

Cadmium

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Domestic production of cadmium metal in 1978 declined 17% from the production level of 1977, and output in 1979 was 4% higher than in 1978. Shipments of cadmium in both years increased over those of 1977 but failed to approach the volume reported during 1976.

Six companies operating seven plants produced all of the domestic cadmium during 1978. An eighth plant, the new electrolytic zinc plant of Jersey Miniere Zinc Co., came onstream at yearend 1978 and began production of cadmium in 1979. In December 1979, St. Joe Zinc Co. permanently closed its zinc smelter at Monaca, Pa., where byproduct cadmium was also produced. Canada continued as the major source of imported zinc concentrates from which cadmium was extracted as a byproduct. The producer price of cadmium, in a range of \$2.25 to \$2.50 per pound, remained unchanged throughout 1978. By the close of 1979, the producer price ranged from \$2.50 to \$3 per pound.

Legislation and Government Programs.—In 1978, the Environmental Protection Agency (EPA) proposed limits on cadmium in specific categories of solid waste destined for agricultural application on lands used for the production of food-chain crops or meats for human consumption.²

On July 11, 1978, EPA issued final effluent limitation guidelines for existing facilities operating within the ore mining and dressing point-source category. The regulation defined limits on cadmium and other substances discharged in effluents originating from specified types of ore milling and concentrating operations.³

The proposed approach for implementation of the Toxic Substances Control Act of 1976 was published by EPA on October 26, 1978. EPA proposed to regulate the manufacture, distribution, use, or dispersal of certain substances, including cadmium and

any of its compounds.⁴

In December 1978, a quality-control standard suggested by the decorated glass tumbler industry was, with some modification, endorsed by a Federal interagency regulatory task force consisting of EPA, the Food and Drug Administration, and the Consumer Product Safety Commission. Industrial compliance with the voluntary quality-control program, which defines the application of cadmium and lead, assures no significant risk to decorated glassware users.⁵

The occupational health and environmental aspects of cadmium and the requirements for additional research were discussed at the 1978 International Conference on Cadmium, cosponsored by the National Institute of Environmental Health Sciences of the U.S. Department of Health, Education, and Welfare and the Karolinska Institute, Stockholm, Sweden.

Effective October 1979, EPA promulgated final regulations on the concentration of cadmium and other pollutants contained in process waste water from plating operations and destined for publicly owned treatment works. The deadline for compliance with this regulation was set for October 12, 1982.⁶

Under the provisions of the Water Pollution Control Loan Program, the Small Business Administration may grant direct loans or loan guarantees of up to 90% for terms of up to 30 years to small electroplaters certified to have been adversely affected by EPA's proposed pretreatment standards for the electroplating point-source category.

In September 1979, EPA issued interim final criteria for the classification and application of cadmium-bearing solid waste to land used for the production of food-chain crops.⁷

The national stockpile goal for cadmium of 11,204 metric tons remained unchanged through 1979.⁸ The total inventory at yearend 1979 was 2,871 tons, with no acquisitions or releases in 1978 or 1979.

Table 1.—Salient cadmium statistics

	1975	1976	1977	1978	1979
United States:					
Production ¹ ----- metric tons.	1,990	2,047	1,999	1,653	1,715
Shipments by producers ² ----- do.	742	2,707	1,837	1,957	2,370
Value ----- thousands.	\$4,166	\$10,498	\$7,072	\$5,906	\$9,498
Exports ----- metric tons.	180	229	107	326	211
Imports for consumption, metal ----- do.	2,375	3,094	2,332	2,881	2,572
Apparent consumption ----- do.	3,055	5,381	3,818	4,510	4,817
Price: Average per pound ³ ----- do.	\$3.36	\$2.66	\$2.96	\$2.45	\$2.76
World: Production ----- metric tons.	15,234	16,773	17,935	16,765	18,280

¹Primary and secondary cadmium metal. Includes equivalent metal content of cadmium sponge used directly in production of compounds.

²Includes metal consumed at producer plants.

³Average quoted price for cadmium sticks and balls in lots of 1 to 5 tons.

DOMESTIC PRODUCTION

Domestic cadmium metal production in 1979 increased slightly over that of 1978; however, production during both years failed to reach levels achieved during 1976 and 1977.

In mid-December 1979, St. Joe Zinc Co., a major producer of zinc and byproduct cadmium, announced the permanent closure of its electrothermic zinc smelter at Monaca, Pa. The company was studying the feasibility of replacing the Monaca facility with a new electrolytic smelter at an unspecified location.

