USGS
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2005 Minerals Yearbook

BROMINE

U.S. Department of the Interior
U.S. Geological Survey

October 2006

BROMINE

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Bromine is one of two elements that are liquid at normal temperatures. Bromine is found principally in seawater, salt lakes, and underground brines associated with oil. In 2005, the quantity of bromine sold or used in the United States was 226 million kilograms (Mkg) valued at $168 million (table 1). The average value of bromine sold or used was $0.74 per kilogram (table 1). Primary uses of bromine compounds were in flame retardants (FRs), drilling fluids, brominated pesticides (mostly methyl bromide), and water-treatment chemicals. World production of bromine, in descending order and percentage of total, for 2004 was estimated to be as follows: United States, 41%; Israel, 38%; China, 8%; Jordan, 8%; and other countries, 5% (table 5). Because of depleting reserves, distribution and economics, environmental constraints, and the emergence of Israel as the world's second-ranked producer, the United States portion of world production has decreased steadily since 1973, when the United States produced 71% of the world's supply.

Legislation and Government Programs

The cost of security and the price of natural gas had a depressing effect on the U.S. chemical industry, including bromine. The leading end use for bromine is in FRs that is used in plastic products. Natural gas used for electrical energy generation and heating competed with gas used in manufacturing plastics. During 2005, prices for petroleum and natural gas continued to increase, and the chemical industry called for a domestic energy policy.

On November 29, New Jersey became the first State in the Nation to introduce mandatory standards for chemical plant security. There are no equivalent national standards. The State's 140 chemical facilities are required to implement existing "best security practices" guidelines. These guidelines were largely crafted by the chemical industry and based on the American Chemistry Council's responsible care security codes (Ember, 2005, p. 13).

The pesticide methyl bromide was listed as a class I ozone-depleting substance in the 1990 Clean Air Act (CAA). Methyl bromide is a broad spectrum pesticide used in the control of nematodes, pathogens, pest insects, rodents, and weeds. Domestically, methyl bromide had proven to be difficult to replace because of its low cost and usefulness against a large variety of agricultural pests. Under the Montreal Protocol, developing countries had until 2015 to phase out methyl bromide production. Countries may request exemptions from phaseout requirements for uses where there are no feasible technical or economical alternatives. The United States made a formal request to the Ozone Secretariat of the United Nations to allow use of methyl bromide after the January 1, 2005, phaseout deadline. The United States and 11 other developed countries were approved to continue to use the fumigant in 2005. The United States is allowed to use methyl bromide at 37% of its 1991 baseline level in 2005 and at 32% in 2006. For the 2007 calendar year, the United States nominated use at 29% of baseline, and 26.4% of baseline was authorized for critical use (U.S. Environmental Protection Agency, 2006§[1]).

Production

Domestic production data for bromine were developed by the U.S. Geological Survey (USGS) from a voluntary canvass of U.S. operations. All of the seven operations to which a canvass form was sent responded (table 2).

Domestic production comes from brine wells in Arkansas and Michigan. After bromine processing, the spent brine was returned underground into the production formation by class V injection wells that are regulated by the U.S. Environmental Protection Agency (EPA). The chemical composition of the spent brine is generally similar to that of the original, except that the concentration of the target elements (such as bromine and magnesium) is reduced, and the concentration of other elements (such as calcium) may have increased through substitution (U.S. Environmental Protection Agency, 1999, p. 1, 2, 5). Brine in Arkansas is found in the Smackover Formation at a depth of about 2,400 meters (m) (8,000 feet) with concentrations of 4,000 to 4,600 parts per million (ppm) bromine.

Albemarle Corporation operated the Magnolia South and Magnolia West plants in Columbia County, AR, which produced bromine, inorganic bromides, and brominated FRs (BFRs) and the satellite plant at Marysville, AR, in Union County, which produced bromine. In addition, it maintained two facilities in Baton Rouge, LA, to conduct research and product development and to produce additives, catalysts, and FRs. Albemarle announced in 2005 that the active brine rights and leasing program was expected to provide the company with 50 years of proven bromine reserves (Albemarle Corp, 2005§).

