

SELENIUM

(Data in metric tons of selenium content, unless otherwise noted)

Domestic Production and Use: Primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. Three copper refineries, one in Utah and two in Texas, accounted for domestic production of primary selenium. The value of production was \$2.4 million. Anode slimes from other primary electrolytic refiners were exported for processing. The estimated consumption of selenium by end use was as follows: glass manufacturing, 35%; chemicals and pigments, 20%; electronics, 20% (a decrease); and other, including agriculture and metallurgy, 25% (an increase). In glass manufacturing, selenium was used as a decolorant in container glass and other soda-lime silica glasses and to reduce solar heat transmission in architectural plate glass. Cadmium sulfoselenide red pigments, which have good heat stability, were used in ceramics and plastics. Chemical uses included rubber compounding chemicals, gun bluing, catalysts, human dietary supplements, and antidandruff shampoos. Dietary supplementation for livestock was the largest agricultural use. Selenium was added to copper, lead, and steel alloys to improve their machinability and to replace lead in brasses for plumbing applications. In electronics, high-purity selenium was used primarily as a photoreceptor on the drums of plain paper copiers; but this application has reached the replacement-only stage as selenium has been supplanted by newer materials in recently manufactured copiers.

| <u>Salient Statistics—United States:</u> | <u>1993</u> | <u>1994</u> | <u>1995</u> | <u>1996</u> | <u>1997^e</u> |
|--|--------------------|--------------------|--------------------|--------------------|--------------------------------|
| Production, refinery | 283 | 360 | 373 | 379 | 380 |
| Imports for consumption, metal and dioxide | 382 | 411 | 324 | 434 | 330 |
| Exports, metal, waste and scrap | 261 | 246 | 270 | 322 | 135 |
| Consumption, apparent ¹ | 460 | 530 | 517 | 543 | 615 |
| Price, dealers, average, dollars per pound, 100-pound lots, refined | 4.90 | 4.90 | 4.89 | 4.00 | 2.90 |
| Stocks, producer, refined, yearend | W | W | W | W | W |
| Employment, number | NA | NA | NA | NA | NA |
| Net import reliance ² as a percent of apparent consumption | 39 | 31 | 38 | 40 | 41 |

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 45 tons of selenium metal recovered from scrap was imported in 1997.

Import Sources (1993-96): Canada, 39%; the Philippines, 28%; Belgium, 12%; Japan, 9%; and other, 12%.

| <u>Tariff: Item</u> | <u>Number</u> | <u>Most favored nation (MFN)</u> <u>12/31/97</u> | <u>Non-MFN³</u> <u>12/31/97</u> |
|----------------------------|----------------------|---|---|
| Selenium metal | 2804.90.0000 | Free | Free. |
| Selenium dioxide | 2811.29.2000 | Free | Free. |

Depletion Allowance: 14% (Domestic), 14% (Foreign).

Government Stockpile: None.

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Events, Trends, and Issues: Domestic selenium demand increased moderately in 1997. World selenium demand and production remained at about the 1996 level, so the oversupply situation was not eased significantly. The price continued the steady decline begun in 1996. The use of selenium in glass remained strong. Use in copiers continued to decline, while use as a metallurgical additive increased.

The use of selenium as an additive to no-lead, free-machining brass for plumbing applications began to increase. Ordinary free-machining brass contains up to 7% lead. Industry consortia have tested several lead-free brasses that could be used as substitutes as more stringent regulation of lead in drinking water takes effect. Bismuth is the main replacement additive; however, its supply is limited and selenium reduces the quantity of bismuth needed, without adverse effect on alloy properties.

World Refinery Production, Reserves, and Reserve Base:

| | Refinery production | | Reserves⁴ | Reserve base⁴ |
|-----------------------|----------------------------|--------------------------------|-----------------------------|---------------------------------|
| | <u>1996</u> | <u>1997^e</u> | | |
| United States | 379 | 380 | 10,000 | 19,000 |
| Belgium | 250 | 250 | — | — |
| Canada | 561 | 560 | 7,000 | 15,000 |
| Chile | 46 | 45 | 19,000 | 30,000 |
| Finland | 30 | 30 | — | — |
| Germany | 120 | 120 | — | — |
| Japan | 610 | 600 | — | — |
| Peru | 21 | 20 | 2,000 | 5,000 |
| Philippines | 40 | 40 | 2,000 | 3,000 |
| Serbia and Montenegro | 30 | 30 | 1,000 | 1,000 |
| Sweden | 30 | 30 | — | — |
| Zambia | 20 | 20 | 3,000 | 6,000 |
| Other countries | <u>13</u> | <u>10</u> | <u>27,000</u> | <u>55,000</u> |
| World total (rounded) | ⁵ 2,150 | ⁵ 2,100 | 70,000 | 130,000 |

World Resources: In addition to the reserve base of selenium, which is contained in identified economic copper deposits, 2.5 times this quantity of selenium was estimated to exist in copper or other metal deposits that were undeveloped, of uneconomic grade, or as yet undiscovered. Coal contains an average of 1.5 parts per million of selenium, which is about 80 times the average for copper deposits, but recovery of selenium from coal appears unlikely in the foreseeable future.

Substitutes: High purity silicon has replaced selenium in high-voltage rectifiers and is the major substitute for selenium in low- and medium-voltage rectifiers. Other inorganic semiconductor materials, such as silicon, cadmium, tellurium, gallium, and arsenic, as well as organic photoconductors, substitute for selenium in photoelectric applications. Other substitutes include cerium oxide in glass manufacturing; tellurium in pigment and rubber compounding; and bismuth, lead, and tellurium in free-machining alloys.

^eEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Calculated using reported shipments, imports of selenium metal, and estimated exports of selenium metal, excluding scrap.

²Defined as imports - exports + adjustments for Government and industry stock changes.

³See Appendix B.

⁴See Appendix D for definitions.

⁵In addition to the countries listed, Australia, China, India, Kazakstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.