

Helium

By Russell J. Foster¹

Domestic sales of high purity helium (minimum 99.995% purity) in 1977 increased 37% to 789 million cubic feet.² The Bureau of Mines sold 28% of the total, and private industry accounted for the remainder. Exports of high purity helium, all by private producers, declined 3% to 168 mil-

lion cubic feet. The Bureau of Mines f.o.b. plant price for high purity helium remained at \$35 per thousand cubic feet, unchanged since 1961. High purity helium sold by private producers averaged approximately \$22.50 per thousand cubic feet.

DOMESTIC PRODUCTION

Nine plants with the capacity to extract helium from natural gas were operational in 1977. Seven of the plants were owned by private industry and the other two were owned by the U.S. Government and operated by the Bureau of Mines. Five extraction plants were located in Kansas, two in Texas, and one each in New Mexico and Oklahoma.

Total helium extracted from natural gas in 1977, by private and government plants, was 1.5 billion cubic feet, an increase of 12% over the amount produced in 1976. High purity helium extraction increased 27%, but the amount of crude helium extracted declined 9%. High purity helium produced for sale comprised 64% of the total helium extracted and crude helium constituted 36%. The Bureau of Mines accounted for 23% of the high purity and 22% of the

crude helium extracted, and private industry the remainder.

The Bureau of Mines awarded two contracts to CTI-Cryogenics, a division of Helix Technology Corp., for the construction, startup, and testing of a new helium purification facility capable of producing 600,000 cubic feet of pure helium per day from a 70% to 78% crude helium feed gas, and a new 500-liter-per-hour-capacity helium liquefaction facility at the Bureau's Exell, Tex., plant.

Liquid helium production capacity of the Bureau will be increased to about 100 liters per hour with the addition of another helium liquefier at the Amarillo, Tex., shipping terminal in 1978. The unit was purchased from Kerr-McGee Corp.'s Navajo, Ariz., plant, which closed in 1976.

Table 1.—Helium extracted from natural gas in the United States

(Thousand cubic feet)

	1973	1974	1975	1976	1977 ^P
Crude helium:¹					
Extracted at Bureau of Mines plants -----	175,976	169,414	183,725	[†] 195,758	117,686
Extracted at private industry plants -----	2,381,971	15,073	149,794	391,553	419,228
Total -----	2,557,947	184,487	333,519	[†]587,311	536,914
High purity helium:²					
Extracted at Bureau of Mines plants -----	180,114	168,662	184,524	[†] 177,677	219,495
Extracted at private industry plants -----	487,102	[‡] 530,312	[‡] 560,899	[‡] 574,087	[‡] 737,453
Total -----	647,216	698,974	745,423	[†]751,764	956,948
Grand total -----	3,205,163	883,461	1,078,942	1,339,075	1,493,862

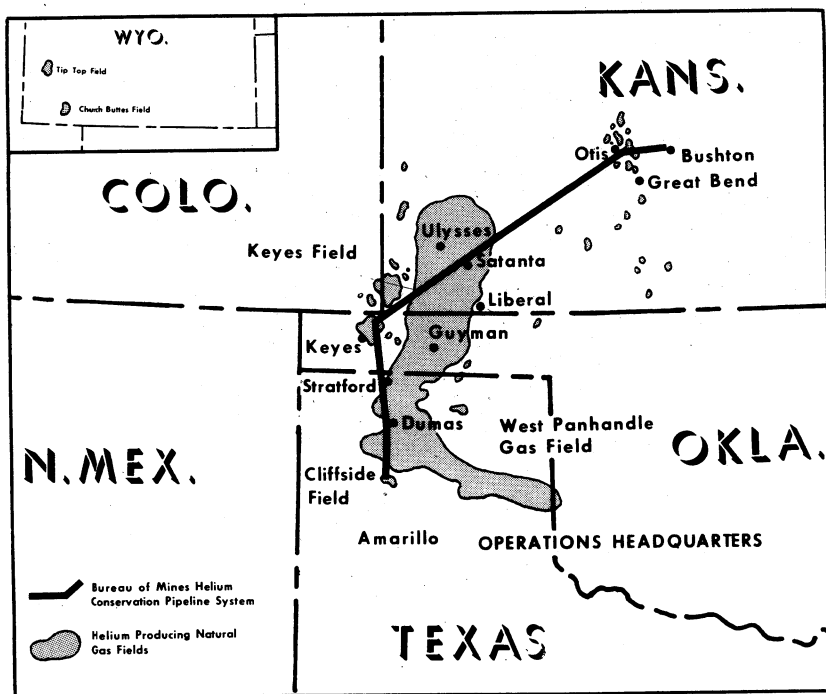
^PPreliminary. [†]Revised.¹Excludes crude helium purified after interplant transfer.²Includes only those quantities produced for sale; quantities entering conservation storage system after purification are included under crude helium.[‡]Includes helium purified at the Bureau of Mines Keyes plant for the accounts of others.