Great Lakes Chemical Corp. merged on March 9 with Compton Corp. to form Chemtura Corp. Chemtura continued production of bromine from brines at plants in Union County, AR. Production was from the El Dorado Central, El Dorado South, Marysville West, and Newell plants. At yearend, the installation of a new well for the extraction of elemental bromine was announced. A chlorine plant to be built at the site of a bromine facility in El Dorado, AR, by Ashta Chemicals was announced. Associated Octel Co. Ltd. of the United Kingdom, which produced bromine from seawater, had closed in 2004.

TETRA Technologies, Inc. was one of the leading users of clear brine fluids (CBFs) in the world. Calcium bromide and

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

zinc bromide were purchased by TETRA from two domestic manufacturers and one foreign manufacturer. TETRA also recycled calcium- and zinc-bromide CBFs repurchased from its oil and gas customers. Its West Memphis, AR, facility produced calcium bromide and zinc bromide. TETRA began operation of an elemental-bromine, calcium-bromide, and sodium-bromide plant at The Dow Chemical Company's Ludington, MI, facility in mid-1998, using crude bromine purchased from Dow's calcium-magnesium chemicals operation. TETRA also owned approximately 33,000 gross acres (13,400 hectares) of bromine-containing brine reserves that are under lease (TETRA Technologies, Inc., 2005§). At yearend, Tetra announced the building of a bromine plant using the leased brines.

Recycling

Hydrogen bromide is emitted as a byproduct in many organic reactions. This byproduct waste is recycled with virgin bromine brines and is a major source of bromine production. Bromine contained in plastics, such as FRs, can be incinerated as a solid organic waste, and the bromine can be recovered (Frim and Ukeles, 2006).

Consumption

The USGS did not collect consumption data on bromine compounds. Apparent consumption of bromine in the United States, calculated by the USGS from production, exports, and imports, remained at an estimated 224 Mkg. The United States was the world's leading market for bromine.

Flame Retardants.—It was estimated that about 50% of the consumption of bromine was used in BFR chemicals commonly used in many domestic and industrial appliances and such equipment as computers, furniture, insulation boards, mattresses, mobile phones, televisions, and many others. About 90% of electrical and electronic appliances contain BFRs to increase their resistance to fire. BFRs are also used in textiles for upholstered furniture.

Healthcare.—A major use of bromine compounds was in the manufacture of pharmaceuticals. Brominated substances are important ingredients of many over-the-counter and prescription drugs, including analgesics, antihistamines, and sedatives. Some bromine containing drugs have proved effective in the treatment of cocaine addiction and pneumonia.

Petroleum.—Bromine compounds are used as a constituent of antiknock fluid in leaded fuel still used in small aircraft, farm equipment, and in third world countries.

Calcium bromide, sodium bromide, and zinc bromide, collectively referred to as CBFs, were used in the oil- and gas-well-drilling industry for high-density, solids-free completion, packer, and workover fluids to reduce the likelihood of damage to the well bore and productive zone. Increased domestic energy demand during 2005 resulted in increased drilling, and therefore, increased used of bromine in completion and packing of the wells (Firm and Ukeles, 2006).

Photography.—Bromine compounds are used to make the light-sensitive component of a photographic emulsion. Other bromine compounds are used in ingredients in photographic development.

Sanitary Preparations.—Bromine compounds are effective pesticides, used both as soil fumigants in agriculture, particularly fruit growing, and as a fumigant to prevent pests from attacking stored grain and other produce. World trade in agriculture goods depends on the use of bromine compounds to ensure compliance with mandatory quarantine rules. Bromine compounds are also used as intermediates to make other agriculture chemicals.

Use of all pesticides, including methyl bromide, on crops in California increased in 2004 (the latest year for which data were available) compared with 2003. The fumigant methyl bromide, however, showed a decline of 4% (134,000 kg or 295,000 pounds) (Brank, 2006).

Water Purification.—One of the major uses of bromine is as a water purifier/disinfectant as an alternative to chlorine. Brominated compounds are used for water treatment in swimming pools and hot tubs and are also used to control algae and bacterial growth in industrial processes.

