



2007 Minerals Yearbook

IODINE [ADVANCE RELEASE]

IODINE

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Iodine production in the United States increased slightly in 2007 compared with that of 2006. Imports of crude iodine increased to 6,060 metric tons (t) valued at \$128 million in 2007 compared with 5,640 t valued at \$109 million in 2006, and exports decreased to 1,060 t valued at \$19.3 million compared with 1,580 t valued at \$24.5 million in 2006. The three U.S. producers supplied 25% of U.S. apparent consumption, which was withheld to avoid disclosing company proprietary data. Reported consumption by producers and consuming industries was 4,730 t in 2007 compared with 4,570 t in 2006.

Legislation and Government Programs

The fiscal year 2008 (October 1, 2007, to September 30, 2008) Annual Materials Plan authorized the disposal of 454,000 kilograms (kg) (1 million pounds) of crude iodine from the National Defense Stockpile (NDS) classified as excess to goal (Defense National Stockpile Center, 2007a). The NDS sold 94,100 kg (207,500 pounds) valued at \$2.10 million during the year (Defense National Stockpile Center, 2007b, c, e). In November, the NDS announced that all iodine in the stockpile had been sold (Defense National Stockpile Center, 2007d).

The Drug Enforcement Administration (DEA), a branch of the U.S. Department of Justice, issued a final rulemaking for changes in the regulation of iodine crystals and chemical mixtures containing more than 2.2% iodine. Changes were made to track the movement of iodine and iodine mixtures more accurately in commerce and make it more difficult for the diversion of iodine for illicit production of methamphetamine. Companies or individuals conducting transactions involving iodine have to register with the DEA, are subject to trade notification requirements of the Controlled Substances Act, and would be required to maintain records of all iodine transactions, regardless of size. The rule became effective August 1, 2007 (U.S. Department of Justice, 2007).

In October, the U.S. Environmental Protection Agency (EPA) approved for 1 year the registration of the soil fumigant iodomethane (methyl iodide) under highly restrictive provisions governing its use. The EPA will make a risk management decision on whether to reregister methyl iodide in 2008. Companies using methyl iodide must adhere to stringent mitigation measures to protect both the handlers and bystanders. Companies must provide training for employees and satisfy data and risk mitigation requirements of the EPA. Workers applying the fumigant are required to be certified and must wear respirators. Tarps must be placed over the treated fields, and buffer zones must be established around fields where the fumigant will be applied. Use of the fumigant is prohibited within a specified distance from such sites as day care facilities, nursing homes, prisons, and schools. The EPA assessed

exposures and potential risks using actual field concentration measurements taken at specific times and locations around treated fields. Use of this data will allow the EPA to make an informed risk management decision on the use of methyl iodide as a pesticide for the future. Methyl iodide can be used to control insects, nematodes, plant pathogens, and weeds and may be used on crops and plants such as ornamentals, peppers, strawberries, tomatoes, trees, turf, and vines (U.S. Environmental Protection Agency, 2007).

Production

The U.S. Geological Survey derived domestic production data for iodine from a voluntary canvass of U.S. operations (table 1).

IOCHEM Corp. (owned by the Kita family and Tomen Corp.) produced iodine at a plant near Vici, OK. The company had 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 operated a miniplant at an oilfield-injection-disposal site near Dover, OK. Woodward Iodine Corp. owned by Ise Chemical Corporation of Japan, produced iodine from 22 brine wells in Woodward County, OK. U.S. production increased in 2007 from that of 2006. Data were withheld to avoid disclosing company proprietary data (table 1).

Consumption

U.S. apparent consumption of iodine increased in 2007 from that of 2006. Reported consumption was 4,730 t in 2007 compared with 4,570 t in 2006. Domestic and imported iodine were used to produce a multitude of intermediate iodine compounds, usually by downstream manufacturers, making it difficult to gather accurate end-use statistics. However, 17 of the 21 companies to which a survey form was sent responded, representing 90% of the total consumption by major domestic users of iodine (table 2).

Both hydriodic acid and resublimed iodine consumption decreased significantly from 2006 to 2007 (table 2). This substantial change was attributed to three companies that altered their product mix between 2006 and 2007. Use of povidine-iodine decreased by 33% as well. This decline might be in part owing to some companies recording povidine-iodine in the "other organic compound" category. Potassium iodide (KI) consumption increased by 13% in 2007 from that of 2006. Use of potassium iodate increased by 44% in 2007 from that of 2006. This was owing to the fact that one more company reported consumption.

