RHENIUM

(Data in kilograms of contained rhenium unless otherwise noted)

Domestic Production and Use: During 2022, rhenium-containing products including ammonium perrhenate (APR), metal powder, and perrhenic acid were produced as byproducts from roasting molybdenum concentrates from porphyry copper-molybdenum deposits in Arizona and Montana. U.S. primary production was approximately 9,000 kilograms in 2022, a 3% decrease from that in 2021. The United States continued to be a leading producer of secondary rhenium, recovering rhenium from nickel-base superalloy scrap, spent oil-refining catalysts, and foundry revert. 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 degrees Celsius) 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.

Salient Statistics—United States:	**2018**	**2019**	**2020**	**2021**	**2022[e]**
Production[1]	8,220	8,360	8,830	9,290	9,000
Imports for consumption					
Rhenium, unwrought and powders[2]	32,000	31,500	15,900	15,900	10,000
Ammonium perrhenate[3]	7,400	12,800	9,320	6,000	10,000
Exports	NA	NA	NA	NA	360
Consumption, apparent[4]	47,600	52,600	34,000	31,200	29,000
Price, average value, gross weight, dollars per kilogram:[5]					
Metal pellets, 99.99% pure	1,470	1,300	1,030	977	1,100
Ammonium perrhenate	1,410	1,280	1,090	866	910
Employment, number	Small	Small	Small	Small	Small
Net import reliance[6] as a percentage of apparent consumption	83	84	74	70	69

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 Canada, Estonia, France, Germany, Japan, Poland, Russia, and the United States. Rhenium-containing catalysts were also recycled. The rhenium recycled from spent catalysts was either returned to the oil companies or to the catalyst producer for production of new catalysts in what is considered a closed-loop system.

Import Sources (2018–21): Ammonium perrhenate: Kazakhstan, 27%; Poland, 16%; Canada, 15%; Germany, 15%; and other, 27%. Rhenium metal powder: Chile, 84%; Canada, 8%; Germany, 6%; and other, 2%. Total imports: Chile, 63%; Canada, 10%; Germany, 8%; Kazakhstan, 7%; and other, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12–31–22**
Salts of peroxometallic acids, other, ammonium perrhenate	2841.90.2000	3.1% ad valorem.
Rhenium, unwrought, waste and scrap; powders	8112.41.0000	Free.
Rhenium, unwrought, waste and scrap	8112.41.1000	Free.
Rhenium, unwrought and powders	8112.41.5000	3% ad valorem.
Rhenium, unwrought and powders	8112.92.5000	3% ad valorem.
Rhenium (and other metals), wrought	8112.99.9100	4% ad valorem.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: In 2022, the price of catalytic-grade APR averaged $910 per kilogram, a 6% increase from the annual average price in 2021. The rhenium metal pellet price averaged $1,100 per kilogram in 2022, a 15% increase from the annual average price in 2021.

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In 2022, apparent consumption in the United States was 8% less than that in 2021. During 2022, the United States continued to rely on imports for much of its supply of rhenium. Canada, Chile, Germany, Kazakhstan, and Poland supplied most of the imported rhenium. Imports of APR increased by 66% in 2022 compared with those in the previous year. Imports of rhenium metal decreased by 37% in 2022 compared with those in the previous year. World rhenium production in 2022 decreased slightly compared with that in 2021.

The United States and Germany continued to be the leading secondary rhenium producers. Secondary rhenium production also took place in Canada, Estonia, France, Japan, Poland, and Russia. Available information was insufficient to make U.S. secondary production estimates; however, industry sources estimated U.S. capacity was between 18,000 and 20,000 kilograms per year of rhenium. Industry sources estimated that approximately 25,000 kilograms of secondary rhenium was produced worldwide in 2022. There were no primary rhenium projects in 2022 that were expected to significantly contribute to rhenium availability in the near future.

On February 24, 2022, a final U.S. critical minerals list was published in the Federal Register (87 FR 10381). The 2022 critical minerals list was an update of the list of critical minerals published in 2018 in the Federal Register (83 FR 23295). The 2022 critical minerals list contained 50 individual mineral commodities instead of 35 minerals and mineral groups. The changes in the 2022 list from the prior list were the addition of nickel and zinc and the removal of helium, potash, rhenium, strontium, and uranium. The list is to be updated every 3 years and revised as necessary consistent with available data.

World Mine Production and Reserves:

	Mine production[e,7]		Reserves[8]
	2021	2022	
United States	9,290	9,000	400,000
Armenia	260	260	95,000
Chile[9]	30,000	29,000	1,300,000
China	2,500	2,500	NA
Kazakhstan	500	500	190,000
Korea, Republic of	2,800	2,800	NA
Poland	9,290	9,500	NA
Russia	NA	NA	310,000
Uzbekistan	4,900	4,900	NA
World total (rounded)	59,500	58,000	Large

World Resources:[8] Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 7 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 continually being evaluated. 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 molybdenum disulfide concentrates. Secondary rhenium production not included.

[2]Includes Harmonized Tariff Schedule of the United States (HTS) code 8112.92.5000 (2018–2021) and HTS code 8112.41.5000 (2022). Does not include wrought forms or waste and scrap.

[3]The rhenium content of ammonium perrhenate is 69.42%.

[4]Defined as production + imports – exports.

[5]Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate. Source: Argus Media group, Argus Metals International.

[6]Defined as imports – exports.

[7]Estimated amount of rhenium recovered in association with copper and molybdenum production. Secondary rhenium production not included.

[8]See Appendix C for resource and reserve definitions and information concerning data sources.

[9]Estimated rhenium recovered from roaster residues from Belgium, Chile, Mexico, and Peru.