Transportation

Bromine in bulk quantities is transported in the United States in 7,570- and 15,140-liter (L) lead-lined pressure tank railcars or 6,435- to 6,813-L nickel-clad pressure tank trailers. The trailers must be filled at least 92% full to prevent inertia effects of the heavy liquid while on the highway. International shipments by The Dead Sea Bromine Group (DSBG) are in 15.2- to 23.3-metric ton (t) lead-lined tank containers (isotanks) with a volume of 5,300 to 8,000 L. For smaller quantities, lead lined tanks ("goslars") of 3.5 t (four tanks packed on one isoframe) and cylinders of 400 kilograms are used. Dry nitrogen gas is recommended for use in pressure transferring bromine, although dry air may be used. The gas used must be absolutely dry or severe corrosion results. When exposed to a high-humidity atmosphere, the water content of bromine can exceed 300 ppm. If the water content increases above 70 ppm, then the corrosiveness of bromine to many metals increases (Ukeles and Freiberg, 2002§).

Prices

At yearend 2005, U.S. bromine prices were 14% lower than those at yearend 2004. The price, however, at yearend 2000 was historically high because of demand in electronics.

Chemtura and Albemarle both announced a price increase for bromine and bromine compounds. Included in the compounds were clear brines and brine components used as oilfield completion, drill-in, and workover fluids. The price increase was the result of a rise in cost of energy, key raw materials, regulatory compliance, and transportation.

The export value of elemental bromine increased by 93% during 2005. The export value of bromine compounds, including ethylene dibromide and methyl bromide, increased by 22% during 2005.

The import value of elemental bromine increased by 15% compared with 2004 levels. The import values of some bromine compounds increased, except for potassium bromide, sodium bromate, and other bromide compounds, which decreased by 27%, 3%, and 11%, respectively.

World Review

European Union.—The European Union made a decision to exempt the widely used BFR, deca-BDE, from its Restriction of Hazardous Substances. Deca-BDE was commonly used in computers, mattresses, mobile phones, office equipment, and TVs, upholstered furniture, and mattresses. Some 90% of all electrical and electronic appliances include BFRs (Greer, 2005).

Israel.—DSBG and Dead Sea Periclase announced its new corporate name, ICL Industrial Products (ICL-IP) in 2004. ICL-IP is the world's leading producer of elemental bromine and a leader in the development and supply of bromine compounds. ICL-IP was organized into six divisions. ICL-IP is a member of Israel Chemical Ltd., which includes Dead Sea Works, which controls potash and salt, and Rotem, which controls fertilizers. ICL-IP announced an increase in capacity from 40,000 metric tons per year (t/yr) to 240,000 t/yr by debottlenecking at its Sdom facility. The company also planned to use excess chlorine at the Sdom plant to manufacture bromine (Mining Engineering, 2005).

Jordan.—Jordan Bromine Company [a joint venture of Arab Potash Company Ltd. (APC) and Albemarle] produced bromine, calcium bromide, and sodium bromide at its plant at Safi on the Dead Sea. In 2004, production amounted to 46,000 metric tons. In December 2004, the company completed construction of its chlorine plant; this facility had a capacity of 25,000 t/yr (Albemarle Corp, 2005, p. 15).

Russia.—Bromine at a concentration of 5-9 kg/cubic meters (five times higher than the concentration of the Dead Sea) was discovered in the Volgograd Region. Bromine is 1 of 70 microelements contained in a large bischofite ($MgCl_2 6\ H_2O$) deposit. The bischofite was confined to a Permian salt-bearing formation in two separate layers. The outer layer of Pricaspian bischofite was encountered in bedding lenses at a depth of 900 to 2,000 m. The inner part of the deposit occurred as lenses in salt domes at a depth of 900 to 4,000 m and was folded. The deposit, with bed-like occurrences of bischofite salt, was formed by two layers of chlorine-magnesium salt 20 to 25 m thick separated by halite and inclined to the west in the direction of the Pricaspian depression. The deposit extends for almost 400 kilometers along both banks of the Volga River. Bischofite comprises 80% to 90% of the formation; the rest is impurities of isomorphic bromine (0.45% to 0.95%) (JSC "Bischofite Avangard," Bischofite Mining, 2006§).