Figure 1.—Major U.S. helium-producing gasfields.

Table 2.—Ownership and location of helium extraction plants in the United States, 1977

Category and owner or operator	Location	Product purity
Government owned:		
Bureau of Mines -----	Exell, Tex -----	Crude helium.
Do -----	Keyes, Okla -----	Crude and high purity helium.
Private industry:		
Alamo Chemical Co.-Gardner Cryogenics Corp -----	Elkhart, Kans -----	High purity helium.
Cities Service Cryogenics, Inc -----	Scott City, Kans -----	Crude helium. ¹
Cities Service Helex, Inc -----	Ulysses, Kans -----	Crude and high purity helium.
Kansas Refined Helium Co -----	Otis, Kans -----	High purity helium.
Northern Helex Co -----	Bushton, Kans -----	Crude helium.
Phillips Petroleum Co -----	Hansford County, Tex -----	Do.
Western Helium Co -----	Shiprock, N. Mex -----	High purity helium.

¹Output is piped to Cities Service Helex, Inc., plant at Ulysses, Kans., for purification.

Table 3.—Summary of Bureau of Mines helium plant and Amarillo shipping terminal operations

(Thousand cubic feet)

	1975	1976	1977
Supply:			
Inventory at beginning of period ¹ -----			
Helium extracted: ²			
Exell plant:			
Crude -----	36,111	12,443	8,733
Keyes plant:			
Crude -----	147,614	[†] 183,315	108,953
High purity ³ -----	186,399	[†] 178,966	218,876
Total Keyes plant -----	334,013	362,281	327,829
Total extracted -----	370,124	374,724	336,562
Helium returned in containers (net) -----	1,349	[†] -1,891	-5,871
Total supply -----	380,764	[†] 382,638	339,272
Disposal:			
Sales of high purity helium -----	184,524	[†] 177,677	219,495
Net deliveries to helium conservation system ⁴ -----	186,435	196,580	114,056
Inventory at end of period ¹ -----	9,805	8,381	5,721
Total disposal -----	380,764	[†] 382,638	339,272

[†]Revised.

¹At Exell and Keyes plants and at Amarillo shipping terminal.

²Excludes conservation helium produced from native gas withdrawal wells at Cliffside field that have been invaded by stored helium.

³Excludes 39,396,000 cubic feet purified for others in 1975, 63,226,000 cubic feet in 1976, and 169,970,000 cubic feet in 1977.

⁴Excludes return of conservation helium produced as indicated in footnote 2 to conservation storage system.

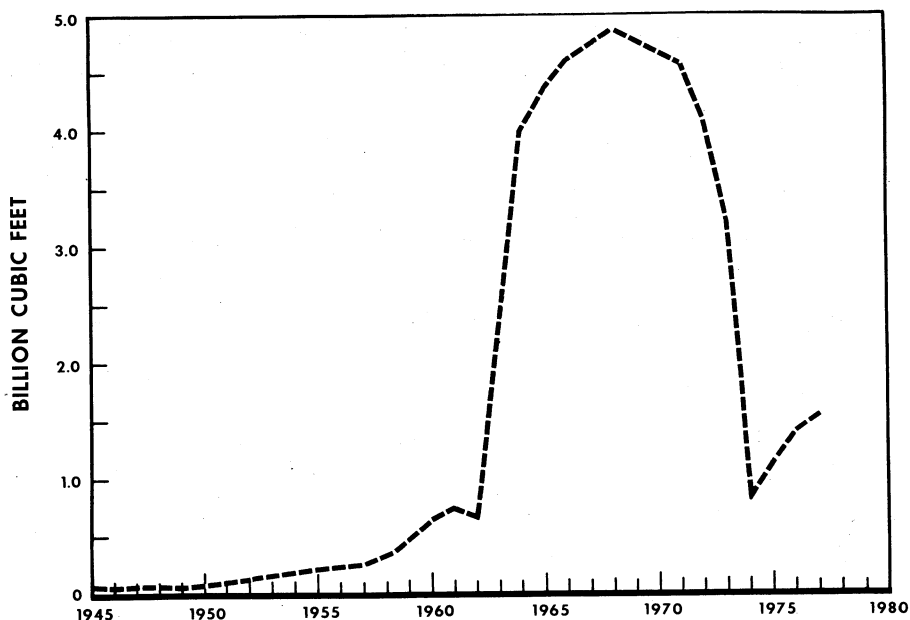


Figure 2.—Helium production in the United States, 1945-77.

