LIME

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In 2003, U.S. production of lime was 19.2 million metric tons (Mt) (21.2 million short tons), an increase of 1.3 Mt (1.4 million short tons) compared with 2002 (table 1). This more than made up for the decrease reported in 2002, although production was still below the quantity reported in 2000. The value of lime sold or used was $1.24 billion.

The term lime as used throughout this chapter refers primarily to six chemicals produced by the calcination of high-purity calcitic or dolomitic limestone followed by hydration where necessary. There are two high-calcium forms—high-calcium quicklime (calcium oxide, CaO) and high-calcium hydrated lime [calcium hydroxide, $Ca(OH)_2$]. There are four dolomitic forms—dolomitic quicklime (CaO•MgO), dolomitic hydrate type N [$Ca(OH)_2$•MgO], dolomitic hydrate type S [$Ca(OH)_2$•$Mg(OH)_2$], and refractory dead-burned dolomite (CaO•MgO). Lime also can be produced from a variety of calcareous materials, such as aragonite, chalk, coral, marble, and shell. It also is regenerated (produced as a byproduct) by paper mills, carbide plants, and water-treatment plants. Regenerated lime, however, is beyond the scope of this report.

Legislation and Government Programs

The section 201 (Trade Act of 1974) import tariffs on various types of steel, which went into effect on March 20, 2002, were repealed by the President in early December 2003 (White House, 2003§[1]). Steel is lime's largest market and a strong domestic steel industry is important to U.S. lime companies, particularly those in the Midwest.

Production

Domestic production data for lime are derived by the U.S. Geological Survey (USGS) from a voluntary survey of U.S. operations. The survey is sent to primary producers of quicklime and hydrate, but not to independent hydrators that purchase quicklime for hydration so as to avoid double counting. Quantity data are collected for 28 specific and general end uses, and value data are collected by type of lime, such as high-calcium or dolomitic. Because value data are not collected by end use, value data listed in table 4 are determined by calculating the average value per metric ton of quicklime sold or used for each respondent and then multiplying it by the quantity of quicklime that the respondent reported sold or used for each end use. The table lists the total quantity sold or used for an end use and the total value of the quicklime and hydrate sold or used for that end use calculated as described above. The same methodology is used to calculate the value of hydrate sold and used listed in table 5.

In 2003, of the 100 lime operations to which an annual survey form was sent, 4 were closed or idle all year, and of the remaining 96, 83 responded to the survey, representing 97% of the total sold or used by producers. Production data for the 13 nonrespondents were estimated based on prior-year production figures and other information. There were 76 plants in the United States that produced high-calcium quicklime and 23 plants that produced dolomitic quicklime. Excluding independent hydrators (which are not surveyed), high-calcium hydrate was produced at 40 facilities, and dolomitic hydrate, at 7 facilities. Most hydrators are actually collocated with lime plants.

Lime is a basic chemical that was produced as quicklime at 89 plants in 32 States and Puerto Rico (table 2). At the end of 2003, hydrated lime was being produced at 12 separate hydrating facilities (including 2 plants where the kilns had been shut down but hydrate was manufactured from quicklime produced offsite). In a few States with no quicklime production, hydrating plants used quicklime shipped in from other States. There was also a small number of slurry plants where lime was converted to liquid form by the addition of water prior to sale; this is sometimes called milk-of-lime. Principal producing States, in descending order of production, were Missouri, Alabama, Kentucky, Ohio, Texas, and Pennsylvania.

Total lime sold or used by domestic producers in 2003 increased to 19.2 Mt, more than 7% higher than in 2002. Production included the commercial sale or captive consumption of quicklime, hydrated lime, and dead-burned refractory dolomite. Production of quicklime increased by 600,000 metric tons (t) (about 660,000 short tons). The production of high-calcium quicklime increased by 3.7%, while dolomitic quicklime production increased by less than 2%. Production of hydrate increased by 680,000 t (750,000 short tons), which represents an increase of 35% compared with that of 2002. Production of high-calcium hydrate and dolomitic hydrate increased by 42.7% and 7.7%, respectively. Commercial sales increased by 1.2 Mt (about 1.3 million short tons) to about 17.7 Mt (19.5 million short tons), and captive consumption increased by 120,000 t (132,000 short tons) to 1.46 Mt (1.61 million short tons). Commercial sales increased in all the large general market sectors—chemical and industrial by 5.7%, construction by 13.6%, metallurgical by 5.5%, and environmental by 7.7%.

[1]References that include a section mark (§) are found in the Internet References Cited section.

In early 2003, Carmeuse NA idled its Detroit lime plant in Michigan and consolidated operations at its River Rouge plant, which is located just south of Detroit. Carmeuse also announced plans to boost investments in its Buffington, IN, and South Chicago, IL, plants to improve plant reliability and to meet future environmental requirements (American Metal Market, 2003). Vulcan Materials Co. closed both of its Illinois lime plants (Manteno and McCook) because of problems with sulfurous odors and particulate matter emissions (Aggregate Research Institute, 2003§). Graymont (PA) Inc.'s Con Lime plant in Centre County, PA, was idle in 2003, as was the Ohio lime plant of captive producer Elkem Metals Co. Mississippi Lime Co. acquired Falco Lime Inc., a Vicksburg, MS, manufacturer of hydrated lime and distributor of quicklime and hydrate to customers in the Arkansas, Louisiana, and Mississippi region (Industrial Minerals, 2003a). In addition, Mississippi Lime added a large preheater rotary kiln to its Ste. Genevieve, MO, plant; kiln startup was expected in early 2004. U.S. Lime & Minerals Inc. was adding a second large preheater rotary kiln to its Arkansas Lime unit in Batesville, AR. The kiln was expected to go online in the first quarter of 2004.