Current Research and Technology

Bromine was being investigated by Southern Company for the removal of mercury from exhaust in coal-fired powerplants. The clean air mercury rule finalized in 2005 required phase I reductions by 2010 and phase II in 2018. Current mercury control tests have used activated carbon that is disposed of along with fly ash. Halogens introduced into the coal-fired powerplants' exhaust can combine with mercury and deposit in the gypsum effluent of wet scrubbers. Tentative results indicated that only a fraction of the amount of bromine as compared with chlorine was required for nearly complete removal of the mercury. Tests by the Electric Power Research Institute projected bromine costs that were slightly more than costs for chlorine per 500 megawatt hours, but the reaction rate was approximately eight times quicker. The mercury bromide is insoluble and could be washed from the gypsum slurry, allowing for mercury-free wallboard (Monroe, 2006, p. 24).

Outlook

Flame Retardants.—Bromine is used as FR in plastics and also acts in synergy with many other materials to increase the overall effectiveness of the FR. Between 40% and 50% of domestic demand for bromine is for FRs. Although usage fluctuates along with overall cycles in the economy, assuming sustained economic growth, demand was expected to grow by 4% per year. The ban and voluntary withdrawal of two polybrominated diphenyl ether compounds resulted in a decrease in demand for bromine between 2001 and 2004. Recycling efforts in Europe for BFR plastics in electrical usage, which are easier to recycle than some other FR compounds, may increase the demand for BFR products because they are thought to be more environmentally friendly, especially by countries concerned with recycling, such as Japan. Growth was expected to increase in BFRs overall as the Consumer Product Safety Commission approves fire safety standards for upholstered furniture in the United States and if higher flammability standards are voluntarily adopted for TVs in Europe.

The Fredonia Group forecast FR value to grow in the United States by 6.5% per year through 2008 with volumes rising by 3.2% per year to more than 453,600 t. The highest growth rate was expected in BFRs with an annual rise of 7% to $600 million.

Healthcare.—The use of bromine in pharmaceuticals was expected to increase in antihistamines if pseudoephedrine, a key ingredient in illegal methamphetamines, is made a prescription product.

Photography.—Digital imaging can produce prints and overhead transparencies without the need for wet processing film. This would appear to cause a decrease in bromine usage in color film and film processing; however, 75% to 85% of all televised programs seen during prime time are recorded on 35-millimeter motion picture film and then transferred to videotape or laser disc for display, and the majority of feature films for movie theater presentations are shot and printed on film because film provides higher image resolution. As digital imaging technology improves and digital equipment and printers become more affordable in the next decade, future uses of bromine in film and film processing may be limited to specialty film imaging.

Petroleum.—Demand for bromine as a gasoline additive has declined since the 1970s when the EPA issued regulations to reduce and eliminate lead in automotive gasoline. In 1979, the amount of bromine sold for this application had reached

a peak of 225 Mkg. The rapid decline to 141 Mkg in 1986 was a direct result of the limits on lead in leaded automotive gasoline. The Clean Air Act requires mobile sources, such as cars and trucks, to use the most effective technology possible to control emissions. Newer prototypes of the fuel cell that burn gasoline can double the mileage and decrease emissions by using unleaded gasoline or other nonbrominated fuels. The use of calcium-, sodium-, and zinc-bromides as CBFs in oil-well-completion and workover fluids has benefited in recent years from high gas and oil prices resulting from the increased demand for petroleum products. Increased demand for CBFs was expected to continue until alternative sources of fuel become available.