Biocides and Disinfectants.—Iodine is used in biocides and disinfecting chemicals. Iodine is one of the most effective medical antiseptics available. NASA uses it as the only water

disinfection process on all manned space flights and in the international space station. Iodine is a cost-efficient, effective, and simple means of water disinfection. The use of iodine to disinfect water is widely used in Australia. It replaces disinfection by chlorine wash systems eliminating all of chlorine's negative aspects.

Nutrition.—Iodine deficiency was once considered a minor problem, causing goiter, an unsightly but seemingly benign cosmetic blemish. However, it is now known to cause not only goiter, but also increased child mortality, irreversible mental retardation, and reproductive failure. Globally, 2.2 billion people (38% of the world's population) live in areas with iodine deficiency. Iodized salt is table salt mixed with a minute amount of iodate, KI, or sodium iodide. Iodized salt is the best means for providing iodine to iodine-deficient populations (International Council for Control of Iodine Deficiency Disorders, 2007). This has prompted several countries to legislate universal salt iodization requirements and in parts of China, to subsidize iodized salt use (China Daily, 2007; Science Daily, 2007; The Economic Times, 2007). Iodized salt continues to undergo extensive quality-control testing to ensure that it meets the required standards for iodine content.

Other Uses.—Developments in digital imaging have produced electronic prints and overhead transparencies without the need for wet processing film. Despite this, 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. Furthermore, the majority of feature films for movie theater presentations are shot and printed on film because film provides higher image resolution. In the next decade, uses of iodine in films and processing may be limited to specialty film imaging as digital imagery technology for motion pictures improves and digital equipment and printers become more affordable.

Performing x-rays using iodine contrast media has been found to increase risk of kidney failure and is used with caution mainly on patients with impaired kidney function. Barium sulphate can also be used as contrast media but can cause complications as well. Many elements have higher atomic numbers than iodine, however no other element has the chemical characteristics that make iodine able to form soluble compounds with low toxicity. It is these latter properties which make iodine-containing contrast media suitable for radiography.

Consumption of iodine for iodine-adsorbed polyvinyl alcohol polarizing films for liquid crystal displays (LCD) is expected to increase with the expanding use of LCDs in electronic equipment, including appliances, computers, digital cameras, personal handheld devices, and televisions. To make LCDs more visible, polarizers are added. These polarizers are usually made from stretched polyvinyl alcohol films that have iodine in them.

Iodine and its derivatives were used principally in animal feed, catalysts, colorants, inks, pharmaceutical and medical applications, photographic equipment, sanitation or disinfectants, and rosin stabilizers.

Specifications

Commercial crude iodine normally has a minimum purity of 99.5% to 99.8%, depending on the supplier. Impurities, in order

of quantity, are chiefly insoluble materials, iron, sulfuric acid, and water. The U.S. Pharmacopeia specifies an 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.

Prices

Actual prices for iodine are negotiated on long- and short-term contracts between buyers and sellers. The average free alongside ship (f.a.s.) value for exported crude iodine in 2007 was \$18.16 per kilogram, an increase from \$15.53 per kilogram in 2006. The average declared cost, insurance, and freight (c.i.f.) value for imported crude iodine was \$21.12 per kilogram, an increase from \$19.34 per kilogram in 2006. The average declared c.i.f. value for iodine imported from Chile was \$21.84 per kilogram in 2007 compared with \$20.01 per kilogram in 2006. The average declared c.i.f. value for imported crude iodine from Japan was \$18.07 per kilogram in 2007, an increase from \$17.26 per kilogram in 2006. The average sale price of iodine sold by the DNSC was \$22.33 per kilogram (\$10.13 per pound) in 2007 compared with \$21.29 per kilogram (\$9.66 per pound) in 2006.

Prices for iodine have increased during the past 20 years. Current prices are at the highest levels seen in the past decade (Harris, 2007).

Foreign Trade

Imports of crude iodine increased to 6,060 t with a c.i.f. value of \$128 million in 2007 compared with 5,640 t valued at \$109 million in 2006 (table 3). Imports of KI increased to 649 t with a c.i.f. value of \$13.5 million in 2007 compared with a revised total of 619 t valued at \$12.0 million in 2006. Exports of crude iodine decreased to 1,060 t with an f.a.s. value of \$19.3 million in 2007 compared with a revised total of 1,580 t valued at \$24.5 million in 2006 (table 4). Exports of KI decreased to 82 t with an f.a.s. value of \$1.95 million in 2007 compared with a revised total of 108 t valued at \$1.93 million in 2006. Iodine also was exported and imported in many forms other than elemental iodine and KI, so net trade is not easily defined.