At yearend, the top 10 companies, in descending order of production, were Carmeuse Lime, Chemical Lime Co., Graymont Ltd., Mississippi Lime, Global Stone Corp., Martin Marietta Magnesia Specialties LLC, U.S. Lime & Minerals, Western Lime Corp., Southern Lime Co., and Ispat Inland Inc. These companies operated 43 lime plants and 8 separate hydrating plants and accounted for 87% of the combined commercial sales of quicklime and hydrated lime and nearly 83% of total lime production.

Environment

On August 25, the U.S. Environmental Protection Agency (EPA) issued a final rule to reduce toxic air pollutant emissions from new and existing lime plants. The rule was authorized by section 112(c) of the Clean Air Act and set limits on hazardous air pollutants (HAP) from commercial lime plants, captive lime plants at steel mills, captive lime plants at nonferrous metal production facilities, and producers of dead-burned dolomite. The EPA has identified the lime industry as a source of HAP emissions that include hydrochloric acid and the metals antimony, arsenic, beryllium, cadmium, chromium, lead, manganese, mercury, nickel, and selenium. The final rule set particulate matter (PM) emission limits for lime kilns, lime coolers, and mineral-processing operations with stacks. PM is not a HAP but is considered a permissible surrogate for HAP metals. The PM emission limit for kilns and lime coolers is 0.10 pound per short ton of stone feed at a new lime plant, 0.10 pound per short ton at existing lime plants, and 0.60 pound per short ton of stone feed at lime plants with wet scrubbers (U.S. Environmental Protection Agency, 2003§). The final rule went into effect with its publication in the Federal Register on January 5, 2004. The compliance date for existing lime plants will be January 5, 2007, but new plants will have to comply immediately (U.S. Environmental Protection Agency, 2004).

Consumption

One of the largest U.S. lime companies changed its accounting system, and although the 2003 data it reported may be more accurate than in past years, there may be inconsistencies between the 2002 and 2003 data. As a result, there may be apparent increases or decreases in markets simply as a result of this change.

The breakdown of consumption by major end uses was as follows: 35% for metallurgical uses, 28% for environmental uses, 23% for chemical and industrial uses, 13% for construction uses, and 1% for refractory dolomite (table 4). Captive lime accounted for less than 8% of consumption and was used mainly in the production of steel in basic oxygen furnaces, sugar refining, magnesia production, and refractories. Almost all data on captive lime consumption, excluding the sugar industry, are withheld to protect company proprietary information. As a result, table 4 lists the total quantity and value of lime by end use. End uses with captive consumption are listed in footnote 4 of the table.

In steel refining, quicklime is used as a flux to remove impurities, such as phosphorus, silica, and sulfur. The steel industry accounted for about 29% of all lime consumed in the United States. Raw steel production in the United States was essentially unchanged in 2003, but lime consumption for ferrous metallurgy reported an increase of 4.7% to 5.62 Mt (6.20 million short tons) compared with 2002. Although U.S. production of raw steel was essentially unchanged, dolomitic quicklime production increased slightly, and less was used to manufacture magnesia (MgO), which indicated that more was used in steel refining. Magnesia is very useful in steelmaking where it helps remove impurities, reduces refractory wear, and provides a foaming slag for extended arc operation. In recent years, dolomitic lime had lost some market share in steelmaking to magnesia, which was believed to dissolve faster in the slag and thus be more effective than dolomitic lime. Research at Carnegie Mellon University, however, showed that the rate of dissolution is essentially the same (Fruehan and others, 2003§). The cost of magnesia is significantly higher than dolomitic lime, so part of the increase in lime consumed by the steel industry may be the result of steel mills shifting back to the use of dolomitic lime from magnesia.

In nonferrous metallurgy, lime is used in the beneficiation of copper ores to neutralize the acidic effects of pyrite and other iron sulfides and to maintain the proper pH in the flotation process. Lime is used to process alumina and magnesia, to extract uranium from gold slimes, to recover nickel by precipitation, and to control the pH of the sodium cyanide solution used to leach gold and silver from the ore. Such leaching processes are called dump leaching when large pieces of ore are involved, heap leaching when small pieces of ore are involved, and carbon-in-pulp cyanidation when the ore is leached in agitated tanks. Dump and heap leaching involve crushing the ore, mixing it with lime for pH control and agglomeration, and stacking the ore in heaps for treatment with cyanide solution. Lime is used to maintain the pH of the cyanide solution at a level between 10 and 11 to maximize the recovery of precious metals and to prevent the creation of hydrogen cyanide. Lime consumed for these various uses is included in table 4 under the category "Nonferrous metallurgy." Lime usage in nonferrous metallurgy (aluminum and bauxite processing, concentration of copper and gold ores, and magnesium production) increased by 10% in 2003. The increase was about equally divided between ore concentration and aluminum and bauxite processing.

Environmentally, lime is used to treat the tailings that result from the recovery of precious metals, such as gold and silver. These tailings may contain elevated levels of cyanides, and lime is used to recover cyanides in such treatment processes as alkaline chlorination, Caro’s acid (H_2SO_5), Cyanisorb™, and sulfur dioxide/air.

In the environmental sector, lime is used in the softening and clarification of municipal potable water and to neutralize acid-mine and industrial discharges. In sewage treatment, the traditional role of lime is to control pH in the sludge digester, which removes dissolved and suspended solids that contain phosphates and nitrogen compounds. Lime also aids clarification and in destroying harmful bacteria. More recently, the largest use in sewage treatment has been to stabilize the resulting sewage sludge. Sewage sludge stabilization, also called biosolids stabilization, reduces odors, pathogens, and putrescibility of the solids. Lime stabilization involves mixing quicklime with the sludge to raise the temperature and pH of the sludge to minimum levels for a specified period of time. Lime consumption for all sludge treatment decreased by more than 5% compared with that of 2002.