CONSUMPTION AND USES

Principal domestic end uses of helium in 1977 were cryogenics, welding, and purging and pressurizing. Other uses included synthetic breathing mixtures, chromatography, leak detection, lifting gas, heat transfer, and controlled atmospheres. Demand during the year was centered mainly in the Pacific and Gulf Coast States.

Federal agency purchases in the form of direct sales from the Bureau of Mines constituted about 78% of the Bureau's total high purity helium production. Almost all of the remaining sales of high purity helium by the Bureau were to Federal agencies through General Services Administration contracts with private distributors. Federal agencies are required by law to purchase from the Bureau. These contracts made relatively small quantities of helium readily available to Federal installations at reduced freight charges for small purchases.

The Bureau of Mines f.o.b. plant price of high purity helium in 1977 was \$35 per thousand cubic feet, unchanged since 1961, and maintained for the purpose of financing the Government's helium conservation program. Except in special circumstances, this was not competitive with the private pro-

ducer average price of \$22.50 per thousand cubic feet, f.o.b. plant.

All high purity helium sold by the Bureau of Mines was shipped in gaseous form in cylinders, railroad tank cars, highway tanker trailers, and in liquid form in containerized dewars from the Amarillo shipping terminal. Private industry distributors shipped helium in both gaseous and liquid forms. Much of the helium transported in liquid form was delivered by semitrailer and/or containerized dewars to distribution centers where it was regasified and compressed into trailers and small cylinders for delivery to the end user.

Table 4.—Total sales of high purity helium in the United States

(Million cubic feet)	
Year	Quantity
1973	^e 530
1974	^e 570
1975	601
1976	578
1977	^p 789

^eEstimate. ^pPreliminary.

Table 5.—Bureau of Mines sales of high purity helium, by recipient
(Thousand cubic feet)

	1975	1976	1977
Federal agencies:			
Energy Research and Development Administration ¹ -----	17,184	14,596	22,297
Department of Defense -----	60,551	67,827	114,690
National Aeronautics and Space Administration -----	21,046	8,884	24,694
National Weather Service -----	1,746	1,515	1,682
Other ² -----	4,968	4,757	8,868
Total Federal agencies -----	105,495	97,579	172,231
Private helium distributor sales ³ -----	77,049	77,577	45,028
Commercial sales -----	1,980	2,521	2,241
Grand total -----	184,524	177,677	219,495

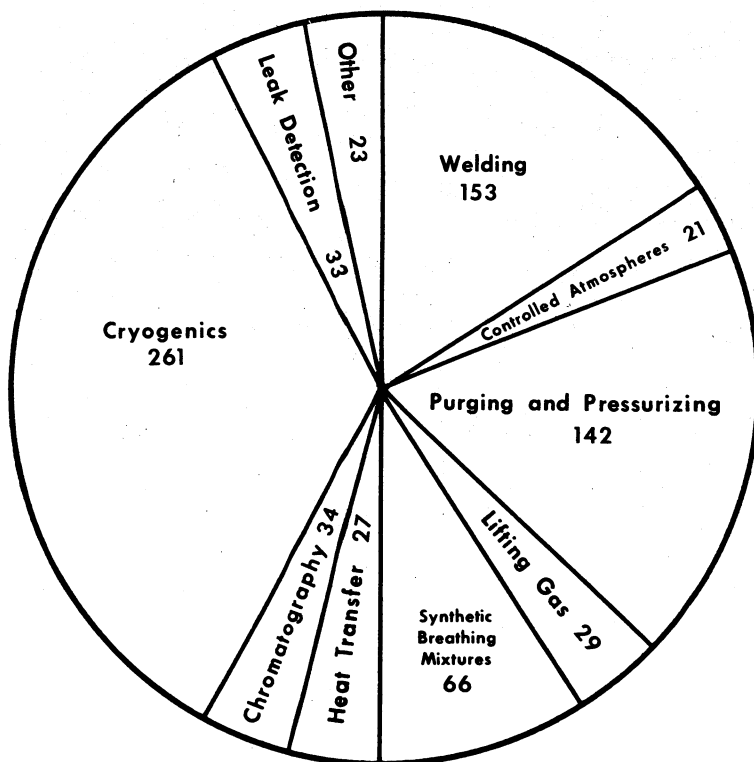
¹Revised.

