

# Helium

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Sales of high purity helium (99.995% purity) in the United States during 1972 increased 9% to a total of 489 million cubic feet.<sup>2</sup> Approximately 36% of this total was sold by the Bureau of Mines and 64% was accounted for by private industry plant sales. Exports of high purity helium, all by private industry, totaled 138 million cubic feet in 1972. The f.o.b. Bureau of Mines plant price for high purity helium sold during the year remained at \$35 per thousand cubic feet while private industry plant prices averaged \$21 per thousand cubic feet.

In compliance with an order of the U.S. District Court for the District of Kansas issued on March 27, 1971, the Bureau of Mines continued to accept helium during 1972 under three of four conservation contracts whose termination provisions had

been invoked by the Secretary of the Interior. This order was affirmed on appeal on the ground that the requirements of the National Environmental Policy Act had not been complied with. On November 13, 1972, the Department released an environmental impact statement prepared in furtherance of an evaluation of the environmental consequences of termination of the contracts.

A ruling made by the U.S. Court of Claims on January 21, 1972, held that the Government had materially breached its agreement with the fourth contractor. The issue of damages is pending. This firm continued to deliver helium to the Bureau of Mines for storage to its account, pursuant to an interim storage agreement until expiration of the agreement on September 28, 1972.

## DOMESTIC PRODUCTION

A total of 12 helium extraction plants were in operation during 1972. Of these two were owned by the Federal Government and operated by the Bureau of Mines, five were private industry plants extracting helium primarily for long-term conservation storage, and five were private industry plants producing helium for independent sale to commercial (non-Federal) customers.

Total helium extracted from natural gas during 1972 declined approximately 10% to 4,089,501 thousand cubic feet despite a 9% increase in the output of high purity helium to 627,250 thousand cubic feet. Approximately 85% of total helium extracted was crude helium<sup>3</sup> and 15% was high purity helium produced for sale. About 92% of crude helium production was from private industry conservation plants and 72% of high purity output was from private industry plants producing for sale to com-

mercial customers. The remaining 8% of crude and 28% of high purity helium produced was extracted by Bureau of Mines plants.

Of the 438,665 thousand cubic feet of helium produced by the Bureau of Mines Keyes and Exell plants in 1972, approximately 88% was extracted from natural gas supplied by a private natural gas pipeline company on a gas-processing contract basis. The remaining 12% was extracted from natural gas that was produced from the Bureau of Mines Cliffside gasfield primarily in order to create additional reservoir space for helium conservation storage. All helium extraction from Cliffside natural gas occurred at the Exell plant.

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<sup>2</sup> All helium statistics in this chapter are reported in terms of contained helium measured at 14.7 pounds per square inch absolute and 70° F.

<sup>3</sup> Helium mixed with various quantities of other light gases, mostly nitrogen.

**Table 1.—Helium extracted from natural gas in the United States**  
(Thousand cubic feet)

	1968	1969	1970	1971	1972
<b>Crude helium: <sup>1</sup></b>					
Extracted at Bureau of Mines plants	199,300	306,200	429,400	504,406	262,147
Extracted at private industry plants	3,591,700	3,596,300	3,523,800	3,483,919	3,200,104
<b>Total</b> .....	<b>3,791,000</b>	<b>3,902,500</b>	<b>3,953,200</b>	<b>3,988,325</b>	<b>3,462,251</b>
<b>High purity helium: <sup>2</sup></b>					
Extracted at Bureau of Mines plants	478,400	360,700	230,700	173,626	173,575
Extracted at private industry plants	388,700	398,800	416,500	403,152	453,675
<b>Total</b> .....	<b>867,100</b>	<b>759,500</b>	<b>647,200</b>	<b>576,778</b>	<b>627,250</b>
<b>Grand total</b> .....	<b>4,658,100</b>	<b>4,662,000</b>	<b>4,600,400</b>	<b>4,565,103</b>	<b>4,089,501</b>

<sup>1</sup> Excludes crude helium purified after interplant transfer.

<sup>2</sup> Includes only those quantities produced for sale; quantities entering conservation storage system after purification are included under crude helium.

