IODINE

By Phyllis A. Lyday

Domestic survey data and tables were prepared by Lisa D. Miller, statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.

Two producers of crude iodine supplied about one-fifth of the domestic demand in 2002 according to reported figures (table 1). Domestic and imported iodine was consumed in intermediate products prior to being sold to consumers (table 2). Iodine and its derivatives, in decreasing order, are used principally in animal feed, catalysts, colorants, inks, pharmaceutical and medical applications, photographic equipment, sanitation or disinfectants, and rosin stabilizers. Published prices for crude iodine in 2002 are found in table 3. Imports of crude iodine increased by 23%, and those of potassium iodide increased by 21% (table 4). Exports of crude iodine decreased by 2%, and those of potassium iodide increased by 254% during 2002 (table 5). Because some exports and imports are in product categories rather than listed as elemental iodine, net imports are not clearly distinguished. The United States is the world's third largest iodine producer, following Japan and Chile. In Chile, iodine is a coproduct of sodium nitrate production. Japan produces iodine from brines associated with natural gas production (table 6).

Legislation and Government Programs

The Defense Authorization Act for Fiscal Year 2003 (Public Law 107-248) was enacted on December 2, 2002. The Revised FY 2002 Annual Materials Plan authorized the disposal of 453,593 kilograms (kg) (1 million pounds) of crude iodine from the National Defense Stockpile (NDS) classified as "excess to goal" (U.S. Department of Defense, 2001). Stocks of iodine classified at the end of fiscal year 2002 (September 30, 2002) were subject to disposal limits. On January 4, 2002, the Defense National Stockpile Center (DNSC) announced the sale of 9,100 kg (20,000 pounds) at a value of $112,000 [$12.35 per kilogram ($5.60 per pound)] (Defense National Stockpile Center, 2002a). On March 8, 2002, the DNSC announced the sale of about 4,500 kg (10,000 pounds) at a value of $55,000 [$12.12 per kilogram ($5.50 per pound)] (Defense National Stockpile Center, 2002b). On June 10, 2002, the DNSC announced no award for crude iodine (Defense National Stockpile Center, 2002d). On September 12, 2002, the DNSC announced the sale of about 11,800 kg (26,000 pounds) at a value of $140,000 [$11.87 per kilogram ($5.38 per pound)] (Defense National Stockpile Center, 2002c). At yearend sales totaled 25,400 kg (56,000 pounds) valued at $307,000, and the excess iodine was 1.66 million kilograms (Mkg) (3.66 million pounds) valued at $20.5 million [$12.26 per kilogram ($5.56 per pound)].

Under the National Pharmaceutical Stockpile Program, which is jointly managed by the Centers for Disease Control and the U.S. Department of Homeland Security, Federal officials are poised to move drugs and supplies in an emergency anywhere in the country within 12 hours. The stockpile program was created in 1999 to help States and cities respond to public emergencies resulting from terrorist attacks or natural disasters. States must be prepared with health professionals who can distribute the drugs and supplies.

The Nuclear Regulatory Commission (NRC) has regularly purchased potassium iodide (KI) pills to give to nuclear powerplant workers nationwide. The pills were stockpiled to be shipped after a radiological event. Radioactive iodine is only one of several radioactive substances that could be released either in a nuclear explosion or by a conventional explosion that spreads radioactive material, but it represents the greatest threat because in the vaporized form it can spread over hundreds of kilometers. The pills would be ineffective against other radioactive substances, such as plutonium, strontium, or tritium (Boyer and Gertz, 2002).

The U.S. Food and Drug Administration (2002§[1]) provided guidance to questions that may arise as State and local governments formulate emergency response plans pertaining to the use of KI in the event that radioactive iodine is accidentally released into the atmosphere. When used correctly, KI can prevent or reduce the uptake of radioiodine by the thyroid gland. KI provides optimal protection when administered immediately prior to or in conjunction with passage of a radioactive cloud.

The approved over-the-counter sale of KI in 1982. Recommended daily allowances of iodine for 10 to 14 days following a nuclear event were as follows: infants, 16 micrograms (µg); children 1 month to 3 years, 32 µg, and age 3 to 18, 65 µg; and adults over 18 and pregnant or lactating women, 130 µg. A one-quarter teaspoon of iodized table salt provides 95 µg of iodine. A 170-gram (6-ounce) portion of ocean fish provides 650 µg of iodine. Most people are able to meet their iodine requirements by eating iodized salt, plants grown in iodine-rich soil, seafood, and seaweed.

