



May 5, 2008

City Of Ann Arbor
Invitation To Bid
Water And Wastewater – High Calcium Quicklime

BID NO. ITB-3950
DUE: Tuesday, May 27, 2008

Sealed bids will be received **(original plus one (1) copy)** by the Purchasing Office, 5th Floor of City Hall, 100 N. Fifth Ave., Ann Arbor, MI 48104, on or before 2:00 p.m., Tuesday, May 27, 2008, at which time they will be opened and publicly read aloud. All bids become the property of the City of Ann Arbor.

Specifications are attached.

We have enclosed our Human Rights Work Utilization Forms to be filled out and returned with your bid or you may submit an updated EEO-1 with your bid. Submittal of these forms with your bid is not a requirement of this bid; however, the first and second low bidders are required to complete a contract compliance form or an acceptable equivalent by no later than 5:00 p.m. of the work day following the opening.

No bidder may withdraw his bid within 60 days after the date set for the opening thereof.

The City of Ann Arbor reserves the right to accept any bid, to reject any bid or all bids, to waive irregularities and/or informalities in any bid, and to make the award in any manner deemed in the best interest of the City.

Specifications referred to herein are used to indicate the desired type, quantity and quality of chemical. An alternate may be offered if deviations from specifications are minor and if all deviations are properly outlined on a separate sheet. Failure to outline all deviations may be grounds for rejection of your bid (see attached specifications).

The decision of the City of Ann Arbor's authorized representative, shall be final as to what constitutes acceptable deviations from specifications.

All envelopes must be marked, "QUICKLIME" and include the bid number, the date due and the time due. We cannot be responsible for any bid not marked as stated above.

City of Ann Arbor

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MATERIAL SAFETY DATA SHEET: Each vendor shall provide the City of Ann Arbor with a complete copy of the U. S. Department of Occupational Safety & Health Administration, Material Safety Data Sheets, (form OSHA-20) for each product you are bidding on.

NSF/ANSI STANDARD 60: The City of Ann Arbor Water Treatment Plant requires an affidavit from the manufacturer or bidder that the quicklime furnished under this contract conforms to NSF/ANSI Standard 60 and meets or exceeds this standard.

COPIES OF BID: The bidder will be required to furnish the original bid plus one (1) copy.

QUANTITY: These quantities shown are for estimating purposes only, not a guarantee of actual usage.

ITEM NO. 1 HIGH CALCIUM QUICKLIME

QUANTITY - APPROXIMATELY 7,300 TONS

	<u>PRICE</u>
QUICKLIME AS SPECIFIED	\$ _____ TON
FREIGHT	\$ _____ TON
TOTAL DELIVERED COST	\$ _____ TON

Please indicate surcharges, and other additional freight charges such as assessed for “Frost Laws” load restrictions.

Additional Freight Costs during Road Weight Restrictions: \$ _____

All shipments will be f.o.b. destination, freight prepaid.

Tech. Specifications on pages 9 thru 11; testing requirements on pages 12 thru 16.

Subject to the terms and conditions of the City of Ann Arbor purchase order.

REMARKS:

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CONTRACT PERIOD: Twelve (12) month period, to start approximately July 1, 2008 through June 30, 2009.

Day of bid opening a 1/4 lb. sample and a typical analysis of the product the bidder proposes to furnish will be supplied to the Purchasing Office, 100 N. Fifth Ave., Ann Arbor, Michigan 48104.

CONTACT PERSONS: If there are any questions concerning the attached specifications, please contact Larry Sanford, Assistant Manager, Water Treatment Plant at (734) 994-2840, or Ron Reese, Assistant Manager, Wastewater Treatment Plant at (734) 971-4834 Monday through Friday, between the hours of 8:30 a.m. through 3:00 p.m.

AWARD: The award will be to the lowest total bid, including freight costs when "frost laws" are in effect or any other factors deemed to be in the best interest of the City of Ann Arbor (including but not limited to material characteristics as they relate to unloading and feed systems at the water and wastewater plants). The City of Ann Arbor reserves the right to reject low bids which do not meet specifications.

