RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2012, 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 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 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 2012 was about $82 million.

Salient Statistics—United States:	2008	2009	2010	2011	2012[e]
Production[1]	7,910	5,580	6,100	8,610	9,400
Imports for consumption	43,700	31,500	33,600	33,500	34,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	51,600	37,100	39,700	42,100	44,000
Price,[2] average value, dollars per kilogram, gross weight:					
Metal pellets, 99.99% pure	10,400	7,500	4,720	4,670	4,000
Ammonium perrhenate	10,300	7,580	4,630	4,360	4,000
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	85	85	85	80	78

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 (2008–11): Rhenium metal powder: Chile, 89%; Netherlands, 5%; Germany, 3%; and other, 3%. Ammonium perrhenate: Kazakhstan, 29%; United Kingdom, 16%; Poland, 11%; Republic of Korea, 11%; and other, 33%.

Tariff:

Item	Number	Normal Trade Relations 12–31–12
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 2012, the United States continued to rely on imports for much of its supply of rhenium, and Chile and Kazakhstan supplied most of the imported rhenium. Rhenium imports for consumption increased slightly from that of 2011. Rhenium production in the United States increased by 9% owing to increased production of byproduct molybdenum concentrates in the United States. Six of the seven copper-molybdenum mines increased byproduct molybdenum production levels in 2012. 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.

In 2012, the catalytic-grade APR price remained at $4,250 per kilogram until March, when the price decreased to $3,950 per kilogram. In November, the price decreased further to $3,800 per kilogram. Rhenium metal pellet price started out the year at $4,630 per kilogram until the end of February, when it decreased to $4,190 per kilogram. In early March, the price increased to $4,300 per kilogram until August, when the price decreased to $3,640 per kilogram. In early November, the price decreased again to $3,400 per kilogram.

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 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: Production data for Canada and Peru were revised based on new information from industry sources.

	Mine production[4]		Reserves[5]
	2011	2012[e]	
United States	8,610	9,400	390,000
Armenia	600	600	95,000
Canada	—	—	32,000
Chile[6]	27,000	27,000	1,300,000
Kazakhstan	3,000	3,000	190,000
Korea, Republic of	500	500	NA
Peru	—	—	45,000
Poland	6,000	6,200	NA
Russia	500	500	310,000
Uzbekistan	3,000	3,000	NA
Other countries	1,500	1,500	91,000
World total (rounded)	50,700	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. 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.

[e]Estimated. NA Not available. — Zero.
[1]Based on 80% recovery of estimated rhenium contained in MoS_2 concentrates.
[2]Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate, from Metal Bulletin.
[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.