Pennsylvania was the third State to distribute free KI antiradiation pills to citizens living within a 16-kilometer (km) radius of nuclear powerplants. There are five nuclear facilities in the State with more than 650,000 people living within a that radius. The Pennsylvania Homeland Security Office joined the States of Delaware and New Jersey in providing the free tablets (Gordon, 2003). The NRC advised States that free stockpiles of KI were available by request (Crane, 2002§).

The U.S. Postal Service (USPS) was purchasing nearly 1.6 million pills for distribution to workers. Two tablets would be given to any employee who wanted to have the pills. The recommendation was a result of a decision by the Mailing Security Task Force (McDonough, 2002§).

In January, the NRC announced that it would provide free stockpiles of KI to 33 States that had residents living within a 10-mile (16-km) radius of the Nation's nuclear reactors. Anbex,

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

Inc., Tampa, FL, was manufacturing the tablets for distribution.

Production

The U.S. Geological Survey (USGS) derived domestic production data for iodine from a voluntary canvass of U.S. operations. The three companies to which a survey request was sent responded, representing 100% of the total production (tables 1, 6).

In 1987, IOCHEM Corp. began producing iodine at a plant 1.2 km east of Vici, Dewey County, OK. IOCHEM, which owned the largest U.S. iodine plant, was owned by the Kita family and Tomen Corp. The majority of production was shipped to Schering AG of Germany under a long-term contract. IOCHEM reported having nine production wells and four injection wells with a total production capacity of 1,400 metric tons per year (t/yr).

North American Brine Resources began operating one miniplant permanently located at Dover, Kingfisher County, OK, in 1983. In 2002, the miniplant continued operating at an oilfield-injection-disposal site near Dover.

Ise Chemical Corporation of Japan owned Woodward Iodine Corp., which began production in 1977. Woodward's plant in Woodward County, OK, produced iodine from 22 brine production wells and injected waste through 10 injection wells. MIC Specialty Chemicals, Inc. (a subsidiary of Mitsubishi International Corp.) was the exclusive distributor of iodine produced by Woodward.

Consumption

In 2002, estimated end uses for iodine were as follows: sanitation, 45%; animal feed, 27%; pharmaceuticals, 10%; catalysts, 8%; heat stabilizers, 5%; and other (including inks and colorants, photographic chemicals, laboratory reagents, production of batteries, high-purity metals, motor fuels, and lubricants), 5% (table 2).

It was estimated that 45% of consumed iodine comes from brines processed in the Commonwealth of Independent States, Indonesia, Japan, and the United States (Industrial Minerals, 2002).

Commercial crude iodine normally has a minimum purity of 99.5% or 99.8% depending on the supplier. Impurities are chiefly water, sulfuric acid, iron, and insoluble materials. The U.S. Pharmacopeia (2003) specifies iodine content of not less than 99.8%. The Committee on Analytical Reagents of the American Chemical Society allows a maximum of 0.005% total bromine and chlorine and 0.010% nonvolatile matter.

Radiopaque agents are drugs used to help diagnose certain medical problems. They contain iodine, which absorbs x rays. Radiopaque-diagnosed medical problems included brain disorders, cardiac disease, central nervous system disorders, cerebrospinal fluid, disk disease, gastrointestinal (gall bladder) disorders, peritoneal disorders, splenic and portal vein disorders, urinary track disorders, and vascular disease. The companies that represent 96% of the medical diagnostics market are as follows: Amersham Health plc (AH), 38%; Bracco Diagnostics Inc., 18%; Mallinckrodt Inc., 14%; Schering AG, 12%; Bristol-Myers Squibb Co., 12%; Guerbet Laboratories Ltd., 2%; and others, 4% (Amersham plc, 2003§). The most effective contrast medium has three iodine atoms attached to its benzene ring. Increasing the iodine content increases the likelihood of complications related to osmolality (dehydration, nausea, and pain).