NOTE: Previous experience and performance may be a factor in making the award.

NOTE: If cost exceeds \$10,000.00 this bid will require Human Rights and if exceeds \$25,000.00 will require City Council approval. Therefore, the bid could be approved after the date stated above. The purchase order will be issued as soon thereafter as possible.

RENEWAL: The proposed agreement may be renewed for up to two (2) one (1) year periods provided that by 60 days prior to end of the contract both parties agree to an extension under the same terms and conditions as exist in the current contract. No further renewal shall be made.

EXTENDED CONTRACT PERIOD(S): Two one (1) year renewals starting July 1, 2009, through June 30, 2010; and July 1, 2010 through June 30, 2011.

DELIVERIES: Supply and transport F. O. B. Destination, Freight Prepaid to the City of Ann Arbor, Wastewater Treatment Plant, and Water Treatment Plant location and/or designated area on an "AS NEEDED BASIS". Please also indicate surcharges, and any other additional freight charges such as that assessed for "**FROST LAW**" load restrictions appropriately (see page 3).

ASSIGNMENTS: The vendor agrees not to assign or transfer this contract or any part thereof without the written consent of the City of Ann Arbor, acting through its

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authorized representative. Any unauthorized assignment may subject the contractor to immediate termination.

CONTRACT COMPLIANCE: The successful bidder must comply with the city of Ann Arbor's Non-Discrimination Regulations (Chapter 112, Section 9:161 of the City Code) before award and at all times during the term of this proposed contract and/or agreement.

ERRORS/OMISSIONS/DISCREPANCIES: Any errors, omissions or discrepancies in the specifications discovered by a prospective contractor and/or service provider shall be brought to the attention of Larry Sanford, Assistant Manager, Water Treatment Plant at (734) 994-2840 or, Ron Reese, Assistant Manager, Wastewater Treatment Plant at (734)971-4834 as soon after discovery as possible. Further, the contractor and/or service provider shall not be allowed to take advantage of errors, omissions or discrepancies in the specifications.

INSURANCE REQUIREMENTS: The successful Provider shall be required to procure and maintain during the life of this Contract, inclusive of any renewal thereof, such insurance policies, including those set forth below, as will protect itself from all claims for bodily injuries, death or property damage which may arise under this Contract; whether the acts were made by the Provider or by any subcontractor or anyone employed by them directly or indirectly. The following insurance policies are required:

- A. Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

- Bodily Injury by Accident - \$500,000 each accident
 - Bodily Injury by Disease - \$500,000 each employee
 - Bodily Injury by Disease - \$500,000 each policy limit

- B. Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 07 98. The City of Ann Arbor shall be an additional insured. There shall be no added exclusions or limiting endorsements including, but not limited to: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further, the following minimum limits of liability are required:

- \$1,000,000 Each occurrence as respect Bodily Injury Liability or Property Damage Liability, or both combined.
 - \$2,000,000 Per Job General Aggregate
 - \$1,000,000 Personal and Advertising Injury

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- C. Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 07 97. The City of Ann Arbor shall be an additional insured. There shall be no added exclusions or limiting endorsements. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. Further, the limits of liability shall be \$1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

- D. Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of \$5,000,000.

Insurance required under this Contract shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the successful Provider agrees to waive any right of recovery by its insurer against the City. In the case of all Contracts involving on-site work, the successful provider shall provide to the City before the commencement of any work under this Contract documentation demonstrating it has obtained the above mentioned policies. Documentation must provide and demonstrate an unconditional 30 day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number; name of insurance company; name and address of the agent or authorized representative; name and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which shall be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified. An original certificate of insurance may be provided as an initial indication of the required insurance, provided that no later than 21 calendar days after commencement of any work the successful Provider supplies a copy of the endorsements required on the policies. Upon request, the successful Provider shall provide within 30 days a copy of the policy(ies) to the City. If any of the above coverages expire by their terms during the term of this Contract, the successful Provider shall deliver proof of renewal and/or new policies to the Administering Department at least ten days prior to the expiration date.