**Table 2.—Ownership and location of helium extraction plants in the United States, 1972**

Category and owner or operator	Location	Type of production
<b>Government owned:</b>		
Bureau of Mines.....	Exell, Tex.....	Crude helium.
Do.....	Keyes, Okla.....	Crude and high purity helium.
<b>Private industry, conservation:</b>		
Cities Service Helex, Inc.....	Ulysses, Kans.....	Crude helium. <sup>1</sup>
National Helium Corp.....	Liberal, Kans.....	Crude helium.
Northern Helex Co.....	Bushton, Kans.....	Do.
Phillips Petroleum Co.....	Dumas, Tex.....	Do.
Do.....	Hansford County, Tex.....	Do.
<b>Private industry, other:</b>		
Alamo Chemical-Gardner Cryogenics.....	Elkhart, Kans.....	High purity helium.
Cities Service Cryogenics, Inc.....	Scott City, Kans.....	Crude helium. <sup>2</sup>
Kansas Refined Helium Co.....	Otis, Kans.....	High purity helium.
Kerr-McGee, Corp.....	Navajo, Ariz.....	Do.
Western Helium Co.....	do.....	Do.

<sup>1</sup> Also purifies crude helium piped from Cities Service Cryogenics, Inc., plant at Scott City, Kans.

<sup>2</sup> Crude helium 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, 1971 and 1972**

	1971	1972
<b>Supply:</b>		
Inventory at beginning of period <sup>1</sup> .....	13,557	11,474
<b>Helium extracted: <sup>2</sup></b>		
<b>Exell plant:</b>		
Crude.....	234,119	99,391
High purity <sup>3</sup> .....	50,304	--
<b>Total Exell plant</b> .....	<b>284,423</b>	<b>99,391</b>
<b>Keyes plant:</b>		
Crude.....	270,287	162,756
High purity <sup>3</sup> .....	123,322	176,518
<b>Total Keyes plant</b> .....	<b>393,609</b>	<b>339,274</b>
<b>Total extracted</b> .....	<b>678,032</b>	<b>438,665</b>
Helium returned in containers (net).....	244	2,635
<b>Total supply</b> .....	<b>691,833</b>	<b>452,774</b>
<b>Disposal:</b>		
Sales of high purity helium <sup>3</sup> .....	173,626	173,575
Net deliveries to helium conservation system <sup>4</sup> .....	506,733	263,057
Inventory at end of period <sup>1</sup> .....	11,474	16,142
<b>Total disposal</b> .....	<b>691,833</b>	<b>452,774</b>

<sup>1</sup> At Exell and Keyes plants and at Amarillo shipping terminal.

<sup>2</sup> Excludes conservation helium produced from native gas withdrawal wells at Cliffside field, which have been invaded by stored helium.

<sup>3</sup> Includes only those quantities produced for sale; quantities entering conservation after purification are included under crude helium.

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

Extensive modernization of the Exell plant was incomplete at yearend because of delays caused by technical problems. The new facilities included in this moderniza-

tion program are for the purpose of consolidating operations, improving efficiency, and facilitating underground helium storage operations.

## CONSUMPTION AND USES

Domestic sales of high purity helium rose 9% during 1972 in a moderate reversal of a 5-year declining trend. Much of the 1972 increase was attributable to the overall improvement in the Nation's economy and increased requirements for helium in research and in breathing mixtures.

Although the quantity of helium sold by the Bureau of Mines in 1972 was almost the same as in 1971, the share of the domestic helium market accounted for by the Bureau declined from 39% in 1971 to 36% in 1972. This resulted from a lack of growth in the need for helium on the part of Federal agencies, which are required by law to purchase all of their major requirements from the Department of the Interior. The f.o.b. Bureau of Mines plant price, which is set at \$35 per thousand cubic feet for the purpose of financing the long-range helium conservation program, was not competitive with the 1972 average f.o.b. private plant price of \$21 per thousand cubic feet.

Approximately 30% of Bureau sales in 1972 were through purchases by Federal agencies from private distributors under General Services Administration contracts which required the distributors to purchase equivalent quantities from the Bureau of Mines. These contracts made rela-

tively small quantities of helium readily available to Federal installations and reduced freight charges for small purchases.

Domestic consumption of helium during 1972 was primarily for purging and pressurizing rockets and spacecraft, research, welding, maintenance of controlled atmospheres, leak detection, and cryogenics. Demand occurred principally in the States along the west and gulf coasts.

All helium sold by the Bureau of Mines was shipped in gaseous form in cylinders, highway semitrailers, or railway tank cars. Private industry plants shipped helium in both gaseous and liquid form. Much of the helium transported in liquid form was delivered by semitrailers to distribution centers, where most of the product was gasified and compressed into small cylinders and trailers for delivery to consumers.

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

(Million cubic feet)

Year	Quantity
1968.....	• 802
1969.....	• 670
1970.....	• 542
1971.....	447
1972.....	489

• Estimate.

