical reagent in water softening. The only useful

constituent of the lime is the calcium oxide content of the quicklime or hydrated lime capable of reacting with the other chemicals in the water or added to it. Inert material, besides reducing the value in proportion to its amount, also makes more sludge to be disposed of for a given amount of chemical action and thus reduces the capacity of the equipment in which it is used.

NOTE 6—In addition to water softening, lime is also used for silica removal from boiler feed-water, and for color removal and clarification of water for municipal and industrial supplies, for most such applications, high-calcium lime is preferred. However, for silica removal from boiler feedwater, dolomitic lime should be employed.

NOTE 7—In manufacture of calcium hypochlorite bleach, lime hydrate in water suspension is reacted with chlorine. Lime hydrate suitable for this

application should be rapidly reactive, low in sludge-forming impurities, and particularly low in iron oxide, that may catalyze bleach decomposition.

NOTE 8—When determining the quantity of liming material for the neutralization of liquid acidic wastes, use is made of an acid value–basicity factor relationship. Acid value and basicity factor test methods are in the Appendix. Calculate the acid value–basicity factor relationship as follows:

$$\text{Acid Value} \times \frac{56.08}{98.08} \times \frac{1}{\text{Basicity Factor}} = \text{grams of lime or limestone product per litre of acidic waste} \quad (1)$$

NOTE 9—When agreed upon between the manufacturer and the purchaser, the methods for neutralization coefficient as given in Test Method C 400.

NOTE 10—The chemical requirements for Type BH, shall be determined by agreement between the manufacturer and the purchaser.

NOTE 11—For limestone, sizing will affect the basicity factor results and size as shipped shall be determined by agreement between the manufacturer and the purchaser.

## 6. Test Methods

6.1 The chemical analyses shall be made in accordance with Test Methods C 25.

6.2 The physical tests shall be made in accordance with Test Methods C 110.

## 7. Keywords

7.1 calcium oxide; calcium silicate; chemical uses; dolomitic hydrated lime; dolomitic lime; dolomitic limestone; dolomitic quicklime; high calcium hydrated lime; high calcium limestone; high calcium quicklime; hydrated lime; hypochlorite bleach; industrial uses; industrial waste; lime; limestone; lime by-product; magnesian hydrated lime; magnesian limestone; magnesian quicklime; quicklime; silica brick; sulfite pulp

## APPENDICES

### (Nonmandatory Information)

#### X1. TEST METHOD FOR FREE CALCIUM OXIDE IN HIGH-CALCIUM HYDRATED LIME

##### X1.1 Scope

X1.1.1 This test method covers the determination of the amount of free calcium oxide (CaO) in high-calcium hydrated lime capable of being hydrated by steam at atmospheric pressure.

##### X1.2 Summary of Test Method

X1.2.1 This test method is based on the principle of gain in weight of CaO when it is hydrated to form calcium hydroxide (Ca(OH)<sub>2</sub>).

X1.2.2 The sample is dried, subjected to steam at atmospheric pressure, again dried, and the gain in weight calculated to CaO.

##### X1.3 Apparatus

X1.3.1 *Drying Oven*, thermostatically controlled, CO<sub>2</sub>-free atmosphere.

X1.3.2 *Analytical Balance*.

X1.3.3 *Steam Bath*, as shown in Fig. X1.1.

##### X1.4 Procedure

X1.4.1 Weigh a clean, dry, 10-mL Erlenmeyer flask on an analytical balance.

NOTE X1.1—Once started, complete the test without interruption.

X1.4.2 Add to the flask, by means of a widestem funnel, 3

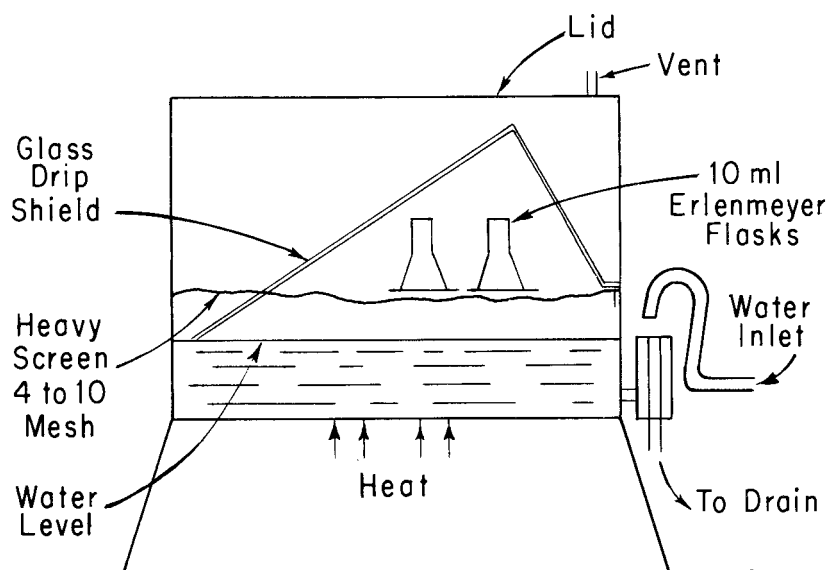


FIG. X1.1 Steam Chamber

to 5 g of the lime to be tested. Reweigh to get the exact sample weight.

