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DIATOMITE

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DIATOMITE

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Production of diatomite in the United States increased by 5% to 653,000 metric tons (t), and its value increased by 1% to $179 million free on board (f.o.b.) plant in 2005 compared with 620,000 t valued at $177 million f.o.b. plant in 2004 (table 1). The United States remained the world's leading producer and consumer of diatomite. Diatomite is used primarily for filtration (table 2). Major diatomite products were sold as various grades of calcined powders.

Encroachment into diatomite markets by natural and synthetic substitute materials remained minimal, and use as fillers and for biological filtration, including filtering human blood plasma, continued to grow. Other uses of diatomite included absorbents, insulation, insecticide, and as pozzolan in cement. Diatomaceous material that contains abundant clay has a growing use as a raw material in the production of portland cement, but that impure material is not considered in this report.

Domestic Data Coverage

Domestic production data for diatomite were developed by the U.S. Geological Survey (USGS) from an annual voluntary survey of U.S. diatomite-producing sites and company operations. The canvass for 2005 covered 7 diatomite-producing companies with 11 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Because two of the companies did not respond to the 2005 survey, sales and use data for these companies were estimated based on past production figures and man-hours worked as reported to the Mine Safety and Health Administration. Data are rounded to no more than three significant figures. All percentages in this report were computed based on unrounded data.

Description and Terminology

Diatomite is a chalk-like, soft, friable, earthy, very fine grained, siliceous sedimentary rock, usually light in color (white if pure, commonly buff to gray in situ, and rarely black). It is very finely porous, very low in density, and essentially chemically inert in most liquids and gases. Diatomaceous earth (often abbreviated as D.E.) is a common alternate name but is more appropriate for the unconsolidated or less lithified sediment. The deposits result from an accumulation in oceans or fresh waters of the amorphous hydrous silica (opal, $SiO_2 \bullet H_2O$) cell walls of dead diatoms, which are microscopic single-cell aquatic plants (algae). The diatom cells contain an internal, elaborate siliceous skeleton consisting of two valves (frustules) that vary in size from less than 1 micrometer (μm) to more than 1 millimeter in diameter but are typically 10 to 200 μm across and have a broad variety of delicate, lacy, perforated shapes varying from spheres and cylinders to discs, ladders, feathers, and needles. Additional information on the environmental and physical properties of diatoms can be found in Moyle and Dolley (2003) and Dolley and Moyle (2003).

Diatomite can form an excellent reservoir rock for hydrocarbons. The Belridge diatomite in the San Joaquin Basin in California is an example of an oil-producing diatomaceous formation (Schlumberger Limited, 2005§[1]). Diatomite is also known as kieselgur (a German name compounded from the words for flint and for an earthy sediment in water) and as tripolite after a diatomite occurrence near Tripoli, Libya. The term tripolite is used in some Government trade documents and tariff codes as the short name for a group of siliceous fossil meals and similar siliceous earths that can include diatomite (U.S. International Trade Commission, 2005§). An impure (up to 30% clay) Danish variety of diatomite is called moler.

Commercial deposits worldwide are reported to be mostly fresh water (lacustrine) deposits of Miocene to Pleistocene age. The oldest occurrences are thought to be of Cretaceous age, deposited about 138 million to 66 million years ago. It is thought that older diatomite occurrences may have altered into other forms of silica, particularly chert, owing to diagenesis, burial, and exposure. Detailed information on the geology of diatomite can be found in Wallace (2003) and Moyle and Dolley (2003).

Production

Recovery of diatomite from most deposits is by low-cost open pit mining because many occurrences are at or near the surface and the topography allows for open pit mining. Outside the United States, however, underground mining is fairly common owing to deposit form and depth as well as topography and other constraints. Explosives are not normally needed either at surface or in underground mines because of the soft, friable nature of the rock. In Iceland, dredging is used to recover diatomaceous mud from the bottom of a lake.

Diatomite usually is processed near the mine to reduce the cost of hauling the crude ore, which can contain up to 65% water. Processing typically involves a series of crushing, drying, size reduction, and calcining operations, using heated air for conveying and classifying within the plant. Fines, especially from baghouses, are used mostly for filler-grade products, and coarser particles are used for filter grades. In the latter stages of processing, calcining is normally done in rotary kilns to effect physical and chemical changes.

Production cost allocations for the United States have been reported to be 10% for mining, 60% for processing, and 30% for packing and shipping, with energy costs composing 25% to

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

30% of direct costs (Breese, 1994, p. 405). The proportion of the product that is calcined directly affects energy consumption.

The two leading domestic producers of diatomite underwent important changes in 2005. World Minerals, Inc. (the parent of Celite Corporation) was purchased by Imerys, USA, Inc. (a subsidiary of the French company Imerys, S.A.), and EaglePicher Incorporated filed for reorganization under Chapter 11 of the U.S. Bankruptcy Code.

