RHENIUM

By John W. Blossom

Domestic survey data and tables were prepared by Jo-Ann S. Sterling, statistical assistant.

In the last 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 used for jet engine components. Other applications of rhenium, primarily as tungsten-rhenium and molybdenum-rhenium alloys, are more diverse; these included thermocouples, heating elements, temperature controls, flashbulbs, vacuum tubes, X-ray tubes and targets, metallic coatings, and electrical contact points. Research by industry continued on the recovery of rhenium from ore and concentrate and the development of new catalysts and alloys.

In the United States, 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 (table 1) 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 imports, the principal source of supply, and domestic recovery and stocks.

In 1998, consumption of rhenium increased by about 60%, and imports for consumption increased by 67% (table 1). The average prices for metal powder and ammonium perrhenate were $500.00 and $400.00 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 in making gasoline and make it possible to operate the production process at lower pressures and higher temperatures, which leads to improved yields (production per unit of catalyst used) and higher octane ratings. In 1998, catalytic units with platinum-rhenium catalysts were used in about 80% of total U.S. reforming capacity. Platinum-rhenium catalysts also were used in the production of benzene, toluene, and xylenes, although this use was 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 at temperatures above 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). In 1998, some of the uses for these alloys, which represented only 10% of total demand, were 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 rhenium metal are listed in tables 1 and 2, and those of ammonium perrhenate are listed in tables 1 and 3.

World Review

World production of rhenium in ore was estimated to be 50 metric tons; the quantity of rhenium actually recovered, however, was much lower because not all concentrates were 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 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. 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 Armenia, northwestern China, Russia, and Uzbekistan and in sedimentary copper-cobalt deposits in the Democratic Republic of the Congo.

Outlook

In the next 5 years, demand for rhenium metal will follow the demand for aircraft engines and petroleum. For the long term (10-20 years), recycling of rhenium-bearing waste and scrap is expected to improve greatly. Identified U.S. resources are estimated to be about 5,000 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 Minerals Yearbook, annual.[1]

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

Rhenium. Ch. in United States mineral resources, U.S Geological Survey Professional Paper 820, 1973.

Other

Rhenium. Ch. in Mineral facts and problems, U.S. Bureau of Mines Bulletin 675, 1985.

TABLE 1
SALIENT U.S. RHENIUM STATISTICS 1/

(Kilograms)

	1994	1995	1996	1997	1998
Mine production 2/	15,500	17,000	14,000	15,400	14,000
Consumption e/	12,900	16,200	24,100	17,900	28,600
Imports, metal	5,870	9,550	10,800	8,510	14,200
Imports, ammonium perrhenate	2,330	3,280	10,000	6,560	11,000

e/ Estimated.

1/ Data are rounded to three significant digits.

2/ Rhenium contained in molybdenite concentrates, based on USGS calculation.

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

	1997		1998	
Country	Gross weight (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
Chile	6,290	$5,910	11,700	$12,100
Germany	2,160	1,700	579	450
Japan	--	--	69	33
Kazakhstan	--	--	35	13
Russia	56	21	1,250	693
Slovakia	--	--	198	104
Switzerland	--	--	301	226
United Kingdom	--	--	15	17
Total	8,510	7,640	14,200	13,600

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/

	1997		1998	
Country	Gross weight (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
Chile	13	$6	2,080	$1,000
Estonia	--	--	87	47
France	--	--	48	43
Germany	81	30	5,140	1,860
Ireland	700	235	--	--
Kazakhstan	3,840	931	1,430	524
Russia	--	--	2,070	576
Switzerland	1,680	497	--	--
United Kingdom	247	58	--	--
Uzbekistan	--	--	149	39
Total	6,560	1,760	11,000	4,090

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

Source: Bureau of the Census.