In the global medical diagnostics market, Amersham International plc's healthcare business merged with Nycomed Pharma AS's imaging business to form Nycomed Amersham Imaging to then form AH, which develops and manufactures diagnostic pharmaceuticals that allow physicians to visualize the human body, from organs to molecules, and a line of immunotherapy products. AH is in the global diagnostics market and provider of x ray, ultrasound, and nuclear imaging agents, the later used in spectroscopy and positron emission tomography scanning machines. Its radiotherapies-four brachytherapies, or "seed," implant for cancer treatment and pain palliation captured 50% of the worldwide radiotherapy market. Omnipaque, a nonionic contrast agent, was believed to cause fewer adverse drug reactions compared with other products and was one reason for the company's growth. The company's line of brachytherapies—OncoSeed (I^{125}) and EchoSeed (I^{125}), which are methods of implanting the therapeutic seed more precisely—is the basis for a line of less invasive products for physicians. The seeds, each about the size of an uncooked grain of rice, are implanted into tumors by using a minimally invasive outpatient procedure. The seeds give off localized doses of radiation without harming healthy tissue, allowing physicians to use it for a wide variety of cancers (Breitstein, 2002).

Iodine is used in tall oil and rosins as a stabilizer. Tall oil rosins (TORs) are friable glassy materials that range from light yellow to dark brown in color and are derived from crude turpentine, extraction of ground timber by organic solvents, or distillation of crude tall oil. TORs are used in the production of synthetic rubber, natural rubbers, and plastic; in skins and varnishes; as a dead flux for tinning and soldering of metals; and by applying, or "drawing," the rosin on a surface of the hair of string instrument bows. Crude tall oil (CTO) originates as tall oil soap, which is separated from recovered black liquor in the Kraft pulping process. The soap is then acidified to yield CTO. The tall oil is fractionated to produce fatty acids, pitch, and rosin. Fatty acids are sold in competition with vegetable fatty acids to producers of detergents, oilfield chemicals, and paint or are converted to derivatives, such as dimer acid. Rosin is almost always chemically modified into esters or adducts that are used to make adhesives, inks, and paper size.

MeadWestvaco Corp. was formed in February 2002 with the merger of Mead Corp. and Westvaco Corp. Its two tall oil plants at Charleston Heights, SC, and De Ridder, LA, have a combined capacity of 215,000 t/yr and use iodine in the processing of TORs (Chemical Market Reporter, 2003).

Honeywell International Inc. acquired BASF Corp.'s nylon fibers business and combined the operations with its nylon carpet fiber and specialty fiber businesses, which include nylon, polyester, polyethylene naphthalate, and Spectra polyethylene fibers. Iodine is used as a catalyst in the manufacture of nylon. Honeywell will receive the headquarters at Charlotte, NC, polymerization and fiber plants in South Carolina and Ontario, Canada, and a carpet fibers plant in Shanghai, China (Tullo, 2003).

Hercules Inc. planned to expand its cost reduction program further with plans to sell its water-treatment division to General Electric Company. Hercules is a major consumer of iodine as a stabilizer for TORs. As a result, Hercules expected an additional $25 million in net annual savings, bringing the total savings for the remaining company, including the cost reductions implemented in 2001, to $150 million by the end of 2002.

Eastman Kodak planned to close the 70,000-t/yr Savannah, SC, CTO plant by 2003 and to expand its Franklin, VA, plant capacity to 100,000 t/yr from 70,000 t/yr (De Guzman, 2002). Eastman uses iodine in the production of acetic acid for the manufacture of films.

Johnson Wax Professional acquired DiverseyLever on May 6, 2002. DiverseyLever was formerly Unilever's institutional and industrial cleaning business that consumed iodine in some of the disinfectants. The acquisition created the second largest company in the institutional and industrial cleaning market (S.C. Johnson Commercial Markets, Inc., 2002§).

Iodine is one of many nutritional and nonnutritional minerals used in animal feed. Nutritional minerals include limestone, magnesia, phosphates and salt, and smaller amounts of cobalt, copper, iodine, iron oxide, selenium, and zinc. In the United States, the cattle feed market was depressed by the summer 2002 drought in the main cattle-rearing States of Colorado, Nebraska, Oklahoma, and Texas. High prices for hay and feed resulted in farmers selling the cattle early and needing less feed supplies than usual (Willis, 2002).

