

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2014, ores containing rhenium were mined at seven operations (four in Arizona, and one each in Montana, 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 use of rhenium were in superalloys used in high-temperature turbine engine components and in petroleum-reforming catalysts, representing an estimated 70% and 20%, respectively, of end uses. 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 2014 was about \$90 million.

Salient Statistics—United States:	2010	2011	2012	2013	2014^e
Production ¹	6,100	8,610	7,910	7,100	7,900
Imports for consumption	33,600	33,500	40,200	35,300	37,500
Exports	NA	NA	NA	NA	NA
Consumption, apparent	39,700	42,100	48,100	42,400	45,400
Price, ² average value, dollars per kilogram, gross weight:					
Metal pellets, 99.99% pure	4,720	4,670	4,040	3,160	3,000
Ammonium perrhenate	4,630	4,360	3,990	3,400	3,100
Employment, number	Small	Small	Small	Small	Small
Net import reliance ³ as a percentage of apparent consumption	85	80	84	83	83

Recycling: Molybdenum-rhenium and tungsten-rhenium scrap continued to be processed by a growing number of companies, mainly in the United States and Germany. All spent platinum-rhenium catalysts were recycled.

Import Sources (2010–13): Rhenium metal powder: Chile, 88%; Poland, 7%; United Kingdom, 2%; and other, 3%. Ammonium perrhenate: Republic of Korea, 39%; Kazakhstan, 31%; Germany, 8%; Poland, 6%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12–31–14
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 2014, the United States continued to rely on imports for much of its supply of rhenium, and Chile, Kazakhstan, and the Republic of Korea supplied most of the imported rhenium. Rhenium imports for consumption increased by 6% from those of 2013. Primary rhenium production in the United States increased 11% from that of 2013. Kazakhstan's only current rhenium producer, Kazakhmys plc, temporarily suspended its operations in mid-2013 at its Zhezkazgan smelter and refinery. The company expected to upgrade the facility to process copper-molybdenum ore from the newly developed Bozshakol mining and concentrating complex in Kazakhstan.

In 2014, the average catalytic-grade APR price remained at \$3,150 per kilogram until July, when the price further decreased to an average of \$3,000 per kilogram and remained at that level until yearend. Average rhenium metal pellet price remained at \$3,000 per kilogram during 2014.

Consumption of catalyst-grade APR by the petroleum industry was expected to remain at high levels. Demand for rhenium in the aerospace industry, although more unpredictable, was expected to continue to increase. However, the major aerospace companies were expected to continue testing superalloys that contain one-half the rhenium used in currently designed engine blades, as well as testing rhenium-free alloys for other engine components. New technology continued to be developed to allow recycling of superalloy scrap. Secondary rhenium recycling rates continued to increase worldwide.

World Mine Production and Reserves:

	Mine production ⁴		Reserves ⁵
	2013	2014 ^e	
United States	7,100	7,900	390,000
Armenia	300	300	95,000
Canada	—	—	32,000
Chile ⁶	25,000	26,000	1,300,000
Kazakhstan	2,500	—	190,000
Peru	—	—	45,000
Poland	7,530	7,600	NA
Russia	NA	NA	310,000
Uzbekistan	5,500	5,000	NA
Other countries	1,000	2,000	91,000
World total (rounded)	48,900	48,800	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. Rhenium is also associated with copper minerals in sedimentary deposits in Armenia, Kazakhstan, Poland, Russia, and Uzbekistan, where ore is processed for copper recovery, and the rhenium-bearing residues are recovered at the copper smelter.

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. — Zero.

¹Based on 80% recovery of estimated rhenium contained in MoS₂ concentrates.

²Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate, from Metal Bulletin.

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 resource/reserve definitions and information concerning data sources.

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