

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2008, ores containing rhenium were mined at eight operations (four in Arizona, and one each in Montana, Nevada, New Mexico, and Utah). Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate (APR), metal powder, and perrhenic acid. The major uses of rhenium were in petroleum-reforming catalysts and in superalloys used in high-temperature, turbine engine components, representing an estimated 20% and 70%, respectively, of the end use. Bimetallic platinum-rhenium catalysts were used in petroleum-reforming for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Rhenium improves the high-temperature (1,000° C) strength properties of some nickel-based superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The estimated value of rhenium consumed in 2008 was about \$91 million.

Salient Statistics—United States:	2004	2005	2006	2007	2008^e
Production ¹	6,500	7,900	8,100	7,100	7,700
Imports for consumption	19,200	28,900	38,800	41,000	50,200
Exports	NA	NA	NA	NA	NA
Consumption, apparent	25,700	36,900	46,900	48,100	57,900
Price, ² average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,090	1,070	1,260	1,620	1,770
Ammonium perrhenate	710	680	840	2,730	2,860
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance ³ as a percentage of apparent consumption	75	78	83	85	87

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 (2004-07): Rhenium metal powder: Chile, 85%; Germany, 7%; Netherlands, 4%; and other, 4%. Ammonium perrhenate: Kazakhstan, 62%; Germany, 10%; Netherlands, 8%; Chile, 6%; and other, 14%.

Tariff: Item	Number	Normal Trade Relations 12-31-08
Salts of peroxometallic acids, other— ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0600	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.9000	4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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Events, Trends, and Issues: During 2008, average rhenium metal price, based on U.S. Census Bureau customs value, was about \$1,770 per kilogram, about 9% more than that of 2007. Rhenium imports for consumption increased by about 22% owing to continued strong demand for superalloys in the gas turbine engine market and improved demand in the catalyst market. Rhenium production in the United States increased by about 8% owing to increased production of byproduct molybdenum concentrates in the United States. The four larger working copper-molybdenum mines maintained byproduct molybdenum production levels near capacity in 2008, while the four smaller operations made incremental increases in production in 2008.

The United States continued to rely on imports for much of its supply of rhenium, and Chile and Kazakhstan supplied the majority of the imported rhenium. Imports of rhenium from Kazakhstan were reduced in 2008 to more normal levels after the influx of stockpiled material in late 2006 and early 2007. Stockpiled quantities of low-grade APR imported into the United States from Kazakhstan in 2007 slowly came into the market after the material was reprocessed. Owing to strong demand, both APR and metal powder spot prices rose sharply in 2007. Basic-grade APR rose from about \$4,600 per kilogram in January to about \$8,200 per kilogram in December. Metal powder rose from about \$5,950 per kilogram in January to about \$9,700 per kilogram in December. These trends continued in 2008 with APR rising from \$8,200 per kilogram in January to \$9,700 in August before retreating to about \$8,500 per kilogram in November. Metal powder rose from about \$9,000 per kilogram in January to about \$11,900 per kilogram in October before retreating to about \$9,900 per kilogram in November.

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 removal also prevents most of the rhenium from escaping into the atmosphere.

World Mine Production, Reserves, and Reserve Base:

	Mine production ⁴		Reserves ⁵	Reserve base ⁵
	2007	2008		
United States	7,100	7,700	390,000	4,500,000
Armenia	1,200	1,200	95,000	120,000
Canada	1,700	1,700	32,000	1,500,000
Chile ⁶	22,900	27,600	1,300,000	2,500,000
Kazakhstan	7,700	8,000	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,500	1,500	310,000	400,000
Other countries	4,000	4,000	91,000	360,000
World total (rounded)	51,000	57,000	2,500,000	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 might decrease rhenium's share of the existing catalyst market; however, this would likely be offset by rhenium-bearing catalysts being considered for use in several proposed gas-to-liquid projects. 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.

^eEstimated. NA Not available.

¹Based on 80% recovery of estimated rhenium contained in MoS₂ concentrates. Roasted MoS₂ concentrate data revised for 2004 and 2005.

²Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.

³Defined as imports – exports + adjustments for Government and industry stock changes.

⁴Estimated amount of rhenium recovered in association with copper and molybdenum production.

⁵See Appendix C for definitions.

⁶Estimated rhenium recovered from roaster residues from Belgium, Chile, and Mexico.