Prices

Actual prices for iodine are negotiated on long- and short-term contracts negotiated between buyers and sellers. The average declared cost, insurance, and freight (c.i.f.) value for imported crude iodine was $12.71 per kilogram. The average declared c.i.f. value for iodine imported from Chile was $12.71 per kilogram. The average declared c.i.f. value for imported crude iodine from Japan was $12.66 per kilogram. The average sale price of iodine sold by the DNSC was $12.26 per kilogram ($5.56 per pound). Published yearend U.S. prices for iodine and its primary compounds are listed in table 3. Solicitations for NDS iodine sales are made on a quarterly basis. Since 1998, only three companies—Dewey Chemicals Inc., H&S Chemical Co. Inc., and West Agro Chemical Inc.—have purchased stockpile iodine. Producers believe that the large quantities of iodine the NDS offers for sale each year depress the price that producers can ask because they are in competition with 1 million pounds [454 metric tons (t)] of excess stockpile iodine each year (figure 1).

During the past few years, the iodine market was oversupplied, and prices dropped. Sociedad Quimica y Minera de Chile SA (SQM) reported a decline in the average sale prices for iodine by $1.30 per kilogram during 2002 compared with 2001. However, during the fourth quarter of 2002, the increased global demand for iodine resulted in price increases (Van Savage, 2003).

During 2002, U.S. domestic iodine prices fell because U.S. chemicals became less competitive owing to a strong U.S. dollar that made the United States an attractive destination for exports from foreign countries and U.S. exports more costly (Hamel, 2003).

Foreign Trade

The U.S. Government adopted the harmonized commodity description and coding system as the basis for its export and import tariff and statistical classification systems. The system is intended for multinational use as a basis for classifying commodities in international trade for tariff, statistical, and transportation purposes. It includes unification of resublimed and crude iodine under the same code and a free duty rate. Values that differ significantly could be a result of items being placed in the wrong category (tables 4, 5). The International Trade Administration of the U.S. Department of Commerce provides monthly and annual import and export data by harmonized tariff code.

The U.S. Census Bureau reported domestic crude iodine shipments, including interplant transfers, to be 1,760 t (3.87 million pounds) valued at $25.4 million in 2001 and 1,560 t (3.44 million pounds) valued at $24.3 million in 2000.

World Review

The worldwide production of iodine in 2002 was estimated to be 20,700 t, of which 11,400 t (55%) was from Chile, and 6,500 t (31%) was produced in Japan. Industrial uses of iodine are still increasing, and areas of applications are expanding beyond the established markets, which are as follows: catalysts, germicides and disinfectants, pharmaceuticals, various additives, x-ray contrast media, and other.

Chile.—Atacama Minerals Corp. reported that its 50% owned Aguas Blancas industrial mineral project located in the Atacama Desert of northern Chile was in its first full year of production in 2002. Operating costs were reported below budget, and total iodine production was 710 t. Iodine prices in 2002 continued a downward trend not experienced by the industry for some time. This trend stabilized by the end of the year, and Atacama successfully established itself as a new and serious supplier of the highest quality iodine, capable of regular supply in quantity. Consequently, processed iodine inventories at Aguas Blancas remain consistently low. Full production at Aguas Blancas (1,500 t of iodine, 300,000 t of sodium sulfate, and 100,000 t of nitrates) requires the construction of a mechanical leaching facility to maximize recoveries from the salt-rich ore at Aguas Blancas. Construction of a pilot mechanical leach plant was expected to be operations by the third quarter of 2003. Design and development of a full-scale commercial plant by September 2004 will follow successful testing and operation of the pilot facility. Significantly, this small pilot operation could increase monthly iodine production at Aguas Blancas by as much as 10% and will produce commercial quantities of sodium sulfate. Aquas Blancas expected to be one of the lowest cost producers of sodium sulfate, enjoying an industry advantage of coproduct production (iodine, sodium sulfate and nitrates) from the same ore. At full production, Aguas Blancas will be the largest producer of sodium sulfate in South America (Richard Clark, Atacama Minerals Corp., written commun., October 9, 2003).

