Cadmium

By John M. Lucas[1]

Domestic cadmium metal production posted a minor decline from that of 1976. Although apparent consumption in 1977 exceeded the quantity consumed during the recession year of 1975, it was less than that consumed in 1976. Shipments of metal reported by producers were below those of 1976, but, far above those of 1975.

Six companies operating seven plants produced all of the domestic cadmium. Canada continued as the major source of zinc concentrates from which cadmium was extracted as a byproduct. The producer price of cadmium remained at $3.00 per pound until December, at which time it was reduced to $2.25 to $2.50.

Legislation and Government Programs.—The Environmental Protection Agency (EPA) issued interim final pretreatment standard (effective July 12, 1977) covering effluent discharges into publicly owned treatment works operating within the electroplating point source category. Shortly after issuing the new regulations, which did not specifically address cadmium, the EPA began considering the inclusion of six other metals, including cadmium.

In October, the EPA issued a notice of rebuttable presumption against the registration of pesticide products containing cadmium. Cadmium is one of 20 substances that the EPA is investigating to determine whether the evidence of health risk is sufficient to revoke registration of pesticides containing these substances. Pesticides containing cadmium have been used for several years to control moles and plant diseases affecting residential lawns and golf courses. Producers of registered cadmium pesticides were notified to submit evidence in rebuttal of the presumption prior to December 12, 1977.

On October 22, pursuant to provisions of the Federal Clean Air Act Amendments of 1977, the EPA initiated inquiries into the health effects of cadmium, arsenic, and polycyclic organic compounds in the ambient air.

The national stockpile goal of 12,351 tons of cadmium established in 1976 by the Federal Preparedness Agency (FPA) was reaffirmed by the President on October 7. The inventory of stockpile metal was 3,163 tons on December 31, 1977.

Table 1.—Salient cadmium statistics

		1973	1974	1975	1976	1977
United States:						
Production[1]	short tons	3,751	3,333	2,193	2,256	2,204
Shipments by producers[2]	do.	4,304	3,250	818	r2,984	2,025
Value	thousands	$23,891	$21,405	$4,166	$10,498	$7,072
Exports	short tons	153	31	198	252	118
Imports for consumption, metal	do.	1,948	1,985	2,618	3,411	2,570
Apparent consumption	do.	6,267	6,050	3,368	5,932	4,480
Price: Average per pound[3]		$3.64	$4.09	$3.36	$2.66	$2.96
World: Production	short tons	18,925	19,041	r16,793	r18,180	18,898

rRevised.

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

[2]Includes metal consumed at producer plants.

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

DOMESTIC PRODUCTION

Total domestic production of cadmium metal during 1977 was 2,204 tons, slightly below the 2,256 tons produced in 1976. Metal production was 631 tons in the first quarter, then declined to 428 tons in the third quarter. Production of cadmium during the fourth quarter rebounded to 583 tons following the September settlement of the nearly 5-month labor strike at The Bunker Hill Co. smelter.

For every ton of slab zinc produced during the year, an average of 9.8 pounds of cadmium metal was recovered. In 1976, the recovery rate averaged about 7 pounds of metal per ton of zinc compared with 10 pounds in 1975 and 12 pounds in 1974. Prior to 1973, an average of 10 to 12 pounds of cadmium was produced for every ton of slab zinc. This decline in cadmium metal recovery may reflect a growing tendency by producers to make more cadmium compounds at the expense of metal production as well as a combination of possible factors such as a greater percentage recovery of zinc as compared with cadmium and an overall decrease in the cadmium content of the ores and concentrates.

Cadmium sulfide production (including cadmium sulfoselenide and lithopone) was 12% below the production level of 1976.

Production of other cadmium compounds (cadmium content), which includes both electroplating salts and cadmium oxide, declined about 14% from production levels of the previous year. However compared with 1974, production of other compounds has increased nearly ninefold. Cadmium oxide was produced at two primary-metal-producing plants. Data on cadmium oxide production are not published to avoid disclosing individual company confidential data.

Table 2.—Primary cadmium producers in the United States in 1977

Company	Plant location
AMAX Zinc Co. Inc	Sauget, Ill.
ASARCO Inc	Corpus Christi, Tex.
Do	Denver, Colo.
The Bunker Hill Co	Kellogg, Idaho
National Zinc Co	Bartlesville, Okla.
New Jersey Zinc Co	Palmerton, Pa.
St. Joe Zinc Co	Monaca, Pa.