Table 5.—Bureau of Mines sales of high purity helium, by recipient, 1971 and 1972

(Thousand cubic feet)

	1971	1972
Federal agencies:		
Atomic Energy Commission.....	19,175	17,447
Department of Defense.....	82,355	61,627
National Aeronautics and Space Administration.....	32,905	35,775
National Weather Service.....	3,066	2,940
Other <sup>1</sup> .....	1,062	3,346
Total Federal agencies.....	138,563	121,135
Non-Federal customers <sup>2</sup> .....	35,063	52,440
Grand total.....	173,626	173,575

<sup>1</sup> Includes quantities used by Bureau of Mines.

<sup>2</sup> Most of this was purchased in bulk by commercial firms, repackaged in smaller containers, and then sold to Federal installations under contract arrangements with the General Services Administration.

## CONSERVATION

The purchase of crude helium by the Bureau of Mines, under the terms of contracts entered into with three private producers in 1961, continued in compliance with a court order obtained during 1971 by Cities Service Helex, Inc., National Helium Corp., and Phillips Petroleum Co. The Bureau also accepted helium from the contractor not involved in that litigation, Northern Helex Co., for storage to that company's account until expiration of an interim storage agreement on September 28, 1972.

Helium held in the Bureau of Mines conservation storage system, which includes the conservation pipeline system and the partially depleted Cliffside gasfield near

Amarillo, Tex., increased 11% during 1972 to a yearend total of 35,630,904,000 cubic feet. Of this total, 97% was stored under the Bureau's conservation program and the remaining 3% was stored under contract for private producer's own accounts. Approximately 8% of the net addition to the helium conservation system in 1972 was accounted for by deliveries from Bureau plants, 76% was acquired from private industry conservation plants for the conservation program, and 16% was added to storage under contract for private producers' own accounts. Most of the latter was accounted for by quantities stored under an interim agreement for the account of Northern Helex Co.

**Table 6.—Summary of Bureau of Mines helium conservation system<sup>1</sup> operations, 1971 and 1972**

(Thousand cubic feet)

	1971	1972
<b>Helium in conservation storage system at beginning of period:</b>		
Stored under Bureau of Mines conservation program.....	28,118,119	31,635,937
Stored under contract for private producers' own accounts.....	58,972	531,806
<b>Total</b> .....	<b>28,177,091</b>	<b>32,167,743</b>
<b>Input to system:</b>		
Net deliveries from Bureau of Mines plants <sup>2</sup> .....	506,733	263,057
Acquired from private industry conservation plants.....	3,011,085	2,729,595
Stored under contract for private producers' own accounts.....	537,671	583,748
<b>Total</b> .....	<b>4,055,489</b>	<b>3,576,400</b>
Redelivery of helium stored under contract for private producers' own accounts.....	64,837	113,239
<b>Net addition to system</b> .....	<b>3,990,652</b>	<b>3,463,161</b>
<b>Helium in conservation storage system at end of period:</b>		
Stored under Bureau of Mines conservation program.....	31,635,937	34,628,589
Stored under contract for private producers' own accounts.....	531,806	1,002,315
<b>Total</b> .....	<b>32,167,743</b>	<b>35,630,904</b>

<sup>1</sup> Includes conservation pipeline system and Cliffside field.

<sup>2</sup> Excludes return to system of conservation helium produced from native gas withdrawal wells at Cliffside field, which have been invaded by stored helium.

**Table 7.—Helium purchased for Bureau of Mines conservation storage, 1971 and 1972**

(Thousand cubic feet)

Company	Helium delivered	
	1971	1972
Cities Service Helex, Inc. <sup>1</sup> .....	741,902	699,038
National Helium Corp. <sup>1</sup> .....	1,165,251	1,107,897
Northern Helex Co. <sup>2</sup> .....	147,463	—
Phillips Petroleum Co. <sup>1</sup> .....	956,469	922,660
<b>Total</b> .....	<b>3,011,085</b>	<b>2,729,595</b>

<sup>1</sup> Deliveries from these companies accepted in compliance with order of the Federal District Court for the State of Kansas after 8:00 a.m., March 28, 1971, when termination provisions of these companies' helium conservation contracts were to have taken effect.

<sup>2</sup> This company ceased delivery of helium for Bureau of Mines conservation program as of 8:00 a.m., March 28, 1971.