SQM was the largest producer of iodine. All production is from caliche ore. The geologic origin of the caliche ore is not

clear, but it is thought to be of sedimentary origin. There is from 0.5 to 2.5 meters of overburden above the ore. Iodine concentrations vary among mines, but as a reference, SQM extracted 23 Mt of ore in 2002 in Maria Elena, Pampa Blanca, and Pedro de Valdivia with an average of 432 parts per million of iodine. At the end of 2002, mining operations were resumed to increase iodine production. Ore was crushed to one-half inch size and transferred to a leaching plant in vats where nitrate, iodine, and sulfate are extracted. At the Pampa Blanca Mine, located in the Sierra Gorda area, the ore is leached in piles to obtain solutions of iodine, which are transported to solar evaporation ponds. SQM produced an intermediate iodine at Maria Elena, Pampa Blanca, Pedro de Valdivia, and Nueva Victoria facilities. The iodine is treated at the Pedro de Valdivia and Nueva Victoria plants to obtain refined iodine that is smelted, prilled, and packed for shipping. SQM has a 50% ownership in AJAY-SQM Group (Sociedad Quimica y Minera de Chile SA, undated).

China.—No more than 2% of consumed iodine comes from seaweed grown primarily in the northern coast of Jiangsu Province and in Shandong and Zhejiang Provinces (Industrial Minerals, 2002).

Japan.—Japan was the world's second largest producer of iodine (table 6). Iodine was manufactured in Chiba, Miyazaki, and Niigata Prefectures; Chiba Prefecture accounted for about 90% of all production in Japan. The following companies operated plants in Japan: Ise Chemical Co, Ltd., two plants in Chiba Prefecture and one in Miyazaki Prefecture, 300 metric tons per month (t/mo); Kanto Natural Gas Development Co., Ltd., Chiba Prefecture, 100 t/mo; Godo Shigen Sangyo Co., Ltd., Chiba Prefecture, 200 t/mo; Japan Energy Development Co., Ltd., Niigata Prefecture, 30 t/mo; Teikoku Oil Co. Ltd., Chiba Prefecture, 50 t/mo; Toho Earthtech, Inc., Niigata Prefecture, 60 t/mo; Nippoh Chemicals Co., Ltd., Chiba Prefecture, 60 t/mo; and Nihon Tennen Gas Co., Ltd., two plants in Chiba Prefecture, 100 t/mo.

Russia.—Iodine content in brines ranges between 30 and 90 milligrams per liter (mg/L) in 20 oilfields of Northern Sakhalin. The highest grade field is the Odoptu where recovery of the iodine content could produce 30 metric tons per day of iodine (Elena Sabirova, American Business Center, written commun., March 19, 2001).

An oil deposit was discovered in Tyumen Oblast, 30 km from the city of Tobolsk. The average content of iodine in the brine is 26 mg/L. Production of 300 t/yr to 500 t/yr for 25 years was estimated (Vladimir Spivak, written commun., August 13, 2002).

A foreign investment project was offered by the Trotsky Iodine Plant. An investment of $15.5 million was sought to reconstruct and increase production capacity of iodine and iodine derivatives at the plant (Foreign Investment Promotion Center, undated§).

The new Land Code of Russia, which took effect on October 30, represented a significant reform owing to sanction and encouragement given to the creation of private ownership rights to land, including ownership rights to foreigners. The full provisions of the Land Code apply only to certain nonagricultural land, which constitutes approximately 2% of Russia's land surface (Moore, 2002).

Turkmenistan.—State Corporation TurkmenDokunKhimiya produces iodine in Turkmenistan at the following state-owned iodine facilities: the Balkanabad Chemical Plant, Boyadag State Chemical Plant, and Hazar State Chemical Plant. The combined nameplate iodine capacity of these plants is about 600 t/yr. In November 2001, TurkmenDokunKhimiya announced a tender for the construction of five new plants with a granulated iodine production capacity of 100 t/yr each, or 500 t/yr in total capacity.

Current Research and Technology

A study sponsored by Press Enterprise of Riverside, CA, found perchlorate, which disrupts thyroid uptake of iodine, in all 18 samples of lettuce analyzed, and a test sponsored by the Environmental Working Group detected perchlorate in 4 of 22 lettuce samples contaminated by irrigation water in southern California. The source is believed to be irrigation water from the lower Colorado River, which carries perchlorate from a former industrial plant near Las Vegas, NV. In 2002, the U.S. Environmental Protection Agency (EPA) planned to lower the safe level of perborate to 1 part per billion (ppb), but the U.S. Department of Defense (DOD) advocated a 20-ppb standard. The EPA, joined by the DOD, the U.S. Department of Energy, and the National Aeronautics and Space Administration, asked the National Academies to review the health impact of perchlorate (Chemical & Engineering News, 2003).

