

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2004, ores containing rhenium were mined by four operations (two in Arizona, one each in Utah and Montana). 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, perrhenic acid, and metal powder. The major uses of rhenium were in petroleum-reforming catalysts and in high-temperature superalloys used in turbine engine components, representing about 40% and 50%, respectively, of the total demand. Rhenium was used in petroleum-reforming catalysts for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Bimetallic platinum-rhenium catalysts have replaced many of the monometallic catalysts. 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 estimated value of rhenium consumed in 2004 was about \$14 million.

| Salient Statistics—United States: | 2000 | 2001 | 2002 | 2003 | 2004^e |
|--|-------------|-------------|-------------|-------------|-------------------------|
| Production ¹ | 7,100 | 5,500 | 4,000 | 3,900 | 4,200 |
| Imports for consumption | 16,400 | 23,400 | 16,600 | 14,500 | 15,700 |
| Exports | NA | NA | NA | NA | NA |
| Consumption, apparent | 23,500 | 28,900 | 20,600 | 18,400 | 19,900 |
| Price, ² average value, dollars per kilogram, gross weight: | | | | | |
| Metal powder, 99.99% pure | 940 | 910 | 1,030 | 1,090 | 985 |
| Ammonium perrhenate | 510 | 790 | 810 | 790 | 840 |
| 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 | 70 | 81 | 81 | 79 | 79 |

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 (2000-03): Rhenium metal: Chile, 88%; Kazakhstan, 4%; Mexico, 3%; and other, 5%. Ammonium perrhenate: Kazakhstan, 65%; Germany, 11%; United Kingdom, 6%; Estonia, 6%; and other, 12%.

| Tariff: | Item | Number | Normal Trade Relations |
|----------------|--|---------------|-------------------------------|
| | | | 12-31-04 |
| | Other inorganic acids, other—rhenium, etc. | 2811.19.6050 | 4.2% ad val. |
| | Salts of peroxometallic acids, other— ammonium perrhenate | 2841.90.2000 | 3.1% ad val. |
| | Rhenium, etc., (metals) waste and scrap | 8112.92.0500 | Free. |
| | Rhenium, (metals) unwrought; powders | 8112.92.5000 | 3% ad val. |
| | Rhenium, etc., (metals) wrought; etc. | 8112.99.0100 | 4% ad val. |

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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Events, Trends, and Issues: During 2004, average rhenium metal price was about \$985 per kilogram, about 10% lower than that of 2003. Rhenium imports increased by about 8% owing to improved demand in the superalloy and catalyst markets. Rhenium recovery in the United States increased by 8% due to increased production of byproduct molybdenum concentrates from porphyry copper deposits. Copper production from these deposits was reduced in 2002 and 2003 to stabilize copper prices. The United States relied on imports for much of its supply of rhenium. Chile and Kazakhstan supplied the majority of the rhenium imported.

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, Reserves, and Reserve Base:

| | Mine production⁴ | | Reserves⁵ | Reserve base⁵ |
|-----------------------|------------------------------------|--------------------|-----------------------------|---------------------------------|
| | <u>2003</u> | <u>2004</u> | | |
| United States | 3,900 | 4,200 | 390,000 | 4,500,000 |
| Armenia | 1,000 | 1,000 | 95,000 | 120,000 |
| Canada | 1,700 | 1,700 | — | 1,500,000 |
| Chile | 15,600 | 15,600 | 1,300,000 | 2,500,000 |
| Kazakhstan | 2,600 | 2,900 | 190,000 | 250,000 |
| Peru | 5,000 | 5,000 | 45,000 | 550,000 |
| Russia | 1,400 | 1,400 | 310,000 | 400,000 |
| Other countries | <u>1,000</u> | <u>1,000</u> | <u>91,000</u> | <u>360,000</u> |
| World total (rounded) | 32,000 | 33,000 | 2,400,000 | 10,000,000 |

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 may decrease rhenium's share of the catalyst market. 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.

⁶Estimated. NA Not available. — Zero.

¹Based on estimated rhenium contained in MoS₂ concentrates assuming 90% recovery of rhenium content.

²Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.

³Defined as imports – exports + adjustments for Government and industry stock changes.

⁴Estimated amount of rhenium extracted in association with copper and molybdenum production.

⁵See [Appendix C](#) for definitions.