**Table 8.—Deliveries of crude helium from private industry conservation plants to Bureau of Mines conservation storage system, 1972**  
(Thousand cubic feet)

Owner	Plant location	Delivered for Bureau of Mines conservation storage	Stored for companies' own accounts in Bureau of Mines conservation system			Total
			Delivered	Withdrawn	Net	
Cities Service Helix, Inc.	Ulysses, Kans.....	699,038	188,654	153,690	34,964	734,002
National Helium Corp.	Liberal, Kans.....	1,107,897	51,878	6,696	45,182	1,153,079
Northern Helix Co.	Bushton, Kans.....	---	429,471	43,107	386,364	386,364
Phillips Petroleum Co.	Dumas, Tex.....	521,378	13,745	9,746	3,999	926,659
Do.	Hansford County, Tex	401,282				
<b>Total</b>	-----	<b>2,729,595</b>	<b>583,748</b>	<b>113,239</b>	<b>470,509</b>	<b>3,200,104</b>

<sup>1</sup> Includes some helium stored for the account of Cities Service Cryogenics, Inc., which pipes its output to Cities Service Helix, Inc., for purification.

## RESOURCES

Proved and probable helium reserves (in natural gas with a minimum helium content of 0.3%) in the United States, exclusive of those quantities in conservation storage at the Cliffside field, were estimated at 120.2 and 15.7 billion cubic feet, respectively, as of December 31, 1972. The total 135.9 billion cubic feet of proved and probable reserves available at yearend was almost 6% less than at the beginning of the year.

Although proved and probable helium reserves were contained in the natural gas reservoirs of over 100 gasfields located in 10 States, the bulk of reserves were in four fields: the Greenwood field in Kansas and Colorado; the Hugoton field in Kansas, Oklahoma, and Texas; the Keyes field in Oklahoma; and the West Panhandle field

in Texas. Almost 83% of proved and probable reserves were in fields being produced at yearend 1972. Approximately 51% of the helium-rich (0.3% helium content) natural gas produced was being processed for helium extraction, and helium contained in the remaining helium rich natural gas output was being wasted incident to the consumption of the gas.

The Bureau of Mines continued its efforts to identify helium resources in the United States and other parts of the world. A total of 369 natural gas samples from 25 States and four foreign countries, Australia, Canada, Indonesia, and the United Kingdom, were collected and analyzed for helium content during 1972. None of these samples indicated the occurrence of significant helium resources.

## FOREIGN TRADE

Exports of high purity helium in 1972 increased 6% and comprised 22% of the U.S. helium industry's total high purity sales as compared with 23% during 1971. All exports were from private industry extraction plants, which depended on foreign markets for 30% of their total high purity sales in 1972. Most of the quantity shipped was destined for Western Europe.

**Table 9.—Exports of high purity helium from the United States**

(Million cubic feet)

Year	Quantity
1968.....	• 65
1969.....	• 90
1970.....	• 105
1971.....	130
1972.....	138

• Estimate.

## WORLD REVIEW

Helium produced outside the United States during 1972 totaled an estimated 122 million cubic feet. Canada produced ap-

proximately 35 million cubic feet from a single plant in Saskatchewan, mostly for export to Japan and other Asian countries,

although some was used in Canada. A plant in France produced about 7 million cubic feet of helium as a byproduct of nitrogen removal operations. The countries of Eastern Europe extracted an estimated 80 million cubic feet during the year.

During 1972, Petrocarbon Developments, Ltd., of the United Kingdom was in the process of planning the construction of a helium and nitrogen extraction plant

which it is to build under contract in Poland. This plant is to separate helium and nitrogen from natural gas that has a nitrogen content of about 45%. A helium purification and liquefaction unit to be integrated with the nitrogen removal process is to have a high purity helium output capacity of 150 million cubic feet per year. Completion of this project was scheduled for mid-1974.

## TECHNOLOGY

Gulf General Atomic Co., a subsidiary of Gulf Oil Corp., initiated a preliminary planning study of a helium gas turbine for the Atomic Energy Commission during 1972. This study is to assess the commercial feasibility of developing a helium-cooled nuclear reactor and employing the same helium in a closed cycle to drive the gas-turbine generator. This would eliminate the steam-turbine cycle ordinarily used in powerplants and allow heat rejection to take place directly to air in dry cooling towers. It would also eliminate thermal pollution of streams, and would allow utility companies more flexibility in picking their powerplant sites. The gas turbines themselves could be located inside the same containment vessel that housed

the reactor core, thus offering a capital cost savings.

Two Japanese companies, Teijin Ltd., and Nippon Sanso KK, reportedly have developed a helium recovery and refining system that utilizes selective permeability of helium gas through synthetic high polymer film. Operating costs for such a system are stated to be approximately 30% lower than for conventional methods, although the initial investment for equipment is similar. The new system is expected to find wide application in the recovery and refining of helium from gas mixtures used for breathing in deep-sea operations, or from contaminated helium evaporated from hyper-refrigerating equipment.