

## RHENIUM

(Data in kilograms of rhenium content, unless otherwise noted)

**Domestic Production and Use:** During 2002, ores containing rhenium were mined by six operations. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits in the Southwestern United States, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate, perrhenic acid, and metal powder. The major uses of rhenium were in petroleum-reforming catalysts and in high-temperature superalloys used in turbine engine components, representing about 40% and 50%, respectively, of the total demand. Rhenium was 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 is used in superalloys, improving the strength properties, at high temperatures (1,000° C), of nickel-based alloys. Some of the uses for rhenium alloys 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. The estimated value of rhenium consumed in 2002 was \$22 million.

<b>Salient Statistics—United States:</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002<sup>e</sup></b>
Production <sup>1</sup>	14,000	12,000	12,400	11,800	9,400
Imports for consumption, gross weight	25,200	15,600	18,200	24,800	13,600
Exports	NA	NA	NA	NA	NA
Consumption:					
Estimated	28,600	32,500	32,000	35,000	23,000
Apparent	NA	NA	NA	NA	NA
Price, average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	960	1,100	1,010	910	1,060
Ammonium perrhenate	370	610	510	790	840
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance <sup>2</sup> as a percentage of estimated consumption	88	48	57	71	59

**Recycling:** Small amounts of molybdenum-rhenium and tungsten-rhenium scrap have been processed by several companies during the past few years. All spent platinum-rhenium catalysts were recycled.

**Import Sources (1998-2001):** Chile, 61%; Kazakhstan, 15%; Germany, 10%; Russia, 5%; and other, 9%.

<b>Tariff: Item</b>	<b>Number</b>	<b>Normal Trade Relations 12/31/02</b>
Other inorganic acids, other—rhenium, etc.	2811.19.6050	4.2% ad val.
Salts of peroxometallic acids, other— ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0500	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.0100	4% ad val.

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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**Events, Trends, and Issues:** During 2002, the average rhenium prices were \$1,060 per kilogram for metal and \$840 per kilogram for ammonium perrhenate. The supply decreased by 22%, and imports of rhenium decreased by about 43%. Decreased rhenium recovery in the United States was due to reduced production of molybdenum concentrates from porphyry copper deposits in 2002. The United States relied on imports for much of its supply of rhenium. Chile and Kazakhstan supplied the majority of the rhenium imported.

Owing to the scarcity and minor output of rhenium, its production and processing pose no known threat to the environment. In areas where it is recovered, pollution control equipment for sulfur dioxide also prevents most of the rhenium from escaping into the atmosphere.

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

	Mine production <sup>3</sup>		Reserves <sup>4</sup>	Reserve base <sup>4</sup>
	<u>2001</u>	<u>2002</u>		
United States	11,800	9,400	390,000	4,500,000
Armenia	750	700	95,000	120,000
Canada	1,700	1,700	—	1,500,000
Chile	2,000	2,000	1,300,000	2,500,000
Kazakhstan	2,500	2,500	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,200	1,200	310,000	400,000
Other countries	<u>590</u>	<u>600</u>	<u>91,000</u>	<u>360,000</u>
World total (rounded)	26,000	23,100	2,400,000	10,000,000

**World Resources:** Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 5 million kilograms, and the identified resources of the rest of the world are approximately 6 million kilograms. In Kazakhstan, rhenium also exists in sedimentary copper deposits.

**Substitutes:** Substitutes for rhenium in platinum-rhenium catalysts are being evaluated continually. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts may decrease rhenium's share of the catalyst market. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper x-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

<sup>0</sup>Estimated. NA Not available. — Zero.

<sup>1</sup>Calculated rhenium contained in MoS<sub>2</sub> concentrates. Recovered quantities are considerably less and are withheld.

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

<sup>3</sup>Estimated amount of rhenium extracted in association with copper and molybdenum production. Rhenium recovery is unknown.

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