In 1978 recovery of cadmium metal averaged just over 4 kilograms per ton of slab zinc produced in domestic smelters, compared with an average of 4.8 kilograms recovered between 1973 and 1977. Recovery of cadmium in domestic smelters between 1964 and 1973 ranged from 4.2 to 6.3 kilograms per ton of slab zinc.

During 1979 production of cadmium compounds other than cadmium sulfide (cadmium content), which includes both electroplating salts and cadmium oxide, increased over that of 1978. The quantity of cadmium produced under this category has, with a few exceptions, registered a steady increase in recent years. Production in 1979, for example, was 30 times greater than that of 1971. Cadmium oxide was produced at two primary-metal-producing plants. Data on cadmium oxide production are not published to avoid disclosing company proprietary data. The production of cadmium sulfide (including cadmium sulfoselenide and lithopone) during 1979 registered a significant increase over 1978 production.

Table 2.—Primary cadmium producers in the United States in 1978 and 1979

Company	Plant location
Amaz Zinc Co., Inc. -----	Sauget, Ill.
ASARCO Incorporated -----	Corpus Christi, Tex., and Denver, Colo.
The Bunker Hill Co -----	Kellogg, Idaho
Jersey Miniere Zinc Co -----	Clarksville, Tenn.
National Zinc Co -----	Bartlesville, Okla.
The New Jersey Zinc Co. -----	Palmerton, Pa.
St. Joe Zinc Co. ¹ -----	Monaca, Pa.

¹Closed permanently Dec. 21, 1979.

Table 3.—U.S. production of cadmium compounds other than cadmium sulfide¹

(Metric tons)	
Year	Quantity (cadmium content)
1975 -----	202
1976 -----	990
1977 -----	695
1978 -----	708
1979 -----	912

¹Includes plating salts and oxide.

Table 4.—Cadmium sulfide¹ produced in the United States

(Metric tons)	
Year	Quantity (cadmium content)
1975 -----	895
1976 -----	729
1977 -----	639
1978 -----	698
1979 -----	1,494

¹Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of cadmium in 1978 was 18% greater than that of 1977, and in 1979 was 7% greater than that of 1978.

Though actual consumption data are not gathered by the Bureau of Mines, the distribution of apparent consumption during

1978 and 1979 was estimated for the following principal use categories: Transportation, coating and plating, batteries, pigments, plastics and synthetic products, and alloys and other uses. Cadmium consumed directly in the transportation category, which included cadmium from each of the remaining end-use categories, accounted for an estimated 17% of the total demand. Electrically or mechanically plated hardware consumed an estimated 34%, while cadmium used in nickel-cadmium, silver-cadmium, and mercury-cadmium batteries was estimated to have consumed 22%. Cadmium used in pigments, plastics and synthetic products, and the alloys-and-other category was estimated to have accounted

for 13%, 11%, and 3%, respectively of the total apparent consumption.

Table 5.—Supply and apparent consumption of cadmium
(Metric tons)

	1977	1978	1979
Stocks, Jan. 1 -----	2,165	2,571	2,269
Production -----	1,999	1,653	1,715
Imports, metal -----	2,332	2,881	2,572
Total supply -----	6,496	7,105	6,556
Exports -----	107	326	211
Stocks, Dec. 31 -----	² 2,571	2,269	1,528
Apparent consumption ¹ --	² 3,818	4,510	4,817

¹Revised.

²Total supply minus exports and yearend stocks.

STOCKS

Inventories of cadmium metal held by metal producers and cadmium metal and cadmium in compounds held by compound manufacturers generally declined from yearend 1977 to yearend 1979; conversely,

the quantity of both cadmium metal and cadmium in compounds held by merchants and distributors of these products increased during the same period.