Table 3.—Cadmium sulfide[1] produced in the United States

(Short tons)

Year	Quantity (cadmium content)
1973	1,412
1974	1,085
1975	987
1976	804
1977	704

[1]Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of cadmium was 4,480 tons, 24% less than that of 1976. Over 95% of the consumption of cadmium was accounted for under five principal use categories: Plating, pigments, alloys, batteries, and plastic stabilizers. Electrically or mechanically plated hardware used in transportation vehicles and fixed electrical and mechanical equipment was estimated to have consumed between 40% and 45% of the apparent consumption. Red, orange, yellow, and maroon pigments formulated from cadmium compounds consumed an estimated 15% of the supply. The balance was consumed in nickel-cadmium batteries, special-purpose alloys, and compounds employed to impart heat and light stability to some plastics, particularly polyvinylchloride.

Table 4.—Supply and apparent consumption of cadmium

(Short tons)

	1976	1977
Stocks—beginning	2,841	2,387
Production	2,256	2,204
Imports, metal	3,411	2,570
Shipments from Government stockpile excesses	63	--
Total supply	8,571	7,161
Exports	252	118
Stocks—end	2,387	2,563
Apparent consumption[1]	5,932	4,480

[1]Total supply minus exports and yearend stocks.

STOCKS

Inventories of metal held by producers at the end of 1977 were 1,553 tons, 13% over those held at the close of 1976. Compound manufacturers' stocks of cadmium compounds rose 15% above those held at yearend 1976. Inventories of metal held by distributors were essentially unchanged from those reported at the end of 1976.

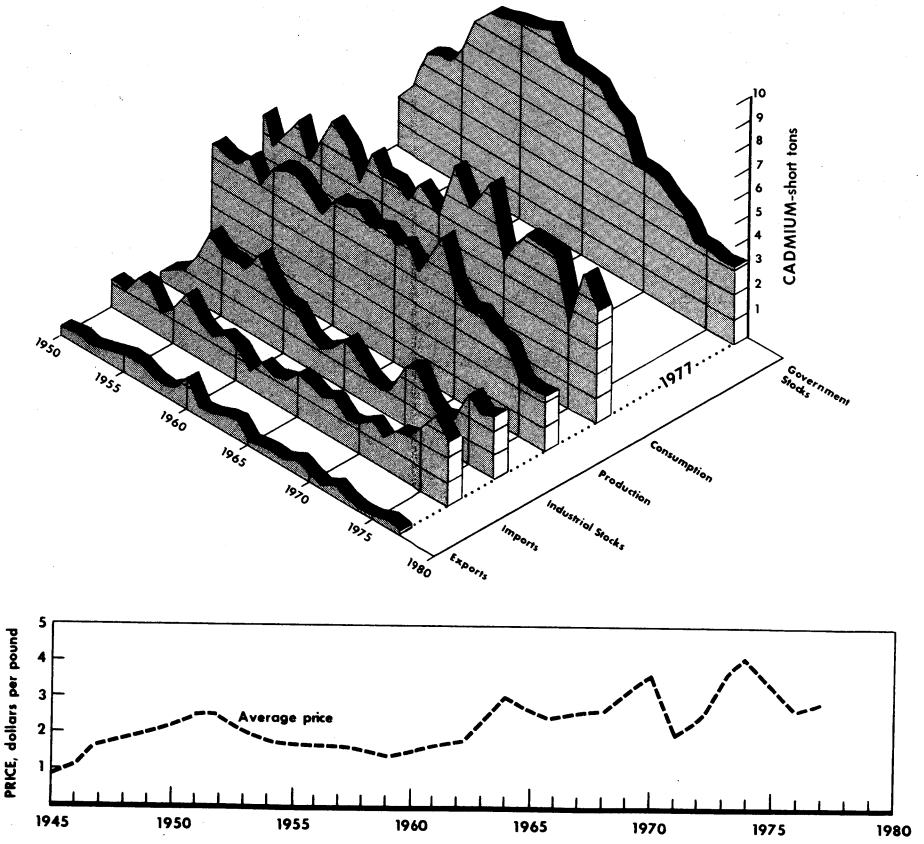

Figure 1.—Trends in production, consumption, yearend stocks, exports, imports, and average price of cadmium metal in the United States.

Table 5.—Industry stocks, December 31

(Short tons)

	1976		1977	
	Cadmium metal	Cadmium in compounds	Cadmium metal	Cadmium in compounds
Metal producers	1,369	W	1,553	W
Compound manufacturers	163	547	79	630
Distributors	279	29	281	20
Total	1,811	576	1,913	650

W Withheld to avoid disclosing individual company confidential data; included with "Compound manufacturers."