In flue gas desulfurization (FGD) systems serving coal-fired powerplants, incinerators, and industrial plants, lime is used to react with sulfur oxides in the flue gas and may be used to stabilize the resulting sludge before disposal. In 2003, the overall FGD market increased by 300,000 t (330,000 short tons) or nearly 10% compared with 2002. The utility powerplant market increased by 470,000 t, but this increase is misleading. There was a large decrease in the sales reported in the “Industrial boilers and other FGD category,” but as was the case in 2002, this appears to be primarily the result of a change in reporting by one of the major FGD reagent suppliers. It is likely that the 2003 data are reasonably accurate but that the 2002 breakdown includes sales (estimated to be about 185,000 t) listed in the “Industrial boilers and other FGD” category that should have been reported in the “Utility powerplants” category. Even with this adjustment, sales of lime to the utility powerplant market increased by nearly 10% in 2003. Lime sales to the incinerator market, which is less than 5% the size of the utility market, increased by more than 9%.

Although there was a significant increase in sales of lime to utility powerplants for FGD, net electricity generation from coal increased by only about 2% compared with 2002 (U.S. Department of Energy, Energy Information Administration, 2004§). Coal-fired powerplants across the country have three options to comply with the sulfur emissions regulations of the Clean Air Act—burning low sulfur coal, operating FGD scrubbers that mainly use limestone or lime, or the acquisition of emission allowances. A relatively small number of large coal-fired powerplants in the Midwest consume a large percentage of FGD lime, so the operating rates of these specific plants have a major impact on the actual amounts of lime consumed for FGD. These operating rates are often affected by seasonal load demands (for example, hot summers mean more air conditioning, which requires more electricity, which requires more coal, which requires more lime). Additionally, compliance with other aspects of the Clean Air Act can necessitate shutdown of powerplants to install additional pollution control equipment.

In 1998 and 1999, total FGD sales were actually higher than reported because lime sold for industrial boilers [approximately 20,000 to 30,000 metric tons per year (t/yr)] was included in the category “Other environmental” in table 4 to avoid disclosing company proprietary data. Beginning with the 2002 report, sales for industrial boilers were combined with sales for “other FGD,” which allows an accurate total FGD number to be reported.

Lime is used by the pulp and paper industry in the basic Kraft pulping process where wood chips and an aqueous solution (called liquor) of sodium hydroxide and sodium sulfide are heated in a digester. The cooked wood chips (pulp) are discharged under pressure along with the spent liquor. The pulp is screened, washed, and sent directly to the paper machine or for bleaching. Lime is sometimes used to produce calcium hypochlorite bleach for bleaching the paper pulp. The spent liquor is processed through a recovery furnace where dissolved organics are burned to recover waste heat, sodium sulfide, and sodium carbonate. The recovered sodium sulfide and sodium carbonate are diluted with water and then treated with slaked lime to recausticize the sodium carbonate into sodium hydroxide (caustic soda) for reuse. The byproduct calcium carbonate is recalcined in a lime kiln to recover lime for reuse. The paper industry also uses lime as a coagulant aid in the clarification of plant process water.

The domestic paper industry has reduced capacity as a direct result of global competition in the form of low-cost imports. Imports have surged in recent years, largely from rising capacity in Asia. Lime consumption in the pulp and paper market decreased by more than 11% in 2003.

Lime is used to make precipitated calcium carbonate (PCC), a specialty filler used in premium-quality coated and uncoated papers, paint, and plastics. The most common PCC production process used in the United States is the carbonation process. Carbon dioxide is bubbled through milk-of-lime to form a precipitate of calcium carbonate and water. The reaction conditions determine the size and shape of the resulting PCC crystals. Lime use for PCC production increased by 11% compared with that of 2002.

Lime is used, generally in conjunction with soda ash, for softening plant process water. This precipitation process removes bivalent soluble calcium and magnesium cations (and to a lesser extent ferrous iron, manganese, strontium, and zinc) that contribute to the hardness of water. This process also reduces carbonate alkalinity and total dissolved solids.

The chemical industry uses lime in the manufacture of alkalies. Quicklime is combined with coke to produce calcium carbide, which is used to make acetylene and calcium cyanide. Lime is used to make calcium hypochlorite, citric acid, petrochemicals, and other chemicals.

In sugar refining, milk-of-lime is used to raise the pH of the product stream, precipitating colloidal impurities. The lime itself is then removed by reaction with carbon dioxide to precipitate calcium carbonate. The carbon dioxide is obtained as a byproduct of lime production.

In road paving, hydrated lime is used in hot-mix asphalt to act as an antistripping agent. Stripping is generally defined as a loss of adhesion between the aggregate surface and the asphalt cement binder in the presence of moisture. Lime also is used in cold in-place recycling for the rehabilitation of distressed asphalt pavements. Existing asphalt pavement is pulverized by using a milling machine, and a hot lime slurry is added along with asphalt emulsion. The cold recycled mix is placed and compacted by conventional paving equipment, which produces a smooth base course for the new asphalt surface. In 2003, sales of lime for use in asphalt increased by 12% compared with those of 2002.

