

## 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. Two copper refineries, both in Texas, accounted for domestic production of primary selenium. 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, 15% (a decrease); and other, including agriculture and metallurgy, 30% (an increase). In glass manufacturing, selenium was used to decolor 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. Combinations of bismuth and selenium were added to brasses to replace lead in plumbing applications. Selenium was added to copper, lead, and steel alloys to improve their machinability. 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 currently manufactured copiers.

<b>Salient Statistics—United States:</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998<sup>e</sup></b>
Production, refinery	360	373	379	W	W
Imports for consumption, metal and dioxide	441	324	428	352	350
Exports, metal, waste and scrap	246	270	322	127	150
Consumption, apparent <sup>1</sup>	530	517	564	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	4.90	4.89	4.00	2.94	2.50
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance <sup>2</sup> as a percent of apparent consumption	31	31	38	W	W

**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 1998.

**Import Sources (1994-97):** Canada, 36%; Philippines, 28%; Belgium, 13%; Japan, 9%; and other, 14%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations (NTR)</b> <b>12/31/98</b>	<b>Non-NTR<sup>3</sup></b> <b>12/31/98</b>
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 consumption increased slightly in 1998. World selenium demand and production remained at about the 1997 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. The use in copiers continued to decline, while the use in metallurgical additives increased. The use of selenium as an additive to no-lead, free-machining brasses for plumbing applications continued to increase as more stringent regulations on lead in drinking water take effect (ordinary free-machining brass contains up to 7% lead). Alloys with bismuth/selenium additions are dominating this new market. Selenium reduces the quantity of bismuth needed, without adverse effects on alloy properties.

Long-range research was continued to confirm the effectiveness of dietary selenium supplementation in cancer prevention. The dosage requirement for direct supplementation is likely to be small: 200 to 400 micrograms per day.

### **World Refinery Production, Reserves, and Reserve Base:**

	Refinery production		Reserves <sup>4</sup>	Reserve base <sup>4</sup>
	1997	1998 <sup>e</sup>		
United States	W	W	10,000	19,000
Belgium	250	250	—	—
Canada	509	545	7,000	15,000
Chile	50	50	19,000	30,000
Finland	28	30	—	—
Germany	115	115	—	—
Japan	540	525	—	—
Peru	21	20	2,000	5,000
Philippines	40	40	2,000	3,000
Serbia and Montenegro	30	30	1,000	1,000
Sweden	20	20	—	—
Zambia	20	20	3,000	6,000
Other countries <sup>5</sup>	13	13	27,000	55,000
World total (rounded)	<sup>6</sup> 1,640	<sup>6</sup> 1,660	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; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses.

<sup>e</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

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

<sup>2</sup>Defined as imports - exports + adjustments for Government and industry stock changes.

<sup>3</sup>See Appendix B.

<sup>4</sup>See Appendix D for definitions.

<sup>5</sup>In addition to the countries listed, Australia, China, India, Kazakhstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.

<sup>6</sup>Excludes U.S. production.