Sanitary Preparations.—The growth potential remains high for bromine-base biocides for use in industrial cooling systems because of environmental restrictions on chlorine and new alkaline-base chemical treatment programs. The most common bromine compounds used in cooling water are 1-bromo-3-chloro-5, 5-dimethylhydantoin and mixtures of sodium bromide with sodium hypochlorous acid. Bromine was used in indoor swimming pools, hot tubs, and whirlpools. Bromine has been found to be safer than its substitutes in sanitary preparations because bromine has a higher biocidal activity level for the same volume of product. The use of bromine compounds was expected to continue increasing in the spa and hot tub sector and to increase as a gentler disinfectant compared with chlorine in swimming pools.

References Cited

Albemarle Corp., 2005, Form 10-K for the fiscal year ended December 1, 2004: Richmond, VA, Albemarle Corp., 97 p.

Brank, Glen, 2006, DPR releases 2004 pesticide use data–more nature-friendly chemicals gain favor: Sacramento, CA, Department of Pesticide Regulation, January 24, 2 p.

Ember, Lois, 2005, New Jersey mandates chemical plant security: Chemical & Engineering News, v. 83, no. 49, p. 13.

Frim, R., and Ukeles, S.D., 2006, Bromine: Mining Journal, v. 57, no. 6, June, p. 23-24.

Greer, Carson, 2005, Albemarle Corp., EU exemption of deca-BDE clears the way for continued use: Richmond, VA, Albemarle Corp., 1 p.

Mining Engineering, 2005, Israel Chemicals adds to Dead Sea bromine capacity: Mining Engineering, v. 57, no. 6, June, p. 13.

Monroe, Larry, 2006, Mercury control in coal-fired power plants: Washington DC Chapter of Women in Mining Iodine meeting, June 1,Washington, DC, Presentation, 27 p.

U.S. Environmental Protection Agency, 1999, The class V underground injection control study—Spent brine flow wells: U.S. Environmental Protection Agency EPA/816-R-99-014i, 27 p.

Internet References Cited

Albemarle Corp. 2005, Company report and 10 K, accessed August 9, 2006, at URL http://www.albemarle.com/Investor_information/Financial_information/Annual_reports/2005/AR2005_10K.pdf.

JSC "Bischofite Avangard," 2006, Bischofite Mining, accessed May 25, 2006, via URL http://www.bischofite.ru/Eng/Geo/mining.htm.

TETRA Technologies, Inc., 2005, 2004 annual report, accessed April 29, 2005, via URL http://www.tetratech.com.

Ukeles, S.D., and Freiberg, M., 2002, Bromine, Kirk-Othmer Encyclopedia of Chemical Technology accessed August 10, 2006, at URL http://www.dsbg.com/Brome/brome.nsf/ExtensionsByUNID/97D9089E513A2A1B42256CA50036E5E4.

U.S. Environmental Protection Agency, 2006, Methyl bromide questions & answers, accessed July 7, 2006, via URL http://www.epa.gov/ozone/mbr.

GENERAL SOURCES OF INFORMATION

U.S. GEOLOGICAL SURVEY PUBLICATIONS

Bromine. Ch. in Mineral Commodity Summaries, annual.

Evaporites and Brines. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

Bromine. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

Bromine Science and Education Forum.

TABLE 1
SALIENT BROMINE AND BROMINE COMPOUNDS STATISTICS[1]

(Thousand kilograms and thousand dollars)