In construction, hydrated lime and quicklime are used to stabilize fine-grained soils in place of materials that are employed as subbases, such as hydraulic clay fills or otherwise poor-quality clay and silty materials obtained from cuts or borrow pits. Lime also is used in base stabilization, which includes upgrading the strength and consistency properties of aggregates that may be judged unusable or marginal without stabilization. Common applications for lime stabilization included the construction of roads, airfields, building foundations, earthen dams, and parking areas. Lime sales for soil stabilization increased by nearly 19% and reached a new record high of 1.64 Mt, surpassing the previous record of 1.53 Mt reported in 2001. The Texas market continued to be the largest consumer of stabilization lime, and coupled with sales within the nearby States of Arkansas, Louisiana, Mississippi, and Oklahoma, the Texas lime producers accounted for 50% of the total U.S. market. In descending order of sales, this market was dominated by Chemical Lime, U.S. Lime & Minerals, Mississippi Lime, Carmeuse Lime, and Austin White Lime Co., which together accounted for nearly 87% of the total.

In the traditional building sector, quicklime is used to make calcium silicate building products, such as sand-lime brick and autoclaved aerated concrete, which has the advantage of producing building materials that can be cut, drilled, and nailed like wood but with the qualities of a concrete product.

Hydrated lime is used in the traditional building sector where it is still used in plaster, stucco, and mortars to improve durability. Hydrated lime used for the traditional building markets increased by nearly 7% in 2003. A small amount of hydrated lime also is used on the renovation of old structures built with lime-based mortars, which was standard before the development of portland-cement-based mortars. Modern portland-cement-based mortars are incompatible with old lime mortars. Hydrated lime also is used to make synthetic hydraulic lime, which is produced by blending powdered hydrated lime with pulverized pozzolanic or hydraulic materials.

Dead-burned dolomite, also called refractory lime, is used as a component in tar-bonded refractory brick used in basic oxygen furnaces. Hydrated lime is used to produce silica refractory brick used to line industrial furnaces.

Prices

The average values per ton for the various types of lime, rounded to three significant figures, are listed in table 8. The values are reported in dollars per metric ton and dollars per short ton. All value data for lime are reported by type of lime produced—high-calcium quicklime, high-calcium hydrate, dolomitic quicklime, dolomitic hydrate, and dead-burned dolomite. Emphasis is placed on the average value per metric ton of lime sold.

In general, prices increased in 2003; the average for all types of lime sold increased by 4% to $64.80 per metric ton ($58.80 per short ton). This is the first significant evidence of the price increases announced by major lime companies beginning in 2001. The price increases were made as companies tried to compensate for increased costs for raw materials, environmental compliance, labor, and health care. In the commercial sector, the average value per ton of high-calcium quicklime, dolomitic quicklime, and dolomitic hydrate all increased, but the average value of high-calcium hydrate and dead-burned dolomite decreased.

Foreign Trade

The United States exported and imported quicklime, hydrated lime (slaked lime), hydraulic lime, and calcined dolomite (dolomitic lime). Combined exports of lime were 97,800 t (108,000 short tons) valued at $13.7 million, with about 88% exported to Canada, about 6% exported to Mexico, about 4% exported to Germany, and the remaining 2% going to various other countries (table 6). Combined imports of lime were 202,000 t (223,000 short tons) valued at $22.5 million, with 63% from Canada, 36% from Mexico, and the remaining 1% from various countries (table 7).

There is some confusion on what is being reported as imports and exports of hydraulic lime. Natural hydraulic lime is produced from siliceous or argillaceous limestones that contain more or less alumina, iron, and silica. There is no production of natural hydraulic lime in the United States. Synthetic hydraulic lime is produced by mixing hydrated lime with pozzolanic or hydraulic materials, such as portland cement. Exports could be synthetic hydraulic lime or, because the chemistry is quite similar, portland cement (or some other hydraulic cement product).

No tariffs are placed on imports of hydraulic lime, quicklime, and slaked lime from countries with normal trade relations (NTR) with the United States. There is a 3% ad valorem tariff on imports of calcined dolomite from NTR countries.

World Review

With the exception of some industrialized nations, accurate lime data for individual countries are difficult to acquire. The variations in quality and types of lime, production technologies, and industries manufacturing lime and the frequent confusion with limestone data make accurate reporting of world lime data extremely difficult and certainly incomplete (table 9). The following is a brief discussion of acquisitions and new construction in specific countries.

Australia.—Pacific Lime (a subsidiary of Cement Australia Pty Limited) is expanding operations by converting a cement kiln at its plant north of Gladstone, Queensland, to produce 300,000 t/yr of lime. The project will require replacement of the preheater, relining the refractories, upgrading the coal plant to direct firing, replacement of the current electrostatic precipitator with a baghouse, installing a new quicklime crushing system, construction of new storage silos, and other improvements. Bolstered by a boom in industrial construction projects in central Queensland, lime demand in Queensland is expected to exceed 350,000 t/yr during the next 3 to 5 years. The project was expected to be operational in April 2004 (White and Ribinsky, 2003).

Boral Ltd. announced plans to build a 150,000-t/yr vertical shaft lime kiln at its recently acquired Galong limestone operation in New South Wales. The lime kiln will produce high-quality quicklime to meet growing demand, especially from the steel sector at Port Kembla. The kiln was expected to be operational in July 2004 (Boral Ltd., 2003§).

Greece.—Production of lime in Greece comes from 33 companies operating 46 kilns on either a seasonal or a year-round basis. The majority of kilns are simple verticals, and only four of the kilns are considered to be of contemporary design. The kilns burn mainly oil or petroleum coke and have high rates of fuel consumption compared with modern vertical shaft kilns. Production is about 500,000 t/yr, almost all quicklime, and the larger companies each produce about 40,000 t/yr. Quality varies greatly and ranges from 60% to 99% calcium oxide. The major markets are traditional construction uses with about 75% of the total and steel refining with 10%. Increasing demand and environmental regulations will likely lead to modernization of the Greek lime industry in the near future (Labrakis, 2004).

