RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2010, ores containing rhenium were mined at four operations (two 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 2010 was about $63 million.

Salient Statistics—United States:	**2006**	**2007**	**2008**	**2009**	**2010[e]**
Production[1]	8,110	7,090	7,910	5,580	6,000
Imports for consumption	32,100	31,700	32,700	24,900	36,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	40,200	38,800	40,600	30,500	42,000
Price,[2] average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,260	1,620	2,030	2,460	2,300
Ammonium perrhenate	840	2,730	2,160	955	540
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	80	82	81	82	86

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 (2006–09): Rhenium metal powder: Chile, 93%; Netherlands, 3%; and other, 4%. Ammonium perrhenate: Kazakhstan, 57%; Chile, 12%; United Kingdom, 8%; China, 6%; and other, 17%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-10**
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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RHENIUM

Events, Trends, and Issues: During 2010, average rhenium metal price, based on U.S. Census Bureau customs value, was about $2,300 per kilogram, 6% less than that of 2009. Rhenium imports for consumption increased by about 45%. 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 increased byproduct molybdenum production levels in 2010, while the one remaining smaller operation ceased byproduct molybdenum production in 2010.

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. In 2010, catalytic-grade APR price continued to decrease to about $4,700 per kilogram in October from about $4,900 per kilogram in February. Metal powder price continued to decrease from $4,900 per kilogram at the end of 2009 to about $4,500 in February, and further to about $3,700 per kilogram in October. However, low-priced rhenium from Chile was expected to come to an end with the expiration of several long-term supply agreements between the Chilean producer and its customers, the manufacturers of aerospace engines.

Consumption of catalyst-grade APR 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]
	2009	2010[e]	
United States	5,580	6,000	390,000
Armenia	400	400	95,000
Canada	1,800	1,800	32,000
Chile[6]	25,000	25,000	1,300,000
Kazakhstan	3,000	2,500	190,000
Peru	5,000	5,000	45,000
Poland	2,400	4,500	NA
Russia	1,500	1,500	310,000
Other countries	1,500	1,500	91,000
World total (rounded)	46,200	48,000	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.

[e]Estimated. NA Not available.
[1]Based on 80% recovery of estimated rhenium contained in MoS_2 concentrates.
[2]Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Estimated amount of rhenium recovered in association with copper and molybdenum production.
[5]See Appendix C for resource/reserve definitions and information concerning data sources.
[6]Estimated rhenium recovered from roaster residues from Belgium, Chile, and Mexico.