World Review

World production of iodine in 2007 was estimated to be 25,700 t compared with 26,700 t in 2006, excluding the United States (table 5). Chile was the leading world producer of iodine, followed by Japan and the United States. Sociedad Quimica y Minera de Chile S.A. estimated that 28,000 t of iodine was used in 2007, with production from Chile accounting for 55% of that tonnage, Japan accounting for 24%, and the United States accounting for 5%. The remainder was split between other producing countries, 3%, and iodine recycled in the manufacturing process, 13% (Sociedad Quimica y Minera de Chile S.A., 2008, p. 30-31).

Chile.—Compania de Salitre y Yodo de Chile (Cosayach) filed paperwork related to expansion of its iodine production. The \$15 million project will expand production to 6,000 t/yr

from 1,800 t/yr. Cosayach controls 300,000 t of iodine reserves in Region I (Tarapacá) (Harris, 2007).

Atacama Minerals Corp. continued construction of its continuous-agitated leach processing plant. This change will allow the company to increase iodine production to 1,500 t/yr. The \$25.5 million plant was expected to increase recovery of iodine to more than 75% from 55%. The plant also was to use less water and reduce processing time. Completion was expected in May 2008. The company also began construction of a 28-mile-long transmission line to connect the plant to a local power grid. The \$8.6 million project was scheduled to be completed in April 2008. Atacama Minerals indicated that its production averaged 84 tons per month (t/mo) in the first three quarters of 2007 compared with 69 t/mo in 2006 (Atacama Minerals Corp., 2008, p. 3, 6). Atacama Minerals also announced that through additional drilling, reserve estimates of iodine, sulfate, and nitrate at the Aguas Blancas Mine were increased by 20% to 24.6 Mt (Atacama Minerals Corp., 2007).

Turkmenistan.—The Turkmenistan Government created Turkmenhimiya State Concern through the merger of its State fertilizer and iodine producers, Turkmendokum and Turkmenyod. Its objective was to stimulate further development of the chemical industry (Turkmenistan.ru, 2007).

Outlook

Most of the iodine producers were operating close to nominal capacity although capacity increases are anticipated to come online in 2008. Prices may increase slightly because of increased demand worldwide.

The water treatment market is expected to increase with more growth anticipated in Asian areas such as China, India, and Pakistan. Expanding treatment of municipal water supplies will probably increase the demand for biocides and disinfectants in the future. Use of iodine derivatives as biocides in paint and wood treatment products also has increased in recent years.

As more countries continue legislation of universal salt iodization, the global demand for iodized salt will continue to increase. Demand for KI pills as a preventative of cancer of the thyroid in the event of a nuclear accident continued to influence sales of pills to government and private individuals. More countries are providing these pills to individuals, and the demand for this compound continued to increase.

Use of x-ray contrast media, which contain as much as 60% iodine, is expected to continue to increase. More medical tests on an aging population will result in increased demand for iodine-containing x-ray contrast media.

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TABLE 1
SALIENT IODINE STATISTICS¹

(Metric tons and dollars)

	2003	2004	2005	2006	2007
United States:					
Production	1,090	1,130	1,570	W	W
Imports:					
Quantity, for consumption ²	5,750	5,700	6,250	5,640	6,060
Price, average ³ dollars per kilogram	11.81	13.38	16.75	19.34	21.12
Exports ²	1,230 ^r	1,060 ^r	2,430 ^r	1,580 ^r	1,060
Consumption:					
Reported ⁴	3,930	4,070	4,680	4,570	4,730
Apparent ⁵	5,240	5,560	5,600	W	W
World, production	24,600	24,800	26,500	26,700 ^r	25,700

^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits, except prices.

²Source: U.S. Census Bureau information reported by Harmonized Tariff Schedule of the United States code 2801.20.0000.

³Cost, insurance, and freight valuation.

⁴Reported by voluntary response to the U.S. Geological Survey from a survey of domestic establishments.

⁵Calculated using domestic production plus imports minus exports plus adjustments for Government and domestic industry stock changes.

TABLE 2
DOMESTIC CONSUMPTION OF IODINE, BY PRODUCT¹

Product	2006		2007	
	Number of plants	Quantity (metric tons)	Number of plants	Quantity (metric tons)
Inorganic compounds:				
Crude iodine	7	615	8	626
Resublimed iodine	7	51	4	11
Potassium iodide	4	398	4	450
Sodium iodide	6	463	5	432
Hydriodic acid	3	93	2	52
Potassium iodate	3	34	4	49
Miscellaneous iodate, and iodides ²	1	39	2	38
Other inorganic compounds	5	507	5	432
Total	XX ³	2,200	XX ³	2,090
Organic compounds:				
Ethylenediamine dihydroiodide	2	189	2	208
Povidine-iodine (iodophors)	2	439	1	293
Other organic compounds ⁴	4	1,740	9	2,140
Total	XX ³	2,370	XX ³	2,640
Grand total reported consumption ⁵	XX	4,570	XX	4,730
Apparent consumption ⁶	XX	W	XX	W

W Withheld to avoid disclosing company proprietary data. XX Not applicable.