PRICES

Despite continued weakening demand and expanding inventories, the producer price of cadmium remained unchanged at $3 per pound throughout most of the year. On December 1, National Zinc Co. reduced its quoted price for cadmium by $0.50, to $2.50 per pound. On December 7, Bunker Hill lowered its price to $2.25 per pound. On the following day, ASARCO Inc., aligned its quote at the $2.50 per pound level established earlier by National Zinc. For the remainder of the year, all domestic cadmium producers were quoting prices in a range of $2.25 to $2.50 per pound. Dealer prices for cadmium remained firm throughout most of the first quarter at $2.90 to $2.95 per pound. In late March, the price began to weaken, and by yearend it had declined to $1.85-$1.95 per pound.

FOREIGN TRADE

Exports of cadmium metal and scrap decreased sharply to 118 tons compared with 252 tons exported during 1976. The principal recipients during 1977 were the Federal Republic of Germany (37%), Belgium-Luxembourg (33%), and Canada (13%).

Cadmium metal imports for consumption were received from 16 countries. Canada continued to be the principal source of imports with 18%; followed by Australia and Mexico (17% each), Yugoslavia (14%), Belgium-Luxembourg (10%), Finland and the Netherlands (5% each), and the Republic of Korea (4%). Fourteen tons of cadmium-bearing flue dust was imported from Canada. No imports of flue dust were received from Mexico, which shipped 246 tons to the United States in 1976.

Table 6.—U.S. exports of cadmium metal and cadmium in alloys, dross, flue dust, residues, and scrap

Year	Quantity (short tons)	Value (thousands)
1975	198	$589
1976	252	713
1977	118	316

Table 7.—U.S. imports for consumption[1] of cadmium metal and cadmium flue dust, by country

Country	1976		1977	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Cadmium metal:				
Australia	421	$2,003	448	$2,353
Belgium-Luxembourg	279	1,330	246	1,322
Canada[2]	1,052	5,361	472	2,519
Finland	43	237	131	580
France	130	533	13	74
Germany, Federal Republic of	133	576	44	217
India	40	187	6	20
Italy	32	146	--	--
Korea, Republic of	110	478	105	462
Mexico	393	1,696	436	2,202
Netherlands	52	220	121	581
Peru	95	419	89	399
Spain	39	173	63	271
Sweden	--	--	22	98

See footnotes at end of table.

Table 7.—U.S. imports for consumption[1] of cadmium metal and cadmium flue dust, by country —Continued

Country	1976		1977	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Cadmium metal —Continued				
U.S.S.R.	[2]193	[2]$133	--	--
United Kingdom	11	65	6	$25
Yugoslavia	322	611	351	483
Zaire	66	343	[2]17	[2]74
Total	3,411	14,511	2,570	11,680
Flue dust (cadmium content):				
Canada	--	--	14	4
Mexico	246	536	--	--
Total	246	536	14	4
Grand total	3,657	15,047	2,584	11,684

[1]General imports and imports for consumption were the same in 1976 and 1977.
[2]Includes waste and scrap (gross weight).

WORLD REVIEW

Total world smelter production of refined cadmium was 18,898 short tons. This represented an increase of 4% above production levels achieved during 1976. The four largest cadmium producers were the U.S.S.R. and Japan (16% each), the United States (12%), and the Federal Republic of Germany (8%). Apparent U.S. consumption of cadmium amounted to nearly 24% of the total world production.

Table 8.—Cadmium: World smelter production, by country[1]

(Short tons)

Country	1975	1976	1977[p]
North America:			
Canada (refined)	1,314	1,448	1,321
United States[2]	2,193	2,256	2,204
Latin America:			
Mexico (refined)	646	783	[e]800
Peru	176	192	[e]200
Europe:			
Austria	33	32	[e]26
Belgium	[r]1,047	1,296	1,574
Bulgaria[e]	220	250	250
Finland	239	470	579
France	502	586	[e]605
German Democratic Republic[e]	22	22	22
Germany, Federal Republic of	1,122	1,405	[e]1,470
Italy	451	480	466
Netherlands[e]	[r]300	[r]439	340
Norway	52	89	106
Poland[e]	390	[r]390	440
Romania	97	110	110
Spain	[r]226	271	332
U.S.S.R.[e]	2,900	3,000	3,050
United Kingdom	[r]303	209	326
Yugoslavia[e]	300	300	330
Africa:			
South-West Africa, Territory of[e]	130	91	96
Zaire	291	293	176
Zambia	[r]7	8	4
Asia:			
China, People's Republic of[e]	120	120	120
India	[r]58	37	40
Japan	2,929	2,756	3,048
Korea, North[e]	120	130	130
Oceania: Australia (refined)	[r]605	717	733
Total	[r]16,793	18,180	18,898