²Became part of Department of Energy on Oct. 1, 1977.

³Includes quantities used by the Bureau of Mines.

⁴Most of this was purchased by commercial firms which sold equivalent quantities to Federal installations under contract agreements with the General Services Administration.

ESTIMATED HELIUM USED
789 million cu. ft.



Source: Midwest Research Institute
"Comprehensive Investigation and
Report on Helium Uses," January 31, 1977

Figure 3.—Helium consumption by end use in the United States, 1977.

CONSERVATION

Helium held in the Bureau of Mines conservation storage system, which includes the conservation pipeline network and the Cliffside gasfield near Amarillo, Tex., increased 1% in 1977 to 39,475 million cubic feet. Helium stored under the conservation program was 37,780 million cubic feet, an increase of 114 million cubic feet during 1977. Private producers had a balance of 1,695 million cubic feet stored

under contract with the Bureau in the conservation system (for future redelivery) at yearend 1977.

The conservation storage system contains crude helium purchased by the Bureau of Mines under contracts entered into with four companies in 1961, and crude helium accepted through November 12, 1973, under a court order obtained during 1973 by three of the companies.

Table 6.—Summary of Bureau of Mines helium conservation system¹ operations

(Thousand cubic feet)

	1975	1976	1977
Helium in conservation storage system at beginning of period:			
Stored under Bureau of Mines conservation program ² -----	37,283,348	37,469,783	37,666,363
Stored under contract for private producers' own accounts -----	995,987	1,087,587	1,424,931
Total -----	38,279,335	38,557,370	39,091,294
Input to system:			
Net deliveries from Bureau of Mines plants ³ -----	186,435	196,580	114,056
Stored under contract for private producers' own accounts -----	200,131	583,133	582,935
Total -----	386,566	779,713	696,991
Redelivery of helium stored under contract for private producers' own accounts -----	-108,531	-245,789	-312,856
Net addition to system -----	278,035	533,924	384,135
Helium in conservation storage system at end of period:			
Stored under Bureau of Mines conservation program ² -----	37,469,783	37,666,363	37,780,419
Stored under contract for private producers' own accounts -----	1,087,587	1,424,931	1,695,010
Total -----	38,557,370	39,091,294	39,475,429

¹Includes conservation pipeline system and Cliffside field.

²Includes helium accepted after Apr. 4, 1973, under court order.

³Excludes return to system of conservation helium produced from native gas withdrawal wells at Cliffside field which have been invaded by stored helium.

Table 7.—Deliveries and withdrawals of crude helium stored for private companies' own accounts in the Bureau of Mines conservation storage system, 1977

(Thousand cubic feet)

Owner	Plant location	Delivered	Withdrawn	Net
Cities Service Helix, Inc -----	Ulysses, Kans -----	--	979	-979
Northern Helix Co -----	Bushton, Kans -----	347,210	121	347,089
Phillips Petroleum Co -----	Dumas, Tex -----	20,700	44,873	-24,173
Jack B. Kelley Co -----	Bushton, Kans -----	--	8,636	-8,636
Kansas Refined Helium Co -----	do -----	215,025	142,886	72,139
Linde Div., Union Carbide Corp -----	do -----	--	96,532	-96,532
Airco, Inc -----	Murray Hill, N. J -----	--	18,828	-18,828
Total ¹ -----		582,935	312,856	270,079

¹Data may not add to totals shown because of independent rounding.

RESOURCES

As of December 31, 1977, domestic measured and indicated helium resources were estimated at 255.2 billion cubic feet. The resources include measured and indicated reserves estimated at 91.6 and 50.5 billion cubic feet, respectively, in natural gas with a minimum helium content of 0.3%. The remaining resource base included 39.5 billion cubic feet stored in the Bureau's conservation storage system, 66.8 billion cubic feet of helium in measured natural gas reserves with a helium content of less than 0.3%, and 6.8 billion cubic feet of indicated helium in natural gas with a helium content of 0.1% to 0.3%. Approximately 39% of the domestic helium reserves are under Federal lease. Included are the Tip Top and Church Buttes fields in Wyoming, the Keyes field in Oklahoma, and the Cliffside field in Texas.