Current Research and Technology

Ferruginous lime [quicklime coated with dicalcium ferrite ($2CaO•Fe_2O_3$)] has attractive properties as a steelmaking flux. Experiments were undertaken to determine the feasibility of producing ferruginous lime in a rotary kiln-type reactor and to assess the operating conditions favorable for both the formation of a hydration-resistant product and the minimization of such problems as accretion and agglomeration within the reactor. The trials indicated that a period of 45 minutes at temperatures in excess of 1,200° C with a peak reaction temperature of 1,260° C provides appropriate conditions for the production of ferruginous lime. The optimal oxide addition is 10% by weight of the limestone charge to the rotary lime kiln. When subjected to hydrating conditions of short duration, that is, 30 minutes in contact with steam at 100° C, the product exhibited good resistance to hydration relative to pure calcium oxide and moderate physical degradation. Laboratory tests demonstrated the significantly enhanced rate and degree of dissolution of ferruginous lime in a steelmaking slag relative to that of uncoated lime (Lee and Barr, 2001).

ReBASE Corp. has formed a joint venture with Caribbean calcium carbonate producer PolyMineral Inc. to process calcium hydroxide (hydrated lime) into ReBASE's plastic filler products. The joint venture will operate as ReBASE Americas LLC and is planning to build a production facility in New Orleans, LA. The New Orleans location is considered ideal because it provides easy access to its Caribbean source of calcium carbonate and to its resin and calcium hydroxide sources. According to ReBASE, these filler products reportedly possess significant advantages compared with competing products such as calcium carbonate and talc. The advantages include antimicrobial properties, high flame retardance, rounded particles that improve melt flow and reduce abrasion, and the ability to neutralize hydrogen chloride gas released during combustion of polyvinylchloride products (Industrial Minerals, 2003b). With the exception of fillers intended for food grade and medical resin uses, the calcium hydroxide will be sourced from byproduct carbide lime.

Outlook

Although lime has many uses, a few uses tend to make up the bulk of consumption. The following discusses some of the major markets and their specific conditions.

The improving economy should help lime's largest market—the steel sector; consolidation in the steel industry has strengthened some of the larger companies. However, repeal of the steel tariffs has removed the safety net protecting domestic steel companies from a flood of imports. This creates a degree of uncertainty in an otherwise positive outlook for lime sales to the sector.

The ore concentration market should be bolstered by Phelps Dodge Corp.'s plans to increase production at several North American operations. In response to "higher copper prices and indications that the improved market for copper is sustainable," specific operational changes include increasing concentrate production to full capacity at its Bagdad Mine in Arizona by the second quarter of 2004 and its Sierrita Mine in Arizona by the fourth quarter of 2004; resuming concentrate production at one-half capacity at its Chino Mine in New Mexico, which was closed in 2001, by the third quarter of 2004; and resuming mining at an unspecified rate at its Cobre Mine in New Mexico, which was closed in 1999, by the third quarter of 2004 (Edelstein, 2004§).

In December, the EPA Administrator signed the proposed interstate air quality rule (IAQR), which would result in the deepest cuts in sulfur dioxide and nitrogen oxide emissions in more than a decade. The sulfur dioxide emissions would be reduced by about 40% from current levels by 2010 and by as much as 70% when the rule is fully implemented in 2015. Nitrogen oxide emissions would see a 65% reduction by 2015. Each affected State would be required to meet specific statewide emission reduction targets, and the proposal suggested that States regulate powerplants under a cap and trade program similar to the present acid rain program (U.S. Environmental Protection Agency, 2004§). The EPA estimated that FGD scrubbers would be installed on an additional 49 gigawatts of powerplant capacity by 2010 to comply with the new rule. A major area of complexity and uncertainty, however, has to do with allowance trading and the resultant timing of control equipment installations. The IAQR allows use of allowance credits banked under the Acid Rain Phase II Program (Clean Air Act Amendments), so credits gained in 2005 by operating below the allowance levels could be used in 2010. This could push out the date of installation of FGD controls and as a result delay or reduce the immediate increase in lime sales to the FGD market.

The currently in-place acid rain program, proposed IAQR, regulations covering emissions from small municipal incinerators and waste-to-energy incinerators, and the standards the EPA is required to develop for control of hazardous air pollutants from various industrial categories all provide significant opportunities for growth in lime's FGD market.

Federal funding for transportation projects, such as highway construction, makes up the bulk of funding for such projects. The current transportation legislation expired last year, but Congress and the administration have been slow in agreeing on new funding levels. If new transportation legislation is enacted at higher funding levels (as was proposed by the Senate), then such an increase will provide a boost to lime stabilization and hot-mix asphalt sales.

Overall, 2004 should be a solid year for the lime industry. The improved economy will benefit chemical, construction, and industrial markets, and higher copper prices will benefit the mining sector. In general, lime prices are expected to continue moving upward in 2004.

