The HELIUM Situation

By ***F. G. Brickwedde***

FROM time to time, cryogenic laboratories have experienced difficulty in obtaining supplies of gaseous helium because helium has been in short supply and can be purchased only with a US Government permit. Usually, these permits to purchase have been obtainable, though sometimes this has involved some trouble. As far as the author is aware, cryogenic laboratories have ultimately obtained the helium needed.

The difficulties experienced in getting helium have drawn the attention of cryogenists to the helium situation. Helium from the atmosphere would be about a thousand times more expensive than helium from natural gas. The helium content of the atmosphere is only about one part in 200 000. Hence cryogenists anticipate a limitation on cryogenic research when the helium is no longer obtainable from natural gas. Helium is important for other areas of research as well: aerodynamic wind tunnels, for example, in which streaming velocities with higher Mach numbers are obtainable using helium than are obtainable with air.

At present the only producer in the Free World of helium from natural gas is the US Bureau of Mines, and the only known Free World reserves of natural gas with significant amounts of helium (in excess of 0.3 percent of helium) are concentrated in a small area within 250 miles of Amarillo, Texas, in the Texas and Oklahoma Panhandles and the adjoining areas of Kansas. Ninety-nine percent of our present helium is contained in only four gas fields in this area. The great gas fields of California, the Texas and Louisiana Gulf Coast areas, and other parts of the United States contain very little helium.

The US Bureau of Mines operates four helium separating plants, processing natural gas that contains from 1 to 6 percent of helium. In 1957 it recovered 300 million cubic feet of helium—five times the production in 1950. Only ten percent of the helium produced goes for civilian use, the rest is channeled into defense, atomic energy, and other government projects. The US Government takes directly for its use 70 to 80 percent of the helium recovered, and the difference to 90 percent is taken by US Government contractors, principally for defense.

Because it is inert and a good conductor of heat, helium is used in arc-welding of magnesium, aluminum, copper, and stainless steel. It is utilized also in important metallurgical processes such as the production of titanium and zirconium, and the growth of silicon and germanium crystals for transistors. Stainless steel tube manufacturers use helium to produce sounder and cheaper tubing for the Atomic Energy Commission.

Natural gas from the helium-rich reserves is cur-

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The largest plant for extracting helium is operated by the Bureau of Mines at Excell, Texas, about 30 miles north of Amarillo, and is about 7 years old. An addition completed in 1957 tripled its capacity. It processes natural gas containing about 0.9 percent helium gathered by a private gas producer for transmission to fuel markets.

rently being piped to fuel markets in Chicago, Detroit, Denver, and other cities in the midwest to supply some 15 million domestic and industrial users. Four billion cubic feet annually of helium in this gas is being wasted into the air.

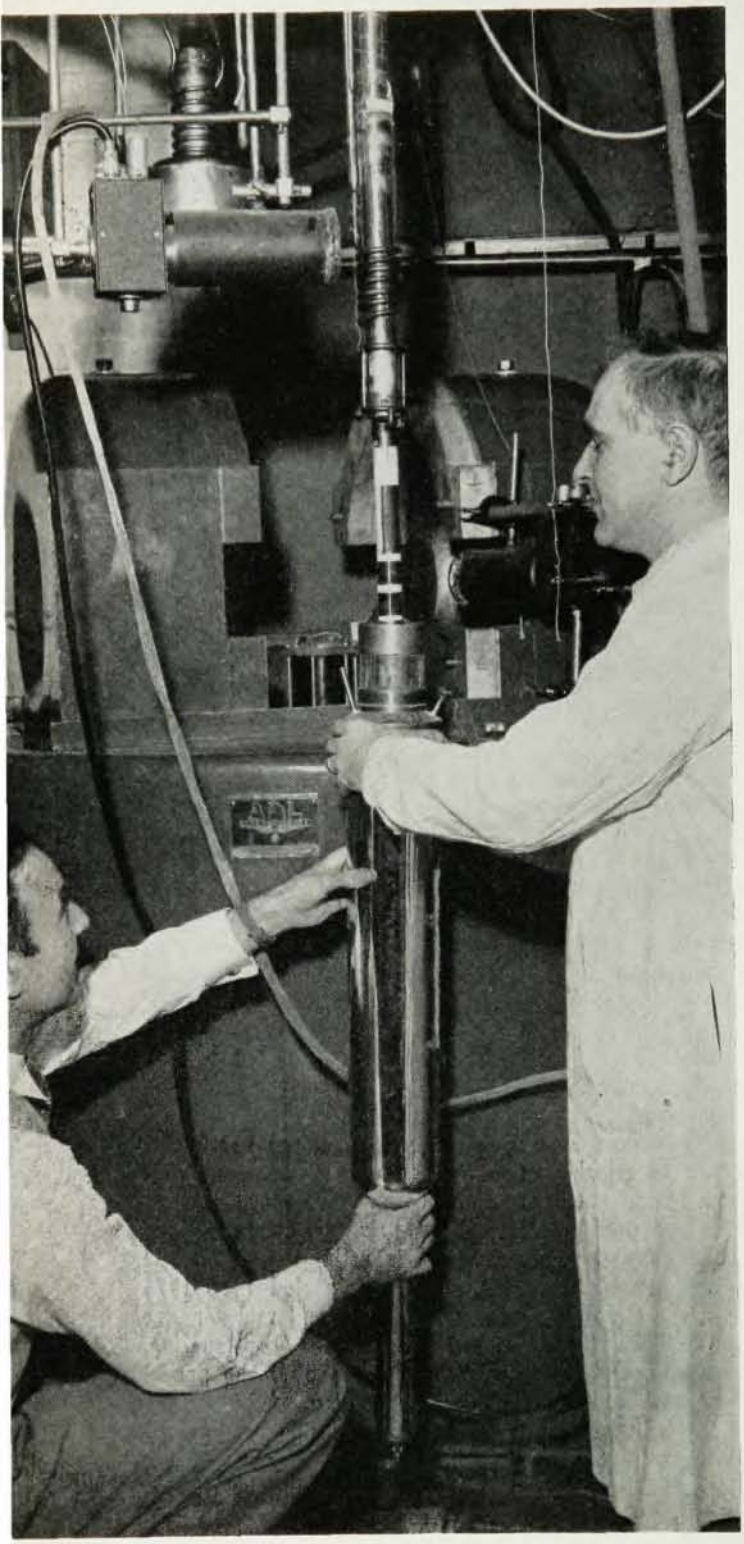
The helium-bearing gas fields in Texas, Oklahoma, and Kansas contain about 120 billion cubic feet of recoverable helium—350 times the present annual consumption of helium in the United States. Between now and 1985, 52 billion cubic feet of recoverable helium will be wasted into the air under furnaces if nothing is done to conserve it. By 1985 the capacity of our helium-bearing reserves to supply helium will have declined from the present level of more than four billion cubic feet annually to only about 2.5 billion cubic feet annually—barely enough to meet the estimated demand for helium in that year. After 1985, the presently known helium-bearing gas fields would be incapable of supplying enough helium to meet all our needs.