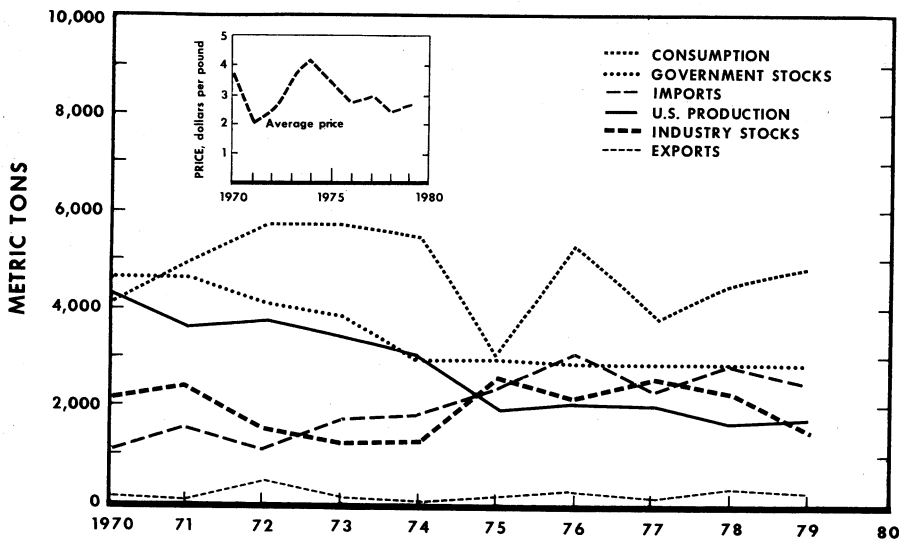


Figure 1.—Trends in production, consumption, yearend stocks, exports, imports, and average price of cadmium metal in the United States.

Table 6.—Industry stocks, December 31

(Metric tons)

	1977		1978		1979	
	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds
Metal producers -----	^r 1,452	W	1,152	W	506	W
Compound manufacturers -----	72	^r 774	^r 45	^r 758	52	609
Distributors -----	255	18	^r 296	^r 18	341	20
Total -----	^r 1,779	^r 792	^r 1,493	^r 776	899	629

^rRevised. W Withheld to avoid disclosing company proprietary data; included with "Compound manufacturers."

PRICES

The producer price range of \$2.25 to \$2.50 per pound for cadmium metal established in December 1977 remained unchanged throughout 1978. Dealer prices, which were \$1.85 to \$1.95 per pound in early 1978, trended generally upward throughout the year, closing at \$2.13 to \$2.23.

During 1979 the producer price for cadmium metal rose to \$2.75 to \$3.25 per pound by April, settled at \$2.50 per pound from Au-

gust to December, and closed the year at \$2.50 to \$3 per pound. Dealer prices during the year followed a similar upward pattern, ending at \$2.85 to \$2.95 per pound.

The announcement in November 1979, that St. Joe Zinc Co. would close its smelter reportedly contributed somewhat to the upward price movement exhibited by both producer and dealer prices toward yearend.

FOREIGN TRADE

Cadmium metal and scrap exports during 1978 registered a significant increase over those of 1977, while exports for 1979, though still significant when compared with 1977 exports, declined from those of 1978. Principal recipient countries during 1978 and 1979 were Belgium-Luxembourg, the Federal Republic of Germany, the Republic of Korea, and Canada.

Cadmium metal imports, which have increased since 1972, reached a peak of 2,881 metric tons during 1978 with receipts from 21 countries. In 1979 the imports from 19 countries were lower. During the 2-year period, Canada continued to be the princi-

pal supplier, followed by Australia, Mexico, and Belgium-Luxembourg. No cadmium-bearing flue dusts were imported during the period.

Table 7.—U.S. exports of cadmium metal and cadmium in alloys, dross, flue dust, residues, and scrap

Year	Quantity (metric tons)	Value (thousands)
1977 -----	107	\$316
1978 -----	326	864
1979 -----	211	550

Table 8.—U.S. imports for consumption¹ of cadmium metal, by country

Country	1978		1979	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Algeria	10	\$49	--	--
Australia	406	1,736	319	\$1,716
Austria	5	22	--	--
Belgium-Luxembourg	292	1,274	237	1,356
Canada ²	667	3,497	695	3,709
Denmark	--	--	5	23
Finland	82	390	128	710
France	56	246	100	537
Germany, Federal Republic of	91	397	20	114
India	8	34	--	--
Italy	6	23	--	--
Japan	4	18	10	45
Korea, Republic of	242	927	200	1,020
Mexico	436	1,896	288	1,579
Netherlands	79	333	103	574
Norway	6	26	107	528
Peru	130	550	142	762
Portugal	--	--	8	36
Spain	162	629	59	272
Sweden ²	48	210	23	135
United Kingdom ²	16	61	23	153
Yugoslavia ²	100	407	80	404
Zaire	35	136	25	167
Total	2,881	12,861	2,572	13,840

¹General imports and imports for consumption were the same in 1978 and 1979.

²Includes waste and scrap (gross weight).

