

RHENIUM

By John W. Blossom

In the past decade, the two most important uses of rhenium have been in platinum-rhenium catalysts used primarily in producing lead-free, high-octane gasoline and in high-temperature superalloys for jet engine components. Other uses of rhenium, primarily as tungsten-rhenium and molybdenum-rhenium alloys, though smaller in quantity, are more diverse. These include use in thermocouples, heating elements, temperature controls, flashbulbs, vacuum tubes, X-ray tubes and targets, metallic coatings, and electrical contact points. Research by industry continues on rhenium recovery from ore and concentrate and on development of new catalysts and alloys.

U.S. rhenium is a byproduct of molybdenite recovered as a byproduct of porphyry copper ore from eight operating porphyry copper-molybdenum-rhenium mines in the Western States. Domestic mine production data for rhenium were derived by the U.S. Geological Survey from reported molybdenum production at the mines. Domestic demand for rhenium metal and other rhenium products was met by domestic recovery, domestic stocks, and imports, the principal source of supply.

Consumption of rhenium increased about 49%, and imports for consumption increased 62%. The major increases in consumption were in bimetallic platinum-rhenium catalysts and high-temperature jet engine components. The average prices for metal powder and ammonium perrhenate were \$900 per kilogram, respectively.

Consumption

Rhenium is used in petroleum-reforming catalysts for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Bimetallic platinum-rhenium catalysts have replaced many of the monometallic catalysts. Rhenium catalysts tolerate greater amounts of carbon formation and make it possible to operate at lower pressures and higher temperatures, which leads to improved yields and octane ratings. Catalytic units with platinum-rhenium catalysts are used in about 80% of total U.S. reforming capacity. Platinum-rhenium catalysts also are used in the production of benzene, toluene, and xylenes, although this use is small compared with that of gasoline production.

A significant property of rhenium is its ability to alloy with molybdenum and tungsten. Molybdenum alloys containing about 50-weight-percent rhenium have greater ductility and can be fabricated by either warm or cold working. Unlike other molybdenum alloys, this alloy is ductile, even at temperatures down to 196° C, and can be welded. Alloys of tungsten with 24-weight-percent rhenium have improved ductility and have lower ductile-to-brittle transition temperatures than pure tungsten. Rhenium improves the strength properties of nickel

alloys at high temperatures (1,000° C). Some of the uses for these alloys, which represented only 10% of total demand, are in thermocouples, temperature controls, heating elements, ionization gauges, mass spectrographs, electron tubes and targets, electrical contacts, metallic coatings, vacuum tubes, crucibles, electromagnets, and semiconductors.

Foreign Trade

Imports for consumption of ammonium perrhenate came from Chile, France, Germany, Kazakhstan, Russia, the United Kingdom, and Uzbekistan, and rhenium metal came from Chile, Germany, Kazakhstan, Russia, and the United Kingdom. World production of rhenium in ore was estimated to be 50 metric tons; the quantity of rhenium actually recovered is, however, much lower because not all concentrates are processed to recover the rhenium values. Rhenium was recovered from some byproduct molybdenite concentrates from porphyry copper deposits in Canada, Chile, China, Iran, Kazakhstan, Peru, Russia, and the United States. Rhenium metal and compounds were recovered from molybdenum concentrates in Chile, France, Germany, Russia, the United Kingdom, and the United States.

World Review

World reserves of rhenium are contained primarily in molybdenite in porphyry copper deposits. U.S. reserves of rhenium are concentrated in Arizona and Utah but also are found in Montana, Nevada, and New Mexico. Canadian reserves are in British Columbia, primarily on Vancouver Island. Chilean reserves are found primarily at four large porphyry copper mines and in lesser deposits in the northern one-half of the country. In Peru, reserves are concentrated primarily in the Toquepala open-pit porphyry copper mine and in about 12 other deposits in the rest of the country.

Other world reserves are in several porphyry copper deposits and one sedimentary copper deposit in the south-central part of the former Soviet Union between the Caspian Sea and northwestern China, in Europe, and in sedimentary copper-cobalt deposits in Zaire.

Outlook

In the next 5 years, increased demand for rhenium metal will follow the demand for aircraft engines and for petroleum. For the long term (10 to 20 years), recycling of rhenium-bearing waste and scrap must be greatly improved. Identified U.S. resources are estimated to be about 5,000 metric tons, and identified rest-of-world resources are about 6,000 tons.

SOURCES OF INFORMATION

U.S. Geological Survey Publications

Rhenium. Ch. in Mineral Commodity Summaries, annual.¹
Rhenium. Ch. in Mineral Yearbook, annual.¹

Rhenium. Ch. in United States Minerals Resources, U.S. Geological Survey Professional Paper 820, 1973.

¹Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT U.S. RHENIUM STATISTICS 1/

(Kilograms)

	1992	1993	1994	1995	1996
Mine production 2/	16,000	12,200	15,500	17,000	14,000
Consumption e/	6,800	6,900	12,900	16,200	24,100
Imports (metal)	6,390	2,700	5,870	9,550	10,800
Imports (ammonium perrhenate)	5,690	3,170	2,330	3,280	10,000

e/ Estimated.

1/ Data are rounded to three significant digits.

2/ Calculated rhenium contained in molybdenite concentrates.

TABLE 2
U.S. IMPORTS FOR CONSUMPTION OF RHENIUM METAL, BY COUNTRY 1/

Country	1995		1996	
	Gross weight (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
Austria	776	\$627	--	--
Chile	3,600	3,180	8,500	\$7,960
Germany	2,510	1,790	1,730	1,380
Kazakstan	2,580	1,430	50	26
Russia	--	--	425	102
United Kingdom	88	29	100	39
Total	9,550	7,050	10,800	9,500

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF AMMONIUM PERRHENATE, BY COUNTRY 1/

Country	1995		1996	
	Gross weight (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
Chile	1,120	\$558	5,280	\$2,100
France	--	--	278	12
Germany	773	340	1,090	310
Kazakstan	--	--	628	147
Kyrgyzstan	89	27	--	--
Russia	744	184	871	322
United Kingdom	551	121	1,500	441
Uzbekistan	--	--	350	105
Total	3,280	1,230	10,000	3,440

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.