Outlook

During the past decade, iodine production capacity in Chile and the United States has doubled, thus ensuring an adequate world supply. Global demand for iodine increased between 4% and 5% in 2002, and the demand for 2003 was forecast to increase by 3% (Van Savage, 2003). Although most of the iodine producers are operating at close to full capacity, some tightness may occur in the short term. The outlook for iodine for the next 5 years is favorable. Domestic demand was expected to remain at current levels because production of derivatives listed in table 2 is expected to move overseas.

Animal Feed Supplements.—Iodine is a necessary part of animal feed to prevent goiter and to regulate metabolism. People commonly receive iodine from the KI added to salt. Demand for KI as a preventive of cancer of the thyroid in the event of a nuclear accident increased sales of pills to government and to private individuals. Demand for KI is expected to peak during 2003 with the distribution of pills to States through a Federal Government program.

Catalyst.—Iodine is used as a catalyst in the making of various chemicals, including acetic acid. Feedstock costs for natural gas increased, resulting in lower profits and increases in prices of acetic acid. Acetic acid used as a solvent in the production of terephthalic acid is growing at a rate of 4.5% per year. The demand for bottles made from polyethylene terephthalate for carbonated drink is increasing, thus increasing demand for iodine. Vinyl acetate production, the largest market for acetic acid, was growing at about 3% per year (Kirschner, 2003).

Photography.—Recent developments in digital imaging can

produce electronic prints and overhead transparencies without the need for wet-processing film. Using a digital camera or scanning the film and converting to digital tapes, the images are produced and stored on disks, hard drives, and tapes. Digital imaging is used for recording most sporting events, game shows, and some situation comedies for television broadcast. This would appear to cause a decrease in iodine usage in color film and developing, but between 75% to 85% of all televised programs seen during prime time are recorded on 35-millimeter (mm) motion picture film and then transferred to videotape or laser disc for display. Furthermore, the majority of feature films for movie theater presentations are shot and printed on film because of better image quality. A frame of 35-mm color negative film contains about 6.6 million pixels, or about 15 times that of the best high-definition television system and 4 times that of the digital systems now in development. Most popular home video rentals have been box office movie hits that were filmed and then transferred to video. In the next decade, future uses of iodine in films and processing could be limited to specialty imaging as digital imagery technology improves and the cost of equipment becomes more affordable.

Stabilizers.—CTO stocks increased during 2002 because of weak demand for CTO derived products, thus resulting in less demand for iodine as a stabilizer. Inventories of CTOs decreased because of restructuring in the pulp and paper industry. CTO exports have reduced the need for additional storage facilities. Crude and refined tall oil stocks have increased since 2001. Average stocks from January to March 2000 were 63,900 t (141 million pounds). In March 2002, CTO stocks were 88,900 t (196 million pounds), a 39% increase according to the U.S. Census Bureau (De Guzman, 2002). Demand for CTOs was expected to increase and deplete stocks when the pulp and paper industry restructuring is completed.

Surfactants.—Demand for biocides and disinfecting chemicals was up by about 7.8% in 2002. The water-treatment market moved from South America to India and Pakistan and then into China. Expanding treatment of water supplies will increase the demand for these chemicals in the future (Challener, 2003).

X-ray Contrast Media.—X-ray contrast media, which contain as much as 60% iodine, will continue to grow between 4% and 5% per year. In 10 years, 20% of the population of Japan, the United States, and Western Europe will be over the age of 65. Improved diagnostic testing can allow physicians to intervene in illness earlier, keeping patients healthier longer and reducing hospitalization costs (Breitstein, 2002). More medical tests on an older population will result in increased demand for iodine containing x-ray contrast media.

Other.—New uses of fluoroiodocarbon as halogen replacements may increase demand for iodine in fire suppression chemicals. More tests need to be completed on the iodated fluorocarbons before they are acceptable, but preliminary tests were promising. Supplemental programs designed to alleviate iodine deficiency disease (IDD) in China and India were consuming large amounts of iodine to prevent IDD. In Chile and Mexico, individual water purification units that use iodine are a new application of a historical purification process. Purification applications could become significant consumers of iodine.