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TABLE 1
SALIENT LIME STATISTICS[1]

(Thousand metric tons[2] and thousand dollars unless otherwise specified)

	1999	2000	2001	2002	2003
United States[3]					
Number of plants[4]	107	106	103	99	96
Sold or used by producers:					
Quicklime:					
High-calcium	14,100	14,300	13,600	13,400	13,900
Dolomitic	3,000	3,000	2,580	2,420	2,460
Total	17,100	17,300	16,200	15,800	16,400
Hydrated lime:					
High-calcium	2,010	1,550	2,030	1,500	2,140
Dolomitic	298	421	447	431	464
Total	2,310	1,970	2,470	1,930	2,610
Dead-burned dolomite[5]	300	200	200	200	200
Grand total	19,700	19,500	18,900	17,900	19,200
Value[6]	1,190,000	1,180,000	1,160,000	1,120,000	1,240,000
Average value dollars per metric ton	60.40	60.60	61.30	62.60	64.90
Lime sold	17,400	17,500	17,000	16,500	17,700
Lime used	2,310	2,020	1,840	1,340	1,460
Exports:[7]					
Quantity	59	73	96	106	98
Value	8,270	9,960	11,900	13,100	13,700
Imports for consumption:[7]					
Quantity	140	113	115	157	202
Value	15,700	13,500	15,100	19,700	22,500
Consumption, apparent[8]	19,700	19,600	18,900	17,900	19,300
World, production	116,000	118,000	119,000 r	118,000 r	120,000 e

[e]Estimated. [r]Revised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]To convert metric tons to short tons, multiply metric tons by 1.102.
[3]Excludes regenerated lime; includes Puerto Rico.
[4]Includes producer-owned hydrating plants not located at lime plants.
[5]Data are rounded to no more than one significant digit to protect company proprietary data.
[6]Selling value, free on board plant, excluding cost of containers.
[7]Source: U.S. Census Bureau.
[8]Defined as sold or used plus imports minus exports.

TABLE 2

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1, 2]

State	Plants[3]	Hydrated (thousand metric tons)[4]	Quicklime[5] (thousand metric tons)[4]	Total (thousand metric tons)[4]	Value (thousands)
2002:					
Alabama	5	100	1,940	2,040	$127,000
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	20	303	1,990	2,300	147,000
California, Oregon, Washington	8	55	233	288	29,100 r
Illinois, Indiana, Missouri	9	312	3,420	3,730 r	221,000
Iowa, Nebraska, South Dakota	3	W	W	293 r	17,800
Kentucky, Tennessee, West Virginia	5	100	2,170	2,270	131,000
Ohio	8	122	1,510	1,630	98,100
Pennsylvania	6	192	1,030	1,230	87,600
Texas	5	289	1,240	1,530	98,400 r
Wisconsin	4	159	444	603	35,600
Other[6]	26	302	1,980	1,990	126,000
Total	99	1,930	16,000	17,900	1,120,000
2003:					
Alabama	5	151	2,140	2,290	151,000
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	19	304	2,300	2,600	167,000
California, Oregon, Washington	8	61	240	301	29,300
Illinois, Indiana, Missouri	8	462	3,250	3,710	236,000
Iowa, Nebraska, South Dakota	3	W	W	363	24,600
Kentucky, Tennessee, West Virginia	5	118	2,400	2,520	148,000
Ohio	8	127	1,760	1,880	114,000
Pennsylvania	6	184	1,000	1,190	90,100
Texas	5	638	989	1,630	110,000
Wisconsin	4	169	589	757	46,000
Other[6]	25	394	1,910	1,940	128,000
Total	96	2,610	16,600	19,200	1,240,000

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Excludes regenerated lime.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]Includes producer-owned hydrating plants not located at lime plants.

[4]To convert metric tons to short tons, multiply metric tons by 1.102.

[5]Includes dead-burned dolomite.

[6]Includes Arkansas, Georgia, Louisiana, Massachusetts, Michigan, Minnesota, North Dakota, Oklahoma, Puerto Rico, Virginia, and data indicated by the symbol W.

TABLE 3

LIME SOLD AND USED BY PRODUCERS IN THE UNITED STATES, BY RANGE OF PRODUCTION[1, 2]

Range of production	2002			2003		
	Plants	Quantity (thousand metric tons)[3]	Percentage of total	Plants	Quantity (thousand metric tons)[3]	Percentage of total
Less than 25,000 tons	27	353	2	24	319	2
25,000 to 100,000 tons	21	1,160	6	23	1,310	7
100,000 to 200,000 tons	21	3,190	18	16	2,370	12
200,000 to 300,000 tons	10	2,460	14	11	2,680	14
300,000 to 400,000 tons	8	2,540	14	9	3,040	16
400,000 to 500,000 tons	6	2,870	16	6	3,070	16
More than 600,000 tons	6	5,320	30	7	6,410	33
Total	99	17,900	100	96	19,200	100

[1]Excludes regenerated lime. Includes Puerto Rico.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]To convert metric tons to short tons, multiply metric tons by 1.102.

TABLE 4

LIME SOLD AND USED BY PRODUCERS IN THE UNITED STATES, BY USE[1, 2]

(Thousand metric tons[3] and thousand dollars)