Any insurance provider of successful Provider shall be admitted and authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-admitted insurance companies are not acceptable unless approved in writing by the City.

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Contractor will maintain all required insurance of the parties as specified during the existence of this agreement, including renewals.

INDEMNIFICATION: To the fullest extent permitted by law, the contractor shall indemnify, defend and hold the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney's fees resulting or alleged to result, in whole or in part, from any negligent, grossly negligent, reckless and/or intentional wrongful or tortious acts or omissions by the contractor or its employees and agents occurring in the performance of this agreement.

DEFAULT: If defined as the failure of the bidder to fulfill the obligations of the contract, including but not limited to: failure to deliver on time or the unauthorized substitution of articles other than those quoted and specified on the contract; or failure to deliver specified quantities (repetitive shortages). If continued abuse of any or all of the above conditions persist, the City of Ann Arbor will notify the contractor in writing. The contractor will be given ten (10) days to correct this "Default" condition. Failure to do so within the specified period will result in the City's canceling the contract and procuring the articles or services from other sources and hold the contractor responsible for any excess cost occasioned thereby.

The City shall have the privilege, with or without cause, to cancel and annul this agreement at any time on 10 days notice to the bidder. The City shall provide notice of termination by first-class mail to the bidder at the address listed in the bid documents. If notice is provided by first-class mail it shall be considered delivered when placed, postage prepaid, in the U.S.Mail.

If the contract is terminated for reasons other than breach of contract by the bidder, the bidder shall be compensated for services provided prior to the date of the notice of termination.

PLEASE CHECK: We have read the attached specifications thoroughly?

Yes No

Are all exceptions to the attached specifications properly outlined?

Yes No

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INVOICE TERMS: Discount of ___% or \$_____ will be allowed for payment of invoice thirty (30) days from day of delivery and acceptance.

OTHER TERMS: Less than 30 days, E.O.M., Proximo, etc., will not be considered in determining award of contract.

CERTIFICATION: WE HEREBY CERTIFY THAT THE "QUICKLIME" DELIVERED TO THE CITY OF ANN ARBOR MEETS OR EXCEEDS YOUR SPECIFICATIONS IN EVERY RESPECT.

Authorized Representative's Signature

Printed

The City of Ann Arbor reserves the right to accept any bid, to reject any bid or all bids, to waive irregularities and/or informalities in any bid, and to make the award in any manner deemed in the best interest of the City.

The undersigned agrees that if the bid is accepted by the City of Ann Arbor, a binding contract will be in effect for the delivery of the goods in accordance with the bid.

All envelopes must be clearly marked with the bid number, "QUICKLIME", due date and time. We cannot be responsible for any bid not marked as stated above.

RETURN BID TO:

CITY OF ANN ARBOR
PURCHASING OFFICE
P.O. BOX 8647
ANN ARBOR, MI 48107

CITY OF ANN ARBOR
PURCHASING OFFICE
100 N. FIFTH AVENUE
ANN ARBOR, MI 48104

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COMPANY

ADDRESS

CITY

STATE

ZIP

Company's Representatives

Signature

Printed

Date

Title

Phone Number

Fax Number

Federal I.D. Number

CITY OF ANN ARBOR

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STANDARD SPECIFICATIONS FOR QUICKLIME

The following standard incorporates the criteria and specifications of ANSI/AWWA B202-93 & B202a-97 and any applicable National Sanitation Foundation (NSF) specification.

SECTION 1: GENERAL INFORMATION

Sec. 1.1 Scope

This standard covers pebble high calcium quicklime for the use of treating municipal water supplies. It sets forth the tests, guarantees and other conditions pertaining thereto. The chemical is used as a softening agent, ie; the removal of calcium and magnesium from raw water.

The quicklime shall meet the following requirements. Failure to meet any of them will be sufficient cause for rejection.