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

²Includes calcium iodate and cuprous iodide.

³Nonadditive because some plants produce more than one product concurrently.

⁴Includes methyl and/or ethyl iodide.

⁵Reported by voluntary response to the U.S. Geological Survey in a survey of domestic establishments.

⁶Calculated using domestic production plus imports minus exports plus adjustments for Government and domestic industry stock changes.

TABLE 3
U.S. IMPORTS OF CRUDE IODINE AND POTASSIUM IODIDE FOR
CONSUMPTION, BY COUNTRY OF ORIGIN¹

Type and country of origin ³	2006		2007	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Iodine, crude:				
Chile	4,330	\$86,600	4,890	\$107,000
France	36	601	62	1,180
India	12	37	--	--
Japan	1,260	21,800	1,110	20,000
Russia	--	--	--	--
Other	(4)	6	(4)	14
Total	5,640	109,000	6,060	128,000
Potassium iodide:⁵				
Brazil	69 ^r	1,350	276	5,680
Canada	444 ^r	8,460	299	6,260
Chile	100 ^r	2,020	68	1,470
Other	6 ^r	137	5	106
Total	619^r	12,000	649	13,500

^rRevised. -- Zero.

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

²Declared cost, insurance, and freight valuation.

³Import information for crude iodine and potassium iodide are reported by Harmonized Tariff Schedule of the United States codes 2801.20.0000 and 2827.60.2000, respectively.

⁴Less than ½ unit.

⁵Gross potassium iodide contains 76% crude iodine.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF CRUDE IODINE AND POTASSIUM IODIDE, BY COUNTRY OF ORIGIN¹

Type and country of origin ³	2006		2007	
	Quantity (metric tons)	Value ² (thousands)	Quantity (metric tons)	Value ² (thousands)
Iodine, crude/resublimed:				
Argentina	1	\$3	--	--
Australia	18	66	2	\$38
Belgium	114	2,030	131	2,970
Canada	164 ^r	3,230 ^r	180	4,020
Chile	144	2,610	--	--
Germany	677	10,900	510	8,780
Japan	38	622 ^r	5	80
India	180	2,370	81	1,340
Mexico	134 ^r	634 ^r	90	1,610
Venezuela	12	178	10	138
Other	96 ^r	1,870 ^r	51	280
Total	1,580 ^r	24,500 ^r	1,060	19,300
Potassium iodide:⁴				
France	47 ^r	888	36	888
Germany	3 ^r	62	2	62
Korea, Republic of	10 ^r	128	7	128
Mexico	12 ^r	254	9	254
Netherlands	1	18 ^r	1	23
Taiwan	21 ^r	290	16	290
Turkey	5 ^r	83	4	83
Other	9 ^r	203 ^r	8	217
Total	108 ^r	1,930 ^r	82	1,950

^rRevised. --Zero.

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

²Declared free alongside ship valuation.

³Export information for iodine, crude/resublimed and potassium iodide are reported by Harmonized Tariff Schedule of the United States codes 2801.20.0000 and 2827.60.2000, respectively.

⁴Potassium iodide contains 76% crude iodine.

Source: U.S. Census Bureau.

TABLE 5
CRUDE IODINE: ESTIMATED WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	2003	2004	2005	2006	2007
Azerbaijan	349 ^r	300	300	300	300
Chile ³	15,580 ⁴	14,931 ⁴	15,346 ⁴	16,494 ^{r,4}	15,473 ⁴
China	500	550	550	560	570
Indonesia	75	75	75	75	75
Japan	6,524 ⁴	7,264 ⁴	8,095 ⁴	8,724 ^{r,4}	8,700 ^c
Russia	300	300	300	300	300
Turkmenistan	200	250	270	270	270
United States	1,090 ⁴	1,130 ⁴	1,570 ⁴	W	W
Uzbekistan	2	2	2	2	2
Total	24,600	24,800	26,500	26,700 ^r	25,700

^rRevised. W Withheld to avoid disclosing company proprietary data; not included in total.

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

²Table includes data available through June 10, 2008.

³Includes iodine production reported by Servicio Nacional de Geología y Minería.

⁴Reported figure.