In 2005, 653,000 t of diatomite was produced from 11 separate mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Major producers were Celite Corporation (a subsidiary of Imerys, USA) (Lompoc and Quincy, WA) and EaglePicher (Lovelock and Fernley, NV, and Vale, OR). California was the leading producing State, followed closely by Nevada. The combined output of these two States accounted for about 70% of the U.S. production in 2005.

Consumption

In antiquity, diatomite was used by the Greeks as an abrasive and in making lightweight building bricks and blocks. However, diatomite only became of industrial interest in Western Europe in the mid-1800s when pulverized diatomite became the preferred absorbent and stabilizer of nitroglycerine used by Alfred Nobel to make dynamite. The site of the first U.S. production of diatomite was in Maryland in 1884. By the late 1880s, very pure, huge deposits near Lompoc became the focus of interest and has continued to dominate world markets (Dolley and Moyle, 2003). Diatomite is now used principally as a filter aid, but it is also used as an absorbent for industrial spills and for pet litter, as a filler in a variety of products from paints to dry chemicals, as an insulation material in sawn and molded shapes and loose granules, as a mild abrasive in polishes, and as a silica additive in cement and various other compounds.

Apparent domestic consumption (excluding stocks for which data were not available) of diatomite in 2005 was about 515,000 t, up by about 8% from 478,000 t in 2004. The total domestic and export quantity of filter-grade diatomite sold or used by U.S. producers was 489,000 t in 2005, up by 5% from 467,000 t in 2004, accounting for 75% of total diatomite consumption. Use of diatomite as a filler was 73,000 t in 2005, down slightly from 75,000 t in 2004, accounting for 11% of total diatomite consumption. For absorbents, 46,000 t of diatomite was consumed, about the same as in 2004, accounting for 2% of total diatomite consumption. Diatomite use for insulation rose by 6% to 12,700 t in 2005 from 12,000 t in 2004, accounting for 11% of total diatomite consumption. Consumption for other applications rose 60% in 2005 to 32,000 t, from 20,000 t in 2004, accounting for 5% of total diatomite consumption. Increased use as a pozzolan and as an ingredient in cement manufacturing constituting the majority of the other use category.

Commercial diatomite products provide fine-sized, irregular-shaped porous noncaking particles that have a large surface area and high liquid absorption capacity. They are relatively inert chemically, have a low refractive index, are mildly abrasive, have low thermal conductivity with a reasonably high fusion point, can be slightly pozzolanic, are very high in silica, and can be produced and delivered at a cost consistent with customer applications. Sawn shapes, which continue to account for a significant part of world diatomite production, have long been used as lightweight building material, especially in China, and primarily for thermal insulation (especially the high-clay-content Danish moler). Both dried natural products and calcined products are used in the aforementioned building applications. The major use of diatomite is as a filtration medium for beverages (especially beer and wine), sugar and sweetener liquors, oils and fats, petroleum and chemical processing (including reprocessing waste dry cleaning fluids), pharmaceuticals, and water (industrial process, potable, swimming pool, and waste). Another leading use is as an absorbent for industrial spills (oil and toxic liquids) and for pet litter.

Another important broad category of use is as a filler, often serving a dual purpose, such as an extender and flatting agent in paints and coatings; a bulking and anticaking agent in granular materials; and as a multieffect component in plastics (including preventing films from sticking). Other filler uses are as an extender and absorbent carrier for dry pesticides, pharmaceuticals, catalysts, and other chemicals (Crossley, 2000, p. 135). Other significant uses are as an insulation material in bulk (loose) and molded forms, other insulation products that include calcium silicate as a component, and as a silica additive in various compounds, including mortar and portland cement where it is used also for its pozzolanic properties.

Commercial diatomite products are offered in a great variety of grades. Principal grading factors are the size, shape, overall arrangement, and proportions of the various types of frustules (factors that affect filtration rate, product clarity, and absorption capacity), the content of silica, and various impurities, such as certain minerals and chemicals especially iron, a major impurity, as well as clay, sand, and organics. Additional specialized application specifications are brightness/whiteness and abrasive hardness. Reduced free-crystalline silica content, although normally low, also is required by some environmental regulations, particularly for calcined products. Calcining removes organics, increases filtration rate, oxidizes iron, increases specific gravity, increases particle hardness, and can lighten the color. Flux-calcining significantly affects the physical and chemical properties and makes a white product. Most filter grades are calcined.