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TABLE 1
SALIENT IODINE STATISTICS[1]

(Thousand kilograms unless otherwise specified)

	1998	1999	2000	2001	2002
United States:					
Production	1,490	1,620	1,470	1,290	1,420
Imports for domestic consumption[2]	5,660	5,140	4,790	5,020	6,190
Exports[2]	2,720	1,110	1,010	1,460	1,430
Consumption:					
Reported[3]	4,100	4,540	3,990	3,560 r	4,540
Apparent[4]	4,950	5,990	5,420 r	4,730 r	6,520
Price, imports, average cost, insurance, and freight value[2] dollars per kilogram	$16.45	$16.15	$14.59	$13.94	$12.70
World, production	18,600	18,400	19,500 r	20,700 r	20,700 e

eEstimated. rRevised.
[1]Data are rounded to no more than three significant digits, except prices.
[2]Source: U.S. Census Bureau information reported by Harmonized Tariff Schedule of the United States number 2801.20.0000.
[3]Reported by voluntary response to the U.S. Geological Survey from a survey of domestic establishments.
[4]Calculated by using domestic production plus imports minus exports plus adjustments for Government and domestic industry stock changes.

TABLE 2
DOMESTIC CONSUMPTION OF CRUDE IODINE, BY PRODUCT[1]

Product	2001 Number of plants	2001 Quantity (thousand kilograms)	2002 Number of plants	2002 Quantity (thousand kilograms)
Inorganic compounds:				
Resublimed iodine	6	91	9	317
Potassium iodide	5 r	297	8	469
Sodium iodide	5	382	7	557
Ammonium iodide	--	--	1	W
Calcium iodate	--	--	1	W
Cuprous iodide	1	W	2	W
Hydriodic acid	2	W	3	W
Potassium iodate	3	69	3	90
Other inorganic compounds	4	976 r	4	883
Total	16 [2]	1,820	16 [2]	2,320
Organic compounds:				
Ethylenediamine dihydroiodide	1	W	3	182
Methyl and/or ethyl iodide	2 r	W	2	W
Povidine-iodine (idophors)	--	--	--	--
Other organic compounds	5 r	1,750 r	7	2,050
Total	16 [2]	1,750 r	16 [2]	2,240
Grand total:				
Reported consumption[3]	16 [2]	3,560 r	16 [2]	4,540
Apparent consumption[4]	16 [2]	4,730	16 [2]	6,520

rRevised. W Withheld to avoid disclosing company proprietary data; included with respective "Other inorganic compounds" and "Other organic compounds." -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Nonadditive because some plants produce more than one product concurrently.
[3]Reported by voluntary response to the U.S. Geological Survey in a survey of domestic establishments.
[4]Calculated by using domestic production plus imports minus exports plus adjustments for Government and domestic industry stock changes.

TABLE 3
YEAREND 2002 PRICES OF ELEMENTAL IODINE AND SELECTED COMPOUNDS

(Dollars)

Elemental iodine/compounds	Value[1] Per kilogram	Value[1] Per pound
Iodine, crude, drums	19.00-20.00	8.76-9.22
Potassium iodide, U.S. Pharmacopeia, drums, 5,000-pound lots, delivered	24.35	11.60

[1]Conditions of final preparation, transportation, quantities, and qualities not stated are subject to negotiations and/or somewhat different price quotations.

Source: Chemical Market Reporter, 2002, Current prices of chemicals and related materials: Chemical Market Reporter, v. 262, no. 21, December 9, p. 28-31; and the U.S. Census Bureau.

TABLE 4
U.S. IMPORTS OF CRUDE IODINE AND POTASSIUM IODIDE
FOR DOMESTIC CONSUMPTION, BY COUNTRY OF ORIGIN[1]

(Thousand kilograms and thousand dollars)

	2001		2002	
Type and country of origin[2]	Quantity	Value[3]	Quantity	Value[3]
Iodine, crude:				
Belgium	9	115	19	253
Canada	4	21	11	182
Chile	2,990	41,900	4,250	54,100
France	--	--	39	544
Japan	1,850	25,400	1,820	23,100
Mexico	20	335	--	--
Netherlands	63	862	18	216
Russia	71	947	--	--
Switzerland	18	209	--	--
Other[4]	2 r	23 r	26	311
Total	5,020	69,800	6,190	78,600
Iodide, potassium:[5]				
Canada	228	3,350	303	3,960
Chile	33	540	103	1,370
Japan	1	23	1	9
Netherlands	249	3,410	123	1,450
Other[6]	11	197	103	1,230
Total	522	7,510	633	8,020

rRevised. -- Zero.

