

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2009, ores containing rhenium were mined at five operations (three in Arizona, and one each in Montana 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 2009 was about \$72 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009^e
Production ¹	7,900	8,100	7,100	7,900	7,400
Imports for consumption	28,900	38,800	41,000	43,600	26,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	36,900	46,900	48,100	51,500	33,000
Price, ² average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,070	1,260	1,620	2,030	2,400
Ammonium perrhenate	680	840	2,730	2,190	3,100
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	78	83	85	85	79

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 (2005-08): Rhenium metal powder: Chile, 93%; Netherlands, 3%; and other, 4%. Ammonium perrhenate: Kazakhstan, 68%; China, 8%; Germany, 7%; Chile, 5%; and other, 12%.

Tariff:	Item	Number	Normal Trade Relations 12-31-09
	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 2009, average rhenium metal price, based on U.S. Census Bureau customs value, was about \$2,400 per kilogram, about 17% more than that of 2008. Rhenium imports for consumption decreased by about 41% owing to the increase in price as well as the downturn in the financial markets. Rhenium production in the United States decreased by about 6% owing to decreased production of byproduct molybdenum concentrates in the United States. The four larger working copper-molybdenum mines decreased byproduct molybdenum production levels in 2009, while the one remaining smaller operation made incremental decreases in production in 2009. Three smaller operations ceased byproduct molybdenum production in 2009.

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. Owing to strong demand, both APR and metal powder spot prices rose sharply at the end of 2008. However, in 2009, catalytic-grade APR price decreased from about \$10,000 per kilogram in January to about \$7,500 per kilogram in April to about \$6,200 per kilogram in November. Metal powder price decreased from about \$9,700 per kilogram in January to about \$6,900 per kilogram in April to about \$4,900 in November. Demand for catalyst-grade APR, supported by the petroleum industry, was expected to continue to remain strong. Demand for rhenium in the aerospace industry, although more unpredictable, was also expected to remain strong. However, the major aerospace companies were expected to continue testing superalloys that contain half the current rhenium content for engine blades, as well as rhenium-free alloys for other engine components.

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 and Reserves:

	Mine production ⁴		Reserves ⁵
	2008	2009 ^e	
United States	7,900	7,400	390,000
Armenia	1,200	1,200	95,000
Canada	1,600	1,600	32,000
Chile ⁶	27,600	25,000	1,300,000
Kazakhstan	7,700	7,500	190,000
Peru	5,000	4,000	45,000
Russia	1,500	1,500	310,000
Other countries	4,000	4,000	91,000
World total (rounded)	56,500	52,000	2,500,000

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.

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. Reserve base estimates were discontinued in 2009; see [Introduction](#).

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