The majority of domestic helium reserves are located in the midcontinent and Rocky Mountain regions of the United States. A total of 69 gasfields in 10 States contain

measured and indicated helium reserves. About 85% of these reserves are located in the Hugoton field in Kansas, Oklahoma, and Texas; the Keyes field in Oklahoma, the Panhandle and Cliffside fields in Texas, and the Tip Top field in Wyoming. Approximately 53% of the measured and indicated reserves (0.3% or greater helium content) at yearend 1977 were in currently producing gasfields. In 1977, about 20% of the helium-rich natural gas (0.3% or greater helium content) produced was processed for helium extraction. Helium produced from the remaining helium-rich natural gas output was dissipated incident to the consumption of the gas.

The Bureau examined a total of 362 gas samples from 16 States and 1 foreign country during 1977 in connection with its efforts to survey and identify possible new sources of helium supply. None of the samples collected and analyzed indicated the presence of major new deposits of helium.

FOREIGN TRADE

Exports of high purity helium, all by private industry, declined 3% in 1977 to 168 million cubic feet. Nearly 76% of exported helium was shipped to Europe, primarily the United Kingdom, 37%; Belgium-Luxembourg, 26%; and France, 10%. The remaining exports were distributed as follows: Asia, 12%; North America, 7%; South America, 3%; and Oceania, 2%. Continued exports of large quantities of helium to Western Europe during 1977 were attributed mainly to its use in the exploration for and development of oil and gas deposits, especially in the North Sea area.

Table 8.—Exports of high purity helium from the United States

(Million cubic feet)

Year	Quantity
1973	^e 117
1974	^e 129
1975	¹ 144
1976	¹ 174
1977	¹ 168

^eEstimate.

¹Bureau of the Census.

WORLD REVIEW

World production of helium, exclusive of the United States, was estimated at 149 million cubic feet in 1977. Canada produced about 15 million cubic feet from one plant in Saskatchewan owned by Canadian Helium, Ltd. However, depletion of the helium-containing natural gasfield forced this plant to close in 1977.³ Production from a plant near Paris, France, was approximately 11 million cubic feet. The U.S.S.R.

and the central economy countries of Europe produced an estimated 123 million cubic feet. A helium extraction plant with a capacity of 150 million cubic feet per year came onstream at Odolanow, Poland, as part of a natural gas upgrading facility, which removes both nitrogen and helium from the gas. Airco, Inc., has contracted to market all helium exported from this plant.

TECHNOLOGY

Midwest Research Institute prepared a report on helium under a Bureau of Mines contract. The study included identification and description of present and potential uses of helium; the volume currently required by each end use; and a forecast of total U.S. helium requirements through the year 2000.

The Bureau has developed analytical methods to meet the specialized needs of helium users. A helium analysis sensitive to 10 parts per trillion freon was created to assist the National Aeronautics and Space Administration with upper atmosphere ozone studies. To aid geochemical uranium prospecting, an analysis for helium in air with a sensitivity to 1 part per million was generated. Analysis of air for the helium-3 isotope down to 1 part per trillion was developed for the Energy Research and Development Administration's analysis of stack gases.

Eight firms from the Federal Republic of Germany and Switzerland signed an agree-

ment with General Atomics Co. to pool their knowledge of helium turbine nuclear reactors. The system uses helium heated by the nuclear reaction to drive a gas turbine that generates electricity, rather than a conventional nuclear system which utilizes a steam turbine.⁴

In December, project U-25B of the joint United States-Soviet magnetohydrodynamics program began producing electricity for the Moscow power grid. The system moves ionized gas (plasma) through a helium-cooled magnetic field which deflects the ions to electrodes, creating an electric current.⁵

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²All helium statistics in this chapter are in terms of contained helium measured at 14.7 pounds per square inch absolute at 70°F.

³Wall Street Journal. Canadian Helium to End Its Production in Spring. V. 188, No. 121, Dec. 21, 1976.

⁴Energy User News. 9 Firms Study Helium-Turbine Reactor. V. 1, No. 7, Nov. 15, 1976.

⁵Science News. U.S.-Soviet MHD Plant Generates First Power. V. 113, No. 1, Jan. 7, 1978, p. 6.