NOTE X1.2—The flask should be kept stoppered at all times, except when weighing, drying, or steaming.

X1.4.3 Place the flask in the drying oven that has been previously heated to 120°C, and maintain at this temperature for 30 min. Remove, stopper, cool in a desiccator, and weigh.

NOTE X1.3—Oven atmosphere can be kept CO<sub>2</sub> free by placing therein a container of soda lime, quicklime, or other suitable CO<sub>2</sub>-absorbing medium.

X1.4.4 Place the flask and the sample in a vigorously boiling steam bath and steam for 30 min. Protect the flask in the steam bath by a drip shield during the steaming period. Remove the flask to the oven, dry for 30 min at 120°C, stopper, cool in a desiccator, and weigh.

X1.4.5 Record all weighings to the fourth decimal place.

## X1.5 Calculation

X1.5.1 Calculate the percentage of water and CaO as follows:

$$\begin{aligned} \text{Free water, \%} &= [(W_1 - W_2)/S] \times 100 & (X1.1) \\ \text{Free CaO, \%} &= \frac{(W_3 - W_2) \times 3.114}{S} \times 100 \end{aligned}$$

where:

- $W_1$  = weight of sample and flask before drying,
- $W_2$  = weight of sample and flask after drying,
- $W_3$  = weight of sample and flask after steaming and drying, and
- $S$  = weight of sample.

## X2. TEST METHOD FOR DETERMINING ACID VALUE-BASICITY FACTOR RELATIONSHIP

### X2.1 Scope

X2.1.1 This test method covers determination of the quantity of liming material required for the neutralization of liquid acid wastes.

### X2.2 Summary of Test Method

X2.2.1 The relationship is based on the basicity factor of the liming material and the acid value of the liquid acidic waste.

X2.2.2 The basicity factor of a liming material is a measure of the alkalinity that avoids dependence on chemical analysis. Basicity factor is grams of calcium oxide equivalent per gram of lime or limestone product and may be used for comparing the relative neutralizing values of the various liming materials for treating acid wastes.

X2.2.3 The acid value is an expression of grams of sulfuric acid equivalent per litre of acid waste.

X2.2.4 The determination is related on a stoichiometric basis to lime neutralization requirements of a liquid acid waste. Unless otherwise stated, neutralization is interpreted to occur at a pH of 8.40.

### X2.3 Procedure

X2.3.1 *Basicity Factor*—Weigh 1 g ± 1 mg of the sample that has been prepared to pass a No. 100 (150-µm) sieve and transfer to a 500-mL Erlenmeyer flask containing approximately 20 mL of cold water. (For quicklime samples, heat to boiling to ensure complete slaking). Add from a buret 100 mL of 0.5000 *N* sulfuric acid and stopper with a two-hole rubber stopper. Place the flask on a hot plate and boil for 15 min. (Glass beads may be added to prevent bumping.) Remove the flask from the hot plate and cool in water. Add several drops of phenolphthalein indicator solution and titrate the excess acid with 0.5000 *N* potassium hydroxide solution. Calculate the basicity factor as follows:

$$\text{Basicity factor} = [(V_1N_1 - V_2N_2)/W] \times 0.028 \quad (X2.1)$$

where:

- $V_1$  = H<sub>2</sub>SO<sub>4</sub>(mL) required for titration of the sample,
- $N_1$  = normality of H<sub>2</sub>SO<sub>4</sub>,
- $V_2$  = KOH solution (mL) required for titration of the excess acid,
- $N_2$  = normality of KOH solution, and
- $W$  = sample (g).

NOTE X2.1—A water-cooled condenser with a tapered, ground-glass joint and a magnetic stir plate may be used during the boiling step.

X2.3.2 *Acid Value*—Pipet 10 mL of the sample of acidic waste into a 250-mL Erlenmeyer flask. (This quantity may be increased or decreased depending on the strength of the acidic waste.) Add an excess of 25 to 30 mL of 0.5000 *N* potassium hydroxide solution and boil for 3 min. Filter through a small Büchner funnel with the aid of vacuum. Wash the residue on the funnel with water. Add several drops of phenolphthalein indicator solution to the filtrate and titrate the excess potassium hydroxide with 0.5000 *N* sulfuric acid solution. Calculate acid value as follows:

$$\text{Acid value} = [(V_1N_1 - V_2N_2)/V] \times 0.049 \quad (X2.2)$$

where:

- $V_1$  = KOH solution (mL) required for titration of the sample,
- $N_1$  = normality of KOH solution,
- $V_2$  = H<sub>2</sub>SO<sub>4</sub>(mL) required for titration of the excess KOH solution,
- $N_2$  = normality of H<sub>2</sub>SO<sub>4</sub>, and
- $V$  = sample (mL).

X2.3.3 *Relationship of Acid Value to Basicity Factor*—Calculate the acid value–basicity factor relationship as follows:

$$\begin{aligned} \text{Acid value} \times \frac{56.08}{98.08} \times \frac{1}{\text{basicity factor}} & \\ &= \text{lime (g) or limestone product per litre of acidic waste.} \end{aligned} \quad (X2.3)$$

NOTE X2.2—When agreed upon between the manufacturer and the purchaser, Test Method C 400 may also be used.



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