Use	2002 Quantity[4]	2002 Value[5]	2003 Quantity[4]	2003 Value[5]
Chemical and industrial:				
Fertilizer, aglime and fertilizer	28	$2,160	65	$4,630
Glass	101	6,140	116	7,250
Paper and pulp	868	50,700	770	46,000
Precipitated calcium carbonate	1,180	76,200	1,310	82,900
Sugar refining	582	35,700	616	36,500
Other chemical and industrial[6]	1,470	103,000	1,600	112,000
Total	4,230	274,000	4,470	289,000
Metallurgical:				
Steel and iron:				
Basic oxygen furnaces	3,600	219,000 r	3,720	240,000
Electric arc furnaces	1,510	92,900	1,490	94,100
Other steel and iron	255	14,700	404	24,700
Total	5,370 r	326,000	5,620	359,000
Nonferrous metallurgy[7]	973	54,900	1,070	63,600
Total	6,340 r	381,000	6,690	423,000
Construction:				
Asphalt	342	28,000	383	31,800
Building uses	447	44,700	478	48,400
Soil stabilization	1,380	83,700	1,640	108,000
Other construction	42	2,880	13	946
Total	2,210	159,000	2,510	189,000
Environmental:				
Flue gas desulfurization (FGD):				
Utility powerplants	2,740	149,000	3,210	180,000
Incinerators	137	9,360	150	10,700
Industrial boilers and other FGD	259	15,600	75	6,610
Total	3,140	174,000	3,440	197,000
Sludge treatment:				
Sewage	148	9,230	252	16,900
Other, industrial, hazardous, etc.	189	11,400	66	4,830
Total	336	20,700	318	21,800
Water treatment:				
Acid mine drainage	76	5,120	112	7,500
Drinking water	813	50,800	886	58,100
Waste water	377	26,000	385	27,100
Total	1,270	81,900	1,380	92,600
Other	191	13,700	167	12,100
Total	4,930	290,000	5,310	323,000
Refractories (dead-burned dolomite)	200 [8]	15,000 [9]	200 [8]	18,600 [9]
Grand total	17,900	1,120,000	19,200	1,240,000

r Revised.

1 Excludes regenerated lime. Includes Puerto Rico.

2 Data are rounded to no more than three significant digits; may not add to totals shown.

3 To convert metric tons to short tons, multiply metric tons by 1.102.

4 Quantity includes lime sold and used, where "used" denotes lime produced for internal company use for magnesia, paper and pulp, precipitated calcium carbonate, basic oxygen furnaces, mason's lime, and refractories.

5 The U.S. Geological Survey does not collect value data by end use; the values shown are mainly derived from average lime values.

6 May include alkalis, calcium carbide and cyanamide, citric acid, food (animal or human), gelatin, oil grease, oil well drilling, tanning, and other uses. Magnesia is included here to avoid disclosing company proprietary data.

7 Includes aluminum and bauxite, magnesium, ore concentration (copper, gold, etc.) and other.

8 Data are rounded to one significant digit to protect company proprietary data.

9 Values are estimated based on average value per metric ton of dead-burned dolomite for each year.

TABLE 5

HYDRATED LIME SOLD OR USED IN THE UNITED STATES, BY END USE[1, 2]

(Thousand metric tons[3] and thousand dollars)

Use	2002 Quantity[4]	2002 Value[5]	2003 Quantity[4]	2003 Value[5]
Chemical and industrial	443	$40,900	498	$45,400
Construction:				
Asphalt	318	26,600	364	30,600
Building uses	432	43,800	467	47,600
Soil stabilization	157	11,200	516	38,200
Other construction	6	526	7	628
Total	913	82,200	1,350	117,000
Environmental:				
Flue gas desulfurization (FGD):				
Utility powerplants	36	3,030	158	8,540
Incinerators	36	2,870	33	2,910
Industrial boilers and other FGD	51	4,710	43	4,440
Total	123	10,600	234	15,900
Sludge treatment:				
Sewage	26	1,950	35	3,050
Other sludge treatment	19	1,690	35	2,980
Total	45	3,640	70	6,030
Water treatment:				
Acid mine drainage	52	3,770	73	5,130
Drinking water	135	11,700	163	13,800
Waste water	136	11,200	122	9,880
Total	323	26,600	358	28,900
Other environmental	64	5,090	58	4,730
Metallurgy	23	1,740	36	3,180
Grand total	1,930	171,000	2,610	221,000

[1]Excludes regenerated lime. Includes Puerto Rico.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]To convert metric tons to short tons, multiply metric tons by 1.102.

[4]Quantity includes hydrated lime sold and used, where "used" denotes lime produced for internal company use in building, chemical and industrial, and metallurgical sectors.

[5]The U.S. Geological Survey does not collect value data by end use; the values shown are mainly derived from average lime values.

TABLE 6

U.S. EXPORTS OF LIME, BY TYPE[1]

Type	2002		2003	
	Quantity (metric tons)[2]	Value[3]	Quantity (metric tons)[2]	Value[3]
Calcined dolomite:				
Canada	19,800	$4,830,000	21,000	$5,060,000
Mexico	558	112,000	626	156,000
Germany	21	9,990	3,520	395,000
Other[4]	120 r	49,200 r	56	13,000
Total	20,500	5,010,000	25,200	5,620,000
Hydraulic lime:				
Bahamas, The	140	19,600	103	19,900
Canada	8,510	957,000	10,500	1,380,000
Mexico	64	19,400	57	10,700
Other[5]	2 r	23,600 r	181	88,000
Total	8,710	1,020,000	10,900	1,500,000
Quicklime:				
Canada	55,100	4,420,000	49,300	4,650,000
Costa Rica	59	9,800	417	96,600
Guyana	7,330	727,000	--	--
Mexico	6,950	769,000	4,840	615,000
Other[6]	336	90,400	367	73,100
Total	69,800	6,020,000	55,000	5,440,000
Slaked lime, hydrate:				
Bahamas, The	42	7,470	--	--
Canada	5,410	837,000	5,740	907,000
Philippines	418	55,600	338	62,400
Other[7]	739	181,000	763	199,000
Total	6,610	1,080,000	6,850	1,170,000
Grand total	106,000	13,100,000	97,800	13,700,000

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]To convert metric tons to short tons, multiply metric tons by 1.102.

[3]Declared free alongside ship valuation.

[4]Includes Belize, Honduras, New Zealand, South Africa, and Taiwan.

[5]Includes Colombia, France, Haiti, Israel, Japan, Trinidad and Tobago, and Venezuela.