	HTS[2] number	2001	2002	2003	2004	2005
United States:						
Bromine sold or used:[3]						
Quantity		212,000	222,000	216,000	222,000	226,000
Value		159,000	166,000	155,000	191,000	168,000
Apparent consumption		214,000	216,000	210,000	224,000	224,000
Exports:[4, 5]						
Elemental bromine:	2801.30.2000					
Quantity		3,710	6,070	2,280	2,840	2,710
Value		3,600	4,680	3,090	2,070	3,990
Bromine compounds:[6]						
Gross weight		7,990	8,000	7,160	7,850	8,130
Contained bromine		6,740	6,750	6,040	6,600	6,830
Value		14,900	13,600	11,800	13,800	16,800
Imports:[4, 7]						
Elemental bromine:	2801.30.2000					
Quantity		5,610	2,020	1,920	2,650	2,740
Value		4,240	1,530	1,450	2,000	2,300
Bromine compounds:						
Ammonium bromide:	2827.59.2500					
Gross weight		59,700	16,900	46,600	3,310	58,200
Contained bromine		4,870	1,380	3,800	2,700	4,750
Value		29,200	8,850	21,100	1,520	30,400
Calcium bromide:	2827.59.2500					
Gross weight[8]		5,880	164	9	--	922 [8]
Contained bromine		4,700	131	7	--	--
Value		3,580 [e]	100 [e]	4 [e]	--	--
Potassium bromate:	2829.90.0500					
Gross weight		124	126 [8]	131 [9]	54	122
Contained bromine		59	36	63	26	58
Value		450	457 [e]	475 [e]	163	394
Potassium bromide:[9]	2827.51.0000					
Gross weight		433 [8]	171 [8]	497	598 [9]	434 [8]
Contained bromine		291	115	334	401	291
Value		1,060 [e]	417 [e]	1,210 [e]	1,800 [e]	1,310 [e]
Sodium bromate:	2829.90.2500					
Gross weight		1,020	1,020	967	992	950
Contained bromine		538	539	512	525	503
Value		2,190	2,020	2,010	1,930	1,860
Sodium bromide:[9]	2827.51.0000					
Gross weight[8]		NA	2,980 [8]	3,670 [8]	4,610 [8]	9,990 [8]
Contained bromine		NA	2,320	2,940	3,580	761
Value		NA	4,600 [e]	5,660 [e]	5,300 [e]	11,500 [e]
Other compounds:[10]						
Gross weight		5,950	4,920	3,280	4,630	5,400
Contained bromine		141	176	246	347	405
Value		5,360	6,090	19,000	19,400	17,300
World, production[e]		509,000 [r]	503,000 [r]	488,000 [r]	544,000 [r]	555,000

See footnotes at end of table.

TABLE 1—Continued
SALIENT BROMINE AND BROMINE COMPOUNDS STATISTICS[1]

[e]Estimated. [r]Revised. NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits.
[2]Harmonized Tariff Schedule of the United States.
[3]Elemental bromine sold as such to nonproducers, including exports, or used by primary U.S. producers in preparing bromine compounds.
[4]Source: U.S. Census Bureau.
[5]Export values are free alongside ship.
[6]Source: U.S. Census Bureau. Includes methyl bromine and ethylene dibromide.
[7]Import values are cost, insurance, and freight.
[8]Source: The Journal of Commerce Port Import/Export Reporting Service.
[9]"Potassium bromide" and "Sodium bromides" import data are usually reported by a mutual HTS number, 2827.51.0000.
[10]Data for these compounds are derived from HTS number 2903.30.0500 (2001-02 and 2004-2005), and 2903.30.1520 (2002-05) information.

TABLE 2
ELEMENTAL-BROMINE-PRODUCING PLANTS IN THE UNITED STATES IN 2005

State and company	County	Plant	Production source	Capacity[1] (million kilograms)
Arkansas:				
Albemarle Corporation	Columbia	Magnolia South	Well brines	(2)
Do.	do.	Magnolia West	do.	(2)
Do.	Union	Satellite plant	do.	148 [2]
Chemtura Corporation	do.	El Dorado Central	do.	(3)
Do.	do.	El Dorado South	do.	71 [3]
Do.	do.	Marysville West	do.	36
Do.	do.	Newell	do.	23
Michigan, The Dow Chemical Company	Mason	Ludington[4]	do.	9
Total				287

[1]Actual production capacity is limited by brine availability.
[2]Cumulative capacity of Magnolia South, Magnolia West, and satellite plants.
[3]Cumulative capacity of El Dorado Central and El Dorado South plants.
[4]Bromine produced at this plant is reprocessed in Arkansas.

