# RHENIUM

(Data in kilograms of rhenium content, unless otherwise noted)

**Domestic Production and Use:** During 2003, ores containing rhenium were mined by three operations. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits in the Southwestern United States, 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 (1,000º C) strength properties of some nickel-base superalloys. Some of the uses for rhenium alloys were in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, and vacuum tubes. The estimated value of rhenium consumed in 2003 was $20 million.

| **Salient Statistics—United States:** | **1999** | **2000** | **2001** | **2002** | **2003[e]** |
|---|---|---|---|---|---|
| Production[1] | 6,600 | 7,500 | 6,300 | 4,400 | 4,600 |
| Imports for consumption | 14,700 | 15,900 | 23,400 | 16,600 | 14,500 |
| Exports | NA | NA | NA | NA | NA |
| Consumption, apparent | 21,300 | 23,400 | 29,600 | 21,000 | 19,100 |
| Price, average value, dollars per kilogram, gross weight: | | | | | |
| Metal powder, 99.99% pure | 1,100 | 1,010 | 910 | 1,030 | 1,110 |
| Ammonium perrhenate | 610 | 510 | 790 | 810 | 840 |
| Stocks, yearend, consumer, producer, dealer | NA | NA | NA | NA | NA |
| Employment, number | Small | Small | Small | Small | Small |
| Net import reliance[2] as a percentage of apparent consumption | 69 | 68 | 79 | 79 | 76 |

**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 (1999-2002):** Rhenium metal: Chile, 87%; and other, 13%. Ammonium perrhenate: Kazakhstan, 28%; Estonia, 6%; United Kingdom, 6%; and other, 10%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/03** |
|---|---|---|
| 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 2003, the average rhenium prices were $1,110 per kilogram for metal and $840 per kilogram for ammonium perrhenate in the United States. Production increased by 5%, and imports of rhenium decreased by about 16%. Increased rhenium recovery in the United States was due to resumed production of byproduct molybdenum concentrates from porphyry copper deposits. Copper production from these deposits had been reduced in 2002 to stabilize copper prices. The United States relied on imports for much of its supply of rhenium. Chile and Germany 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:** Production data for the United States were revised to reflect rhenium recovered from byproduct molybdenum concentrates. Production data for Chile were revised based on new information.

| | Mine production[3] | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 2002 | 2003 | | |
| United States | 4,400 | 4,600 | 390,000 | 4,500,000 |
| Armenia | 800 | 800 | 95,000 | 120,000 |
| Canada | 1,700 | 1,700 | — | 1,500,000 |
| Chile | 14,100 | 15,000 | 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 | 1,500 | 310,000 | 400,000 |
| Other countries | 1,000 | 1,000 | 91,000 | 360,000 |
| World total (rounded) | 31,000 | 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 4.5 million kilograms, and the identified resources of the rest of the world are approximately 5.5 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.

[e]Estimated. NA Not available. — Zero.

[1]Based on estimated rhenium contained in $MoS_2$ concentrates assuming 90% recovery of rhenium content.

[2]Defined as imports – exports + adjustments for Government and industry stock changes.

[3]Estimated amount of rhenium extracted in association with copper and molybdenum production.

[4]See Appendix C for definitions.