Prices

The calculated weighted average unit value of diatomite sold or used by U.S. producers during 2005, using USGS survey data, was $274.02 per metric ton free on board (f.o.b.) plant, a decrease of about 4% compared with about $285.72 per ton in 2004 (table 3). The average values for filtration uses fell in 2005 to about $261.79 per ton, down by 3% from the 2004 values. The value for diatomite used for absorbents decreased by more than one-half to $30.68 per ton. The unit value for diatomite used as fillers increased by 6% to $382.27 per ton in 2005, and the value for diatomite used in insulation increased by 2% to $44.09 per ton in 2005 compared with that of 2004. The average value for specialized or other uses in 2005 fell by about 36%

to $652.34 per ton, down from $1,020 per ton in 2004. The decreases in the unit value of use categories in 2005 probably resulted from the competition of less expensive substitutes in many uses. Diatomite used in cement manufacture commands a much lower value than some specialty uses, which most likely caused the value per ton of the other use category to drop.

Foreign Trade

Export and import data presented here, which are from the U.S. Census Bureau, are of limited accuracy owing to inconsistencies in producer reporting and because there is a lack of detail for the various materials specified in the 2005 Harmonized Tariff Schedule of the United States (HTS) issued by the U.S. International Trade Commission. Exports of diatomite from the United States in 2005 were about 142,000 t, about 1,000 t less than in 2004 (table 4). Exports accounted for about 22% of total domestic production sold or used. The trade data were issued under heading 2512 of the HTS, described as applying to natural and straight-calcined diatomite. Industry sources, however, indicated that exports also included some flux-calcined material, whish is included under code 3802.90.2000 where it is not differentiated from activated clays. Similarly, heat-insulating mixtures and sawn and molded unfired shapes of diatomite are collected under data classification code 6806.90.0090 and are not exclusively identified as diatomite. Also, fired, sawn, and molded shapes of diatomite are covered under heading 6901 that is not exclusively used for diatomite data.

According to the U.S. Census Bureau data, diatomite products were exported to 97 countries in 2005. The main export markets were Canada (21,500 t), Germany (16,300 t), Belgium (14,700 t), Japan (9,330 t), Australia (7,070 t), the United Kingdom (4,975 t), Russia (4,944 t), and Thailand (4,915 t), accounting for 59% of the total exports reported. Based on the available data, the average unit value free alongside ship of exported diatomite was $426 per ton in 2005 compared with $375 per ton in 2004, an increase of 14% (table 4). Because the data may not include all the higher value material, as discussed above, actual average unit values may be higher. Import data available for diatomite show that 4,320 t came from 12 countries in 2005. Mexico provided 2,580 t (60%), France provided 646 t (15%), and the remainder came from the Netherlands, China, Italy, Spain, Canada, Australia, Japan, Chile, Argentina, and India, in descending order of tonnage.

World Industry Structure

The estimated world production in 2005 was about 2 Mt (table 5). World reserves are estimated to be almost 1 billion metric tons (Gt), which is more than 500 times the current annual estimated world production rate of 1.97 Mt (the average world production of the past 5 years). About 250 Mt, or 25%, of the estimated 1-Gt world reserve is in the United States (Founie, 2006). The world reserve base was estimated by the U.S. Bureau of Mines in 1985 to be almost 2 Gt (Meisinger, 1985). The world's reputed leading producing district is near Lompoc. A resource estimate based just on the dimensions of the those deposits, suggests that diatomite from those deposits alone could meet the world's current needs for centuries. Information on reserves is difficult to calculate because some companies are reluctant to release proprietary data and data, from some nations is inadequate. Huge deposits also occur in China (Lu, 1998, p. 53).

World Review

For 2005, world output was estimated to be 2.02 Mt, 4% higher than that of 2004 (table 5). Chinese, Japanese, and Mexican diatomite production increased by 4% to 5% in 2005 when compared with the previous year. The United States was the leading producer, consumer, and exporter of diatomite and accounted for 32% of total world production, followed by China with 20%, Denmark with 12% (all moler products), Japan with 6%, the Commonwealth of Independent States and France each with 4%, and Mexico with 3%. Small amounts of diatomite were produced in 24 other countries.

Outlook

The increase in production was small, and the diatomite market grew only slightly in 2005. Much of the growth was owing to a growing use of diatomite as a lightweight component and as a pozzolan in the cement industry. The diatomite market is expected to be stable for the next several years, with the export market continuing to remain strong. A change in the amount of diatomite used as a filtration medium would be linked to changes in the markets of products that use diatomite in their filtering process. Diatomite use in filtration of human blood plasma was expected to continue expanding. Increased energy costs and possible global overcapacity, however, may be impediments to future expansion. The past concerns of encroachments into filter applications by more advanced technologies using carbon membranes, ceramics, and polymers were not a major concern to diatomite producers in 2005 because cost factors and tradition, particularly in the brewing and wine industries, precluded changing to substitutes. Disposal of diatomite waste, however, continued to be a problem not fully resolved by recycling. The association problem of free-crystalline silica with diatomite, particularly when calcined, was expected to continue to be a concern. Finally, with the large domestic and world reserve bases and small change in demand, it appears that there will be adequate supplies of diatomite for the foreseeable future.