TABLE 3
U.S. IMPORTS OF OTHER BROMINE COMPOUNDS[1, 2]

		2004		2005		
Compound	HTS[3] number	Gross weight (kilograms)	Value[4] (thousands)	Gross weight (kilograms)	Value[4] (thousands)	Principal sources, 2005
Hydrobromic acid	2811.19.3000	753	$543	222	$286	Israel, 96%; other, 4%.
Ethylene dibromide	2903.30.0500	548	395	499	337	Israel, 100%.
Methyl bromide	2903.30.1520	821	2,690	327	1,620	Israel, 100%.
Dibromoneopentyl glycol	2905.50.3000	995	3,260	995	3,260	Israel, 99%.
Tetrabromobisphenol A	2908.10.2500	658	1,800	414	1,480	Israel, 96%; India, 2%; Japan, 2%.
Decabromodiphenyl oxide and octabromodiphenyl oxide	2909.30.0700	4,360	8,080 [e]	4,630	9,790	Israel, 99%; other, 1%.
Total		8,130	16,800	8,130	16,800	

[e]Estimated.
[1]These data detail the information included in table 1 under "Imports, bromine compounds, other compounds."
[2]Data are rounded to no more than three significant digits; may not add to totals shown.
[3]Harmonized Tariff Schedule of the United States.
[4]Declared cost, insurance, and freight valuation.

Source: U.S. Census Bureau.

TABLE 4
WORLD BROMINE ANNUAL PLANT CAPACITIES AND SOURCES AS OF DECEMBER 31, 2005[1]

Country and company or plant	Location	Capacity (thousand kilograms)	Source
Azerbaijan, Neftechala Bromine Plant	Baku	4,000	Underground brines.
China, Laizhou Bromine Works	Shandong	43,000	Do.
India:			
Hindustan Salts Ltd.	Jaipur	NA	Seawater bitterns from salt production.
Mettur Chemicals Ltd.	Mettur Dam	NA	Do.
Tata Chemicals Ltd.	Mithapur	NA	Do.
Total		1,500	
Israel, Dead Sea Bromine Co. Ltd.	Sdom	210,000	Bitterns of potash production from surface brines.
Italy, Societa Azionaria Industrial Bromo Italiana	Margherita di Savoia	900	Seawater bitterns from salt production.
Japan, Toyo Soda Manufacturing Co. Ltd.	Tokuyama	20,000	Seawater.
Jordan, Jordan Bromine Co. Ltd.	Safi	50,000	Bitterns of potash production from surface brines.
Spain, Derivados del Etilo S.A.	Villaricos	900	Seawater.
Turkmenistan:			
Nebitag Iodine Plant	Vyshka	3,200	Underground brines.
Cheicken Chemical Plant	Balkan	6,400	Do.
Ukraine, Perekopskry Bromine Plant	Krasnoperckopsk	3,000	Do.

NA Not available.
[1]Excludes U.S. production capacity, which is detailed in table 2.

TABLE 5
BROMINE: ESTIMATED WORLD REFINERY PRODUCTION, BY COUNTRY[1, 2]

(Thousand kilograms)

Country[3]	2001	2002	2003	2004	2005
Azerbaijan	2,000	2,000	2,000	2,000	2,000
China	40,000	42,000	42,000	43,000	43,000
France	2,000	2,000	2,000	2,000	2,000
Germany	500	500	500	500	500
India	1,500	1,500	1,500	1,500	1,500
Israel	200,000 r, 4	185,000 r, 4	176,000 r, 4	202,000 r, 4	210,000
Italy	300	300	300	300	300
Japan	20,000	20,000	20,000	20,000	20,000
Jordan	-- 4	-- r, 4	-- r, 4	46,000 r, 4	46,000
Spain	100	100	100	100	100
Turkmenistan	150	150	150	150	150
Ukraine	3,000	3,000	3,000	3,000	3,000
United Kingdom	27,900 r, 4	24,500 r	25,000 r	1,000 r	--
United States[5]	212,000 4	222,260 4	216,000 4	222,000 4	226,000 4
Total	509,000 r	503,000 r	488,000 r	544,000 r	555,000

rRevised. -- 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.
[2]Table includes data available through June 26, 2006.
[3]In addition to the countries listed, several other nations, including Iran, produced bromine, but output data were not reported; available general information is inadequate to formulate reliable estimates of output levels.
[4]Reported figure.
[5]Sold or used by producers.