Sec. 1.2 Definition

Quicklime is the product resulting from the calcination of limestone, shell, or equivalent. This standard covers only limes which composed mainly of calcium oxide. Special limes such as dolomitic limes are not subject to the specifications contained herein. Quicklime consists primarily of calcium oxide (CaO), and to a lesser extent magnesium oxide (MgO). Hydrated lime is a finely divided powder which results from the hydration of quicklime with enough water to satisfy it's chemical affinity.

The following definitions shall apply in this standard:

Manufacturer: *The party that produces quicklime, as covered in this standard.*

Vendor: *The party that entering into a contract or agreement to ship and supply quicklime in accordance to this standard.*

Purchaser: *The party entering into a contract or agreement to purchase quicklime (typically from the Vendor) in accordance with this standard. In this case, The City of Ann Arbor, henceforth known as the City.*

Sec. 1.3 Compliance

The City requires (1) an affidavit of compliance from the manufacturer or vendor that the quicklime furnished under the purchaser's specification complies with all applicable requirements of this standard; (2) a certified analysis of the quicklime furnished by either the vendor or the manufacturer and (3) an affidavit of compliance with NSF/ANSI standard 60/61.

Sec. 1.4 Purchase of Quicklime

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The purchase of quicklime shall be based on 93 percent available calcium oxide (CaO). Where the calcium oxide content of any shipment exceeds 93%, the City will pay a bonus of 1% of the contract price for each 1% of calcium oxide in excess of 93%, unless waived by the bidder. If the calcium oxide content falls below 93%, the City shall deduct a penalty of 1% of the contract price for each 1% of calcium oxide content that falls below 93% down to 91% calcium oxide. In the event that any shipment has a calcium oxide content of less than 91%, the City shall deduct an additional penalty of 5% of the contract price for each 1% of calcium oxide content below 91%.

The quicklime provided shall be of the "quick-slaking" type and shall disintegrate into a solution of finely divided particles upon addition to water. This reaction shall be evidenced by a production of heat, raising the temperature of the solution to 40⁰ C in three minutes, and the entire slaking reaction should be complete in approximately ten minutes. Slaking of the quicklime shall not produce an objectionable amount of undissolved or insoluble material, and shall not in any way interfere with the feeding machinery used to feed quicklime.

Sec. 1.5 Basis for Rejection

Failure of the material to meet the specifications of this standard shall be considered grounds for rejection of the material.

The basis of rejection shall be the following:

Available CaO content less than 80 percent. This percentage represents a minimum chemical requirement.

Failure of the quicklime to produce more than a 10⁰ rise in temperature in three minutes.

The production of more than five percent insoluble material upon slaking.

Greater than 5% passes through a ¼" seive. (i.e. >5% dust).

Determination of impurities in excess of those specified in section 2.3 of this standard.

Sec. 1.6 Notice of Nonconformance

Notice of Nonconformance with a shipment, as caused by the failure of the material to meet the specifications contained herein, shall be provided to the vendor within 15 calendar days after receipt of the shipment in question. The purchaser's results shall prevail unless the vendor 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 one of the samples taken in accordance to section 4 of this standard to the vendor. In the event that the results determined by the vendor do not agree with those of the purchaser, a second sample, as

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above, shall be forwarded to a referee laboratory agreed upon by both parties. The results of the referee laboratory shall be accepted as final. The cost of the referee analysis shall be paid by the vendor if the material in question is found not to meet the specifications of this standard, and by the purchaser if the material does meet the specifications of this standard.

If the material does not meet the requirements of the purchaser, the vendor shall assume full responsibility for the removal of the material from the premises of the purchaser or the point of destination unless some agreement is reached between the purchaser and the vendor that a price adjustment can be made.

SECTION 2: REQUIREMENTS

Sec. 2.1 Physical Requirements

The lime supplied shall be three quarter inch pebble lime and in no case shall it exceed the following limits: None shall be retained on a one inch sieve and not more than 5 % shall pass a one quarter inch (0.25") sieve. The lime shall be of the medium-burned or hard-burned type. Soft- burned lime is unacceptable to the water plant due to severe dusting problems..