The purchase of World Minerals and the bankruptcy filing by EaglePicher did not apparently affect diatomite production in 2005; production by these two companies is expected to continue and may even expand.

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TABLE 1
DIATOMITE SOLD OR USED, BY PRODUCERS IN THE UNITED STATES[1]

(Thousand metric tons and thousand dollars)

	2004	2005
Domestic production, sales:		
Quantity	620	653
Value	177,000	179,000

[1]Data are rounded to no more than three significant digits.

TABLE 2
DIATOMITE SOLD OR USED, BY MAJOR USE[1]

(Percentage of U.S. production)

	2004	2005
Absorbents	7	7
Fillers	12	11
Filtration	75	75
Insulation	2	2
Other[2]	3	5

[1]Includes exports.
[2]Includes silicate admixtures (especially for cement) and unspecified uses.

TABLE 3
AVERAGE VALUE PER METRIC TON OF DIATOMITE,
BY MAJOR USE[1]

	2004	2005
Absorbents	$72.94	$30.68
Fillers	360.65	382.27
Filtration	269.25	261.79
Insulation	43.41	44.09
Other[2]	1,020.00	652.34
Weighted average	285.72	274.02

[1]Based on unrounded data.
[2]Includes absorbents and silicate admixtures.

TABLE 4
U.S. EXPORTS OF DIATOMITE[1, 2]

(Thousand metric tons and thousand dollars)

Year	Quantity	Value[3]
2004	143	53,700
2005	142	60,400

[1]Harmonized Tariff System (HTS) heading 2512.00.0000, natural and straight-calcined grades, but in practice probably includes an undetermined quantity of flux-calcined product HTS heading 3806.90.2000.
[2]Data are rounded to no more than three significant digits.
[3]Free alongside ship U.S. customs value.

Source: U.S. Census Bureau.

TABLE 5
DIATOMITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country	2001	2002	2003[e]	2004[e]	2005[e]
Algeria	3	3	3 [3]	3 [3]	3
Argentina	17	23	36 [r, 3]	8 [r, p]	10
Australia[e]	20	20	20	20	20
Brazil, marketable[e]	7 [r]	6 [r, 3]	7 [r]	7 [r]	8
Chile	23	30	26 [3]	30 [r, 3]	30
China[e]	350	370	380	390	410
Colombia[e]	4	4	4	4	4
Commonwealth of Independent States[e, 4]	80	80	80	80	80
Costa Rica	26	26 [e]	26 [3]	27 [r]	27
Czech Republic	83	28	41	33 [r]	35
Denmark[e, 5]	231	230	232	233	234
Ethiopia[6]	(8) [e]	1 [e]	1 [3]	2 [3]	2
France[e]	85 [r]	80 [r]	80 [r, 3]	75	75
Germany	50	54	55 [3]	54	55
Iceland	30	26 [r]	28 [r, 3]	28 [r, 3]	29
Iran[7]	-- [r]	2 [r]	10 [r, 3]	8 [r, 3]	8
Italy[e]	25	25	25	25	25
Japan	129 [r]	124 [r]	112 [r, 3]	125 [r, 3]	130
Kenya	(8)	1	(8) [r]	(8) [r, 3]	(8)
Korea, Republic of	28	21	16 [3]	2 [r, 3]	2
Macedonia[e]	5	5	5	5	5
Mexico	69	62	53 [r, 3]	59 [r, 3]	62 [3]
Mozambique	--	--	-- [3]	3	5
Peru[e]	35	35	35	35	35
Poland	1	1	1	1 [3]	1
Portugal[e]	(8) [r]	(8) [r]	(8) [r]	(8) [r]	(8)
Romania	10	20	31 [3]	30	30
Spain[e, 9]	35	35	35	35	35
Thailand	1	1	1 [3]	1 [3]	1
Turkey[e]	10	10	10	10	10
United States[10]	644	624	599 [3]	620 [3]	653 [3]
Total	2,000 [r]	1,950 [r]	1,950 [r]	1,950 [r]	2,020

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

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

[2]Table includes data available through April 4, 2006.

[3]Reported figure.

[4]Information is inadequate for formulation of reliable estimates for individual countries.

[5]Data represent "extracted moler" (reported cubic meters times 1.5). Contains about 30% clay.

[6]Year ending July 7 of that stated.

[7]Data are for year beginning March 21 of that stated.

[8]Less than ½ unit.

[9]Includes tripoli.

[10]Sold or used by producers.