RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2018, ores containing 8,300 kilograms of rhenium were mined at six operations (four 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 superalloys used in high-temperature turbine engine components and in petroleum-reforming catalysts, representing an estimated 80% and 15%, 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-base 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 value of rhenium consumed in 2018 was about $83 million as measured by the value of imports of rhenium metal and APR.

Salient Statistics—United States:	**2014**	**2015**	**2016**	**2017**	**2018[e]**
Production[1]	8,510	7,900	8,440	8,200	8,300
Imports for consumption[2]	25,000	31,800	31,900	34,500	42,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent[3]	33,500	39,700	40,300	42,700	51,000
Price, average value, dollars per kilogram, gross weight:[4]					
Metal pellets, 99.99% pure	2,980	2,670	2,030	1,550	1,500
Ammonium perrhenate	3,080	2,820	2,510	1,530	1,400
Employment, number	Small	Small	Small	Small	Small
Net import reliance[5] as a percentage of apparent consumption	75	80	79	81	84

Recycling: Nickel-base superalloy scrap and scrapped turbine blades and vanes continued to be recycled hydrometallurgically to produce rhenium metal for use in new superalloy melts. The scrapped parts were also processed to generate engine revert—a high-quality, lower cost superalloy meltstock—by an increasing number of companies, mainly in the United States, Canada, Estonia, Germany, and Russia. Rhenium-containing catalysts were also recycled.

Import Sources (2014–17): Ammonium perrhenate: Kazakhstan, 34%; Canada, 19%; Republic of Korea, 13%; Germany, 10%; and other, 24%. Rhenium metal powder: Chile, 85%; Germany, 6%; Belgium, 4%; Poland, 3%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–18**
Salts of peroxometallic acids, other, ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium (and other metals), waste and scrap	8112.92.0600	Free.
Rhenium, unwrought and powders	8112.92.5000	3% ad val.
Rhenium (and other metals), wrought	8112.99.9000	4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: During 2018, the United States continued to rely on imports for much of its supply of rhenium. Canada, Chile, Germany, Kazakhstan, and the Republic of Korea supplied most of the imported rhenium. Rhenium imports for consumption increased by 22% from those of 2017. Primary rhenium production in the United States slightly increased compared with that in 2017. Germany and the United States continued to be the leading secondary rhenium producers. Secondary rhenium production also took place in Canada, Estonia, France, Japan, Poland, and Russia. Reliable secondary production estimates were not available. For the seventh year in a row, rhenium metal and catalytic-grade APR prices declined. In 2018, catalytic-grade APR prices averaged $1,400 per kilogram, an 8% decrease from 2017 prices. Rhenium metal pellet prices averaged $1,500 per kilogram in 2018, a slight decrease from 2017 prices.

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RHENIUM

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. The major aerospace companies, however, were expected to continue testing superalloys that contain one-half the quantity of rhenium used in engine blades as currently designed, as well as testing rhenium-free alloys for other engine components.

In May 2018, the U.S. Department of the Interior, in coordination with other executive branch agencies, published a list of 35 critical minerals (83 FR 23295), including rhenium. This list was developed to serve as an initial focus, pursuant to Executive Order 13817, ‘‘A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals” (82 FR 60835).

World Mine Production and Reserves: The reserves estimate for the United States was revised based on company reports.

	Mine production[6]		Reserves[7]
	2017	2018[e]	
United States	8,200	8,300	400,000
Armenia	300	260	95,000
Canada	—	—	32,000
Chile[8]	27,000	27,000	1,300,000
China	2,500	2,500	NA
Kazakhstan	1,000	1,200	190,000
Peru	—	—	45,000
Poland	9,300	9,300	NA
Russia	NA	NA	310,000
Uzbekistan	460	500	NA
World total (rounded)	48,800	49,000	2,400,000

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 also is 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 copper smelters.

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 molybdenum disulfide concentrates. Secondary rhenium production is not included.
[2]Does not include wrought forms or waste and scrap. The rhenium content of ammonium perrhenate is 69.42%.
[3]Defined as production + imports – exports.
[4]Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate, from Argus Media group–Argus Metals International.
[5]Defined as imports – exports.
[6]Estimated amount of rhenium recovered in association with copper and molybdenum production. Secondary rhenium production not included.
[7]See Appendix C for resource and reserve definitions and information concerning data sources.
[8]Estimated rhenium recovered from roaster residues from Belgium, Chile, and Mexico.