Sec. 2.2 Chemical Requirements

Quicklime supplied under this standard shall be freshly burned and be free of carbonate solids and siliceous residue. Insoluble material shall not exceed 5 percent by weight.

Sec. 2.3 Impurities

The quicklime supplied under this standard shall contain no inorganic or organic material in quantities capable of producing deleterious or injurious effects on the health of persons consuming water that has been properly treated with lime and/or lime products.

The quicklime shall be certified as meeting the specifications of American National Standards Institute/National Sanitation Foundation Standard 60 (ANSI/NSF 60) as revised August 13, 1999. A copy of the ANSI/NSF 60 letter of acceptance of the quicklime proposed to be supplied shall accompany the prospective vendor's bid. Failure to comply with this requirement may, at the discretion of the City, be considered grounds for disqualification of the vendor's bid. It is the responsibility of the supplier to inform the City the NSF certification has been revoked or lapsed within 24 hours of the time the supplier receives verbal or written notification. Loss of certification shall constitute sufficient grounds for immediate termination of the contract.

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SECTION 3: SAMPLING

Sec. 3.1 Sampling Method

To minimize contact with air, samples shall be taken expeditiously **at the point of destination**. Samples shall be collected as per AWWA B202-93 and B202a-97 or any other applicable standard. One three pound sample shall be collected from each shipment. It shall be split into four samples sealed in airtight glass or metal containers, one for the immediate analysis by the purchaser, and three for storage in the case that the material is found to be unacceptable.

Sec. 3.2 Shipping and Delivery

Quicklime shall be shipped in truckload lots with a 20 ton minimum (except during periods of "frost law" restrictions). Trucks used for transportation shall be of a highly specialized type, which is especially adapted for this particular commodity. The body shall be designed to prevent leakage in transit; shall give protection against precipitation, condensation, contamination and corrosion. The closed truck shall have suitable truck mounted pressurized pneumatic unloading equipment, including sufficient lengths of hose, capable of delivering the quicklime into the storage bins of the City of Ann Arbor, Water Treatment Plant at 919 Sunset Road or Waste Water Treatment Plant at 49 S. Dixboro Road. The lime shall be unloaded using a maximum of 8 psi and a maximum of 750 cfm of air. The truck and its compressor shall be equipped with a muffler or other suitable noise suppression equipment. The City shall accept delivery between 0900 hours and 1500 hours or as arranged by the purchaser.

The City will not pay detention charges for unloading times that are less than three (3) hours nor for any times over three hours in length where the City is not the cause of the delay.

The net weight of the shipment shall not deviate from the recorded net weight by more than 1.5 percent. The City may require that the vendor supply, on receipt of the shipment, a certificate of certified weighers attesting to the actual weight of the shipment in question.

If the reported weight of the shipment is found to be less than the actual weight, using any of the methods described above or as agreed to by the City and the vendor, the City may accept the shipment, reject the shipment, or agree to a price adjustment accounting for the weight deficiency.

Sec. 3.3 Marking

Each shipment shall be labeled in accordance to current Department of Transportation standards. These labels may include such information as contents, lot number, net weight, manufacturer and any applicable safety warnings.

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SECTION 4: TESTING METHODS

Sample collection, testing methods and any other relevant tests shall be performed in accordance with the AWWA Standard for Quicklime, ANSI/AWWA B202-93 and B202a-97. Modifications of these procedures may be used only if they result from mutual agreement between the vendor and the purchaser.

Sec. 4.1 Preparation of Samples

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

4.1.1 *Sieve analysis.* The 2.5-lb (1.1-kg) sample taken for sieve analysis (Sec.3.1.3.3) needs no further preparation. The screen analysis should be made as quickly as possible after the sample is taken.

4.1.2 *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. 3.1.3.2. The following procedure shall be used:

4.1.2.1 Crush approximately half of the 2-lb (0.9-kg) sample so that it passes 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.