WORLD REVIEW

The Korean Zinc Co. dedicated its new electrolytic zinc plant at Onsan in the Republic of Korea in November 1978. The plant has an annual capacity of 50,000 tons of zinc and 300 tons of cadmium.

On February 6-8, 1979, the Second International Cadmium Conference was held in Cannes, France. The conference was jointly sponsored by the Cadmium Association of London, The Cadmium Council, and the International Lead-Zinc Research Organization, Inc., of New York, and dealt primarily with the technical, economic, and occupa-

tional health and environmental aspects of cadmium.

On August 30, 1979, the Government of Sweden ratified a decision by the Swedish Product Control Board to impose a partial ban on the importation and use of cadmium. Exemptions from the ban, which was due to become effective in 1980, would be extended to industries that cannot replace cadmium with other materials or that can control the amount of cadmium released into the environment.

Table 9.—Cadmium: World smelter production,¹ by country

Continent and country	1976	1977	1978 ^P	1979 ^e
North America:				
Canada (refined)-----	1,314	1,185	964	1,480
United States ² -----	2,047	1,999	³ 1,653	³ 1,715
Latin America:				
Mexico (refined)-----	710	908	897	990
Peru-----	174	182	^e 190	220
Europe:				
Austria-----	29	26	33	35
Belgium-----	1,196	1,434	1,139	1,420
Bulgaria ^e -----	220	200	210	210
Finland-----	428	527	611	600
France-----	532	790	694	790
German Democratic Republic ^e -----	20	20	20	20
Germany, Federal Republic of-----	1,275	1,336	1,182	1,170
Italy-----	^r 436	449	383	460
Netherlands ^e -----	^r 397	302	402	400
Norway-----	80	97	120	110
Poland-----	^e 750	754	761	766
Romania ^e -----	100	90	90	90
Spain-----	246	303	253	230
U.S.S.R. ^e -----	2,700	2,750	2,800	2,850
United Kingdom-----	190	295	291	410
Yugoslavia-----	^e 180	189	185	200
Africa:				
South-West Africa, Territory of-----	^r 83	80	70	70
Zaire-----	266	246	186	240
Zambia-----	7	4	^e 4	4
Asia:				
China, mainland ^e -----	^r 100	^r 100	120	120
India-----	34	44	113	180
Japan-----	2,500	2,844	2,530	2,590
Korea, North ^e -----	^r 110	^r 110	110	110
Oceania: Australia (refined)-----	649	^r 671	754	800
Total-----	16,773	17,935	16,765	18,280

^eEstimate. ^PPreliminary. ^rRevised.

¹This table gives unwrought metal production from ores, concentrates, flue dusts, and other materials of both domestic and imported origin. Sources generally do not indicate if secondary metal (recovered from scrap) is included or not; where known, this has been indicated by footnote. Data derived in part from World Metal Statistics (published by World Bureau of Metal Statistics, London) and from Metal Statistics (published by Metallgesellschaft Aktiengesellschaft, Frankfurt am Main). Cadmium is found in ores, concentrates, and/or flue dusts in several other countries, but these materials are exported for treatment elsewhere to recover cadmium metal; therefore, such output is not recorded in this table to avoid double counting.

²Includes secondary.

³Final figure.

TECHNOLOGY

A 9-volt, rechargeable, nickel-cadmium battery was developed utilizing sealed cylindrical cell technology. Potential applications were in calculators and radios. Reported advantages include quick recharging, long life, high-rate discharge, and no maintenance.⁹ Cadmium is an essential ingredient in electrical contacts that must resist high temperatures, wear, and seizing. Recent patents on electrical contacts employing alloys of cadmium include contacts resistant to wear and seizing which employ a sintered silver-cadmium alloy, and high-current electrical contacts produced by liquid-phase sintering of cadmium-tungsten-silver alloys.¹⁰

Cadmium sulfide, when quenched under a pressure of nearly 600,000 pounds per square inch, is partially transformed into a glassy, metallic, reversibly magnetic phase

that seems to function as a magnetically controllable superconductor at room temperature. This discovery could lead to the development of ultrafast solid state computer switches and a broad range of other electromagnetic devices.¹¹

A new analytical reagent was developed that is both sensitive and highly selective for cadmium and does not react with zinc. By the addition of appropriate masking agents, the reaction is made specific for cadmium.¹² A method for determining cadmium in feces was developed and used to estimate the average daily cadmium intake in different age groups in Sweden. It was observed that smokers had a higher daily fecal cadmium content than nonsmokers. Age-related changes in daily fecal cadmium were also observed.¹³