[6]Includes The Bahamas, Colombia, the Republic of Korea, Saudi Arabia, Slovenia, Trinidad and Tobago, and Venezuela.

[7]Includes Honduras, Mexico, Namibia, South Africa, and Trinidad and Tobago.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF LIME, BY TYPE[1]

Type	2002 Quantity (metric tons)[2]	2002 Value[3]	2003 Quantity (metric tons)[2]	2003 Value[3]
Calcined dolomite:				
Canada	9,790	$774,000	9,910	$833,000
Mexico	1,550	268,000	453	60,400
Other[4]	401	107,000	506	161,000
Total	11,700	1,150,000	10,900	1,050,000
Hydraulic lime:				
Canada	162	38,900	70	8,580
Mexico	2,000	229,000	3,430	391,000
Other[5]	528	293,000	1,440	417,000
Total	2,690	562,000	4,940	817,000
Quicklime:				
Canada	113,000	14,700,000	109,000	14,600,000
Mexico	13,500	860,000	57,700	3,150,000
Other[6]	126	217,000	153	299,000
Total	127,000	15,800,000	166,000	18,000,000
Slaked lime, hydrate:				
Canada	6,370	617,000	8,760	905,000
Mexico	8,780	1,100,000	11,000	1,290,000
Other[7]	672	498,000	489	349,000
Total	15,800	2,210,000	20,200	2,540,000
Grand total	157,000	19,700,000	202,000	22,500,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]To convert metric tons to short tons, multiply metric tons by 1.102.
[3]Declared cost, insurance, and freight valuation.
[4]Includes Argentina, Austria, China, Germany, the Republic of Korea, and Spain.
[5]Includes the Dominican Republic, France, Switzerland, and the United Kingdom.
[6]Includes Australia, China, Finland, Germany, Italy, Japan, the Netherlands, Norway, Thailand, and the United Kingdom.
[7]Includes Belgium, Brazil, China, Ecuador, France, Germany, Italy, Japan, Switzerland, Taiwan, Thailand, and the United Kingdom.

Source: U.S. Census Bureau.

TABLE 8
LIME PRICES[1]

Type	2002 Dollars per metric ton	2002 Dollars per short ton[2]	2003 Dollars per metric ton	2003 Dollars per short ton[2]
Sold and used:				
Quicklime	59.20	53.70	61.30	55.70
Hydrate	88.50	80.30	84.80	77.00
Dead-burned dolomite	86.70	78.70	90.80	82.30
Average all types	62.60	56.80	64.90	58.80
Sold:				
High-calcium quicklime	58.50	53.10	61.00	55.40
Dolomite quicklime	59.80	54.20	62.10	56.30
Average quicklime	58.70	53.30	61.20	55.50
High-calcium hydrate	86.20	78.20	81.20	73.70
Dolomite hydrate	97.40	88.40	102.70	93.20
Average hydrate	88.60	80.40	84.90	77.00
Dead-burned dolomite	94.30	85.50	92.10	83.50
Average all types	62.30	56.50	64.80	58.80

[1]Average value per ton, on a free on board plant basis, including cost of containers.
[2]Conversions were made from unrounded metric ton values and may not be conversions of the rounded values.

TABLE 9

QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country[3]	1999	2000	2001	2002	2003[e]
Australia[e]	1,500	1,500	1,500	1,500	1,500
Austria[e]	2,000	2,000	2,000	2,000	2,000
Belgium[e]	1,750	1,750	1,750	1,750	1,750
Brazil	6,137	6,273	6,300	6,500 r, e	6,500
Bulgaria	1,068	1,388	2,025 r	2,000 r, e	2,000
Canada	2,565	2,525	2,213 r	2,237 r	2,200
Chile[e]	1,000	1,000	1,000	1,000	1,000
China[e]	21,500	21,500	22,000	22,500	23,000
Colombia[e]	1,300	1,300	1,300	1,300	1,300
Czech Republic	1,142	1,202	1,300 r, e	1,120 r, e	1,200
France[e]	2,500	2,500	2,400	2,500	2,500
Germany[e]	6,440	6,850 4	7,000	7,000	7,000
Iran[e]	2,138 4	2,200	2,000	2,200 r	2,200
Italy[e, 5]	3,500	3,500	3,500	3,000	3,000
Japan, quicklime only	7,594	8,106	7,586 r	7,420 r, e	7,500
Mexico[e]	6,500	6,500	6,500	6,500	6,500
Poland	2,299	2,376	2,049 r	1,960 r	1,900
Romania	1,623	1,480	1,790 r	1,829 r	1,800
Russia[e]	7,000	8,000	8,000	8,000	8,000
South Africa, burnt lime sales	1,920 r	1,391	1,615	1,598 r	1,600
Spain[e]	1,500	1,500	1,500	1,500	1,500
Turkey[6]	975	914	855 r, e	850 r, e	900
United Kingdom[e]	2,500	2,500	2,500	2,000	2,000
United States, including Puerto Rico, sold or used by producers	19,700	19,500	18,900	17,900	19,200 4
Vietnam	1,026	1,156 r	1,180 r	1,200 r, e	1,200
Other[e]	9,020 r	9,460 r	10,600 r	11,000 r	11,000
Total	116,000	118,000	119,000 r	118,000 r	120,000

[e]Estimated. [r]Revised.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through April 6, 2004.

[3]In addition to the countries listed, Argentina, Iraq, Pakistan, Syria, and several other nations produce lime, but output data are not reported; available general information is inadequate to formulate reliable estimates of output levels.

[4]Reported figure.

[5]Includes hydraulic lime.

[6]Lime produced for steel production; does not include the widespread artisanal production of lime for whitewash and sanitation purposes.