[e]Estimate. [p]Preliminary. [r]Revised.
[1]This 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 produced 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.
[2]Includes secondary.
[3]Output of Tsumeb Corp. for calendar years.

TECHNOLOGY

In February, the First International Cadmium Conference was convened in San Francisco, Calif., to review technological, occupational health, and marketing aspects of cadmium; over 50 papers on cadmium were presented.[2] During the first week of October, the Government-Industry Workshop on Alternatives for Cadmium Electroplating and Metal Finishing was held at the National Bureau of Standards, Gaithersburg, Md. Representatives from both Government and industry appraised various anticorrosive coatings and processes such as zinc and aluminum coatings, mechanical-plating techniques, and several relatively new electroless organic coatings.

Research focusing on cadmium in the environment and its possible effects upon human health continued to be an important area of investigation. The accumulation and distribution of heavy metals, including lead, zinc, and cadmium, were studied in the soil profile at two sites, which had been irrigated for an extended period of time with treated wastewater and sludge-injected wastewater. No serious contamination of the soils by heavy metals was found in either area.[3] Another study noted that although biological accumulations of cadmium are found in many living organisms, most of the dissipated cadmium eventually becomes fixed in soil, sediment, and ocean sinks.[4]

The results of a sampling program conducted around and below several copper and zinc mills and smelters in high runoff regions detected up to0.1% cadmium in the suspended sediments of some streams used for irrigation and drinking water. The report recommended techniques for control and treatment of contaminated wastewater destined for discharge into these streams.[5] Samples of polished and unpolished rice were analyzed for zinc and cadmium, and the results indicated that polishing brings about a loss of zinc, an essential dietary trace element, but no loss of cadmium. In countries where rice is a major food staple, uncontrolled cadmium may be taken up by the rice and result in excessive absorption of the metal.[6]

The degree of toxicity of metal oxide fumes generated by various materials during different welding and brazing processes was evaluated. The threshold limit value (TLV) for cadmium was found to be 0.05 milligram per cubic meter of air. The control of airborne pollutants and the use of special breathing and ventilating apparatus were also discussed.[7] A systematic study of factors such as acid strength and temperature that may influence the leaching of cadmium from solid acrylonitrile-butadiene-polystyrene (ABS) plastic toys containing cadmium selenide or sulfide pigments has been undertaken in the Netherlands.[8]

Photovoltaic solar cells using cadmium compounds received much attention during the year. The use of cadmium sulfide may lead to lower cost solar cells that could be a competitive energy source within a few years.[9] Pressure-sintered electrodes of cadmium selenide, subsequently, doped with cadmium vapor have demonstrated solar energy conversion efficiencies approaching three-fourths of those of single crystal specimens in sunlight experiments. Expanded use of these polycrystalline electrodes may result in a substantial cost advantage over single crystal electrodes.[10]

A new process developed in the United Kingdom for producing a grid alloy for maintenance-free batteries employs a lead matrix in which a cadmium-tin eutectic phase has been dispersed. The recommended levels of cadmium and tin are 0.6% to 0.8% by weight.[11] Electric automobiles powered by nickel-cadmium batteries are being developed as a semipublic rent-a-car network to serve the downtown area of Amsterdam, Netherlands. The batteries in the small two seat, three-wheeled vehicles can be quickly recharged at strategically located stations.[12]

Cadmium telluride probes are being employed clinically to diagnose venous thrombosis of the leg and to detect concealed dental infections in patients scheduled for cardiovascular and orthopedic surgery.[13]

A new liquid barium-cadmium-zinc heat stabilizer is expected to find application in

flexible automotive plastics such as polyvinylchloride. The stabilizer is reported to provide protection to rolled and extruded plastic sheet against color change for up to 2 weeks of testing at 175°F (79°C).[14]

Developments in cadmium technology are abstracted in Cadmium Abstracts, a bimonthly publication available from the Zinc Institute Inc., 292 Madison Ave., New York 10017.

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