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

[2]Import information for crude iodine and potassium iodide are reported by Harmonized Tariff Schedule of the United States numbers 2801.20.0000 and 2827.60.2000, respectively.

[3]Declared cost, insurance, and freight valuation.

[4]Includes Germany (2002), India, and the United Kingdom (2001).

[5]Gross potassium iodide contains 76% crude iodine.

[6]Includes Brazil, Denmark (2001), France (2001), Germany, Italy (2002), and the United Kingdom (2001).

Source: U.S. Census Bureau.

TABLE 5
U.S. EXPORTS OF CRUDE IODINE AND POTASSIUM IODIDE,
BY COUNTRY OF DESTINATION[1]

(Thousand kilograms and thousand dollars)

Type and country of destination[2]	2001		2002	
	Quantity	Value[3]	Quantity	Value[3]
Iodine, crude/resublimed:				
Brazil	--	--	32	366
Belgium	--	--	154	1,950
Canada	85	1,370	63	1,280
Chile	11	208	252	2,210
France	--	--	1	18
Germany	972	10,800	607	6,900
India	--	--	3	47
Japan	78	885	46	687
Malaysia	33	146	10	58
Mexico	221	3,080	132	2,130
Netherlands	1	15	86	793
Thailand	11	128	14	197
Venezuela	12	156	10	154
United Kingdom	18	234	--	--
Other[4]	14	160	19	271
Total	1,460	17,200	1,430	17,100
Iodide, potassium:[5]				
Australia	1	10	2	45
France	7	114	39	526
Jamaica	--	--	1	11
Korea, Republic of	--	--	2	41
Mexico	1	15	3	55
Netherlands	1	21	--	--
Singapore	--	--	(6)	19
Taiwan	7	80	30	306
Trinidad and Tobago	--	--	1	10
United Kingdom	--	--	6	139
Other[7]	7	212	1	22
Total	24	452	85	1,170

-- Zero.

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

[2]Export information for iodine, crude/resublimed and potassium iodide are reported by Harmonized Tariff Schedule of the United States numbers 2801.20.0000 and 2827.60.2000, respectively.

[3]Declared free alongside ship valuation.

[4]Includes Argentina, China (2002), Colombia (2002), Denmark, the Dominican Republic, El Salvador (2002), Honduras (2002), Hong Kong (2002), Israel (2001), Jamaica (2001), the Republic of Korea (2002), New Zealand (2001), Peru (2001), Sweden, Taiwan, and Uruguay (2002).

[5]Gross potassium iodide contains 76% crude iodine.

[6]Less than 1/2 unit.

[7]Includes Belgium (2002), Chad (2001), El Salvador (2001), Germany, Guatemala (2001), the Philippines (2002), Saudi Arabia (2001), Sweden (2001), and Switzerland (2001).

Source: U.S. Census Bureau.

TABLE 6
CRUDE IODINE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand kilograms)

Country	1998	1999	2000	2001	2002[e]
Azerbaijan[e]	300	300	300	300	300
Chile[3]	9,722	9,317	10,474	11,355 [r]	11,400
China[e]	500	500	500	500	500
Indonesia	65	74	75 [e]	75 [e]	75
Japan	6,142	6,152	6,157	6,643 [r]	6,500
Russia[e]	280	300	300	300	300
Turkmenistan[e]	90	150	200 [r]	200 [r]	200
United States	1,490	1,620	1,470	1,290	1,420 [4]
Uzbekistan[e]	1	2	2	2	2
Total	18,600	18,400	19,500 [r]	20,700 [r]	20,700

[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 June 10, 2003.
[3]Includes iodine production reported by Servicio Nacional de Geologia y Minería.
[4]Reported figure.

FIGURE 1
HISTORIC IODINE PRICES