Research directed toward reducing and

controlling industrial emissions of cadmium to the environment continued to be an important area of investigation. A new method for recovering metals, including cadmium, from dilute solutions was developed in England. The process, which uses a fluidized bed of glass beads 0.0005 millimeter in diameter in combination with screen-like, expanded mesh electrodes, can reportedly recover metals from dilute solutions such as electroplating rinse-tank fluids, where the typical concentrations are 100 to 200 parts per million.¹⁴ A safe cadmium emission threshold limit during typical brazing operations and ways of preventing toxic fumes of cadmium oxide from reaching workers were developed, and recommendations for safe practice were presented. The safe threshold limit reported for cadmium oxide is 0.05 milligram per cubic meter of air measured as cadmium. A booth developed for safe brazing operations was described.¹⁵

The Bureau of Mines conducted research aimed at developing economical techniques for greater recovery of cadmium and other substances from both liquid and solid industrial process discharge streams. The Bureau developed a pyrometallurgical method for recovering metallic cadmium and nickel-iron residue low in cadmium from scrapped nickel-cadmium batteries.¹⁶

Developments in cadmium technology are abstracted in Cadmium Abstracts, a bi-monthly publication available through the

Cadmium Association, 34 Berkley Square, London W1X 6AJ, England.

¹Physical scientist, Section of Nonferrous Metals.

²Federal Register. Solid Waste Disposal Facilities. V. 43, No. 25, Feb. 6, 1978, pp. 4942-4955.

³Federal Register. Protection of Environment. Part 440, Ore Mining and Dressing Point Source Category. V. 43, No. 133, July 11, 1978, pp. 29771-29781.

⁴Federal Register. Toxic Substances Control. V. 43, No. 208, Oct. 26, 1978, pp. 50140-50147.

⁵Federal Register. Lead and Cadmium in Decorated Glass Tumblers. V. 43, No. 242, Dec. 15, 1978, p. 58633.

⁶Federal Register. Effluent Guidelines and Standards; Electroplating Point Source Category; Pretreatment Standards for Existing Sources. V. 44, No. 175, Sept. 7, 1979, pp. 52590-52629.

⁷Federal Register. Criteria for Classification of Solid Waste Disposal Facilities and Practices. V. 44, No. 179, Sept. 13, 1979, pp. 53438-53468.

⁸Quantities in metric tons unless otherwise noted.

⁹Nickel Topics. GE Comes Out With 9-Volt Rechargeable Battery. V. 31, No. 1, 1978, pp. 14-15.

¹⁰Kim, H. J., F. J. Reid, and F. J. Scimeca (assigned to GTE Laboratories, Inc.) Refractory Metal Silver-Cadmium Alloys. U.S. Pat. 4,083,480, May 9, 1978.

¹¹Siemens, A. C. Silver Alloys for Electrical Contacts. Japan Kokai 78 30,412, Mar. 22, 1978.

¹²Homan, C. G., and D. P. Kendall. Magnetic Moment of Pressure Quenched Cadmium Sulfide. Solid State Communications (UK), v. 32, September 1979, pp. 521-524.

¹³Libergott, E. K., C. L. S. Roquette Pinto, and P. L. A. Aguiar Neto. The Selective Detection of Traces of Cadmium With Benzothiazole Derivative (Pyruvylidene-2-Hydrazinobenzothiazole). Anal. Chim. Acta. (Netherlands), v. 101, No. 1, October 1978, pp. 229-230.

¹⁴Kjellstrom, T., K. Borg, and B. Lind. Cadmium in Feces as an Estimator of Daily Cadmium Intake in Sweden. Environ. Res., v. 15, No. 2, 1978, pp. 242-251.

¹⁵Chemical Engineering. V. 85, No. 28, Dec. 18, 1978, p. 44.

¹⁶British Association for Brazing and Soldering. Recommendations for the Safe Use of Cadmium-Containing Filler Metals for Brazing. July 1978, 11 pp.; available from BNF Metals Technology Center, Grove Laboratories, Denchworth Road, Wantage, Oxfordshire, OX129BJ, England.

¹⁷Wilson, D. A. Recovery of Cadmium From Ni-Cd Scrap Batteries. Proc. 6th Miner. Waste Utilization Symp., U.S. Bureau of Mines and IIT Research Institute, Chicago, Ill., May 2-3, 1978, pp. 420-423.