4.1.2.2 Mechanically pulverize a 50-g portion of the crushed sample until it passes 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 glass container.¹

4.1.3 *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. 3.1.3.2. As described in Sec. 4.1.2.2, a 50-g portion of sample shall be mechanically pulverized so that it passes a No. 100 US sieve, mixed, and placed in an airtight, moisture-proof glass container.

4.1.4 *Composite sample.* In the case of a composite sample, the test sample shall be worked up from the container (Sec. 3.1.1.2)

¹ A 2-oz, wide mouthed bottle, similar to that used for bacteriologic samples of water, is convenient for storing the pulverized sample, preferably 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.

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

Sec. 4.2 Determining Available Calcium Oxide in Quicklime and Hydrated Lime²

Available calcium oxide content in quicklime and hydrated lime is that constituent that enters into the reaction under the conditions of the rapid sugar method (Sec. 4.2.2(2)). Several modifications in test procedures have been suggested and used by different workers. The method adopted for this standard has had wide use and will give satisfactory and reproducible results if the procedure is followed carefully. In this procedure, the term “lime sample” shall mean one that has been ground so that all of it passes a 100-mesh sieve, and the temperature at titration shall be room temperature, 20-25° C (68-77°F).

4.2.1 Reagents.

1. 0.1782N hydrochloric acid solution. Prepare a solution containing 15.7 mol Hal (specific gravity 1.19) per liter. This solution will be slightly stronger than necessary. Standardize the Hal 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 90mL of the standard Hcl solution. One mL of the standard Hcl solution is equivalent to 1.0 percent CaO or 1.32 percent Ca(OH)₂ 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. Carbon dioxide-free distilled water.

4. Cane sugar.

4.2.2 Procedure.

1. Weigh 0.5 g of the pulverized sample and brush into a 250mL Erlenmeyer flask containing about 10mL of CO₂-free distilled water, and immediately stopper the flask loosely with a rubber stopper. (It is particularly important to have a small amount of water in the flask before adding the sample. This is especially true in the case of 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

²Adapted from ASTM C25, Standard Methods of Chemical Analysis of Limestone, Quicklime, and Hydrated Lime; available from American Society for Testing and Materials 1916 Race St., Philadelphia, PA 19103.

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more rapid solution. In the case of quicklime, some slaking action probably occurs to facilitate the dispersion and solution.)

2. 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. Add about 50 mL of CO₂-free distilled water, and then approximately 15-17 g of pure cane sugar. Stopper the flask, swirl, and let stand for 15 min to react. Reaction time should not be less than 10 min, nor more than 20 min. Swirl at 5-min intervals during reaction. Remove stopper, add four to five 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 $x 1 \frac{1}{2}$ in. (10 x 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 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.

4.2.3 *Calculation for CaO.* The number of milliliters of standard acid solution used in step 4 equals the percentage of available calcium oxide in the sample.

4.2.4 *Procedure for hydrate.* The procedure for determining Ca(OH)₂ is the same as for CaO, except that cold CO₂-free distilled water is used and the boiling and cooling procedures are omitted.

4.2.5 *Calculation for Ca(OH)₂.* The number of milliliters of standard acid solutions used in step 4 multiplied by 1.32 is the percentage of available calcium hydroxide in the sample.

Sec. 4.3 Slaking-Rate Test for Quicklime³

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:

³Adapted from ASTM C110, Physical Testing of Quicklime, Hydrated Lime, and Limestone.

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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.

4.3.1 *Principle.* Samples of quicklime may be slaked under controlled conditions with reproducible results insofar as the temperatures attained after any time intervals are concerned. Because some slight variations in temperature at the various time intervals can occur, it is recommended that three consecutive slaking-rate tests be made on each sample and an average temperature at each time interval 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.

4.3.2 *Apparatus.*

1. Mechanical stirrer, with a speed of 400 rpm + 50 rpm, fitted with a special stainless-steel rod. A rheostat or high-voltage transformer may be necessary for controlling the stirring speed.

2. A 665-mL, heat-resistant glass dewar flask, 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.

8. Stopwatch.

9. Speed indicator or tachometer.

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