Eventually, we shall be obliged to get along with less helium than we need. The likelihood of finding important new sources in this country is not promising. The era of helium sufficiency can be prolonged by conserving the helium currently wasted in fuel gas.

The US Bureau of Mines formulated a plan in 1958 for conserving about 60 percent of the helium that is now being wasted. It proposed that 12 helium recovery plants be built near the natural gas fields producing natural gas for fuel markets. These recovery plants would process the natural gas before it is piped to consumers and separate the helium from it. Thirty-two billion cubic feet of helium could thus be recovered between 1960 and 1975, or about 2 billion cubic feet annually. Excess helium beyond that needed to supply current demands for helium would be piped to the Government-owned Cliffside gas field near Amarillo, Texas, and there stored. This method of storing helium has been used successfully for the last ten years.

The Interior Department estimates the cost of construction of these 12 plants to be about $224 million. Fourteen million dollars in addition would be needed for a connecting pipeline. It is estimated that $382 million would be required over the period 1960–1975 to cover the out-of-pocket operation and maintenance costs. Thus the total expenditure for constructing, operating, and maintaining the plants over the period 1960–1975 would be about $620 million. If 85 percent of the helium recovered is stored away (about 15 percent is sold to meet current demands), only 85 percent of the $620 million, or $525 million, would be chargeable to conservation. If the cost of financing the program is included the cost might be $300 million more depending on how the program is financed.

Based on estimates of future helium sales, the cost of conserving 32 million cubic feet of helium over the period 1960–1975 would be only $25 to $30 per thousand cubic feet. If the price of helium were increased



Helium was an essential ingredient in the crucial and historic experiments at the National Bureau of Standards which first demonstrated that the law of parity conservation does not hold in the beta decay of oriented cobalt-60 nuclei. NBS physicists R. P. Hudson and E. Ambler are shown immersing cobalt sample in liquid helium preparatory to cooling the experimental assembly to a required temperature of about 0.003° K.

by this amount and this increase continued through 1985, it is estimated that the revenue should be sufficient to retire the capital investment and pay deferred interest charges that would accrue during the early years of the program. Thus, it is seen that the cost of conserving the helium is really small in terms of the value of the helium and very much less than the cost of separating helium from the atmosphere.

It has been proposed that private industry build and operate the 12 recovery plants, and private industry has shown an interest in this. If private industry should not want to build the plants, it is proposed that the Government build and operate them.

In order to put the Bureau of Mines' plan into operation new legislation is needed from Congress, to permit the Department of Interior to: (1) enter into long-term contracts with industry for the purchase of helium for conservation, (2) to raise the price of helium to cover the cost of the helium conservation program, and (3) condemn helium-bearing natural gas after its removal from the ground.

Senator James E. Murray of Montana, Chairman of the Senate Committee on Interior and Insular Affairs, introduced Senate Bill 827 in this 86th Congress, on February 2, 1959, for the Department of the Interior, to provide the legislation needed for undertaking the conservation plan of the Bureau of Mines. At the moment, S.827 is in the hands of the Senate Committee on the Interior and Insular Affairs, awaiting a revision in wording from the Department of the Interior to strengthen some legal parts of the bill. It is hoped that the bill will be acted upon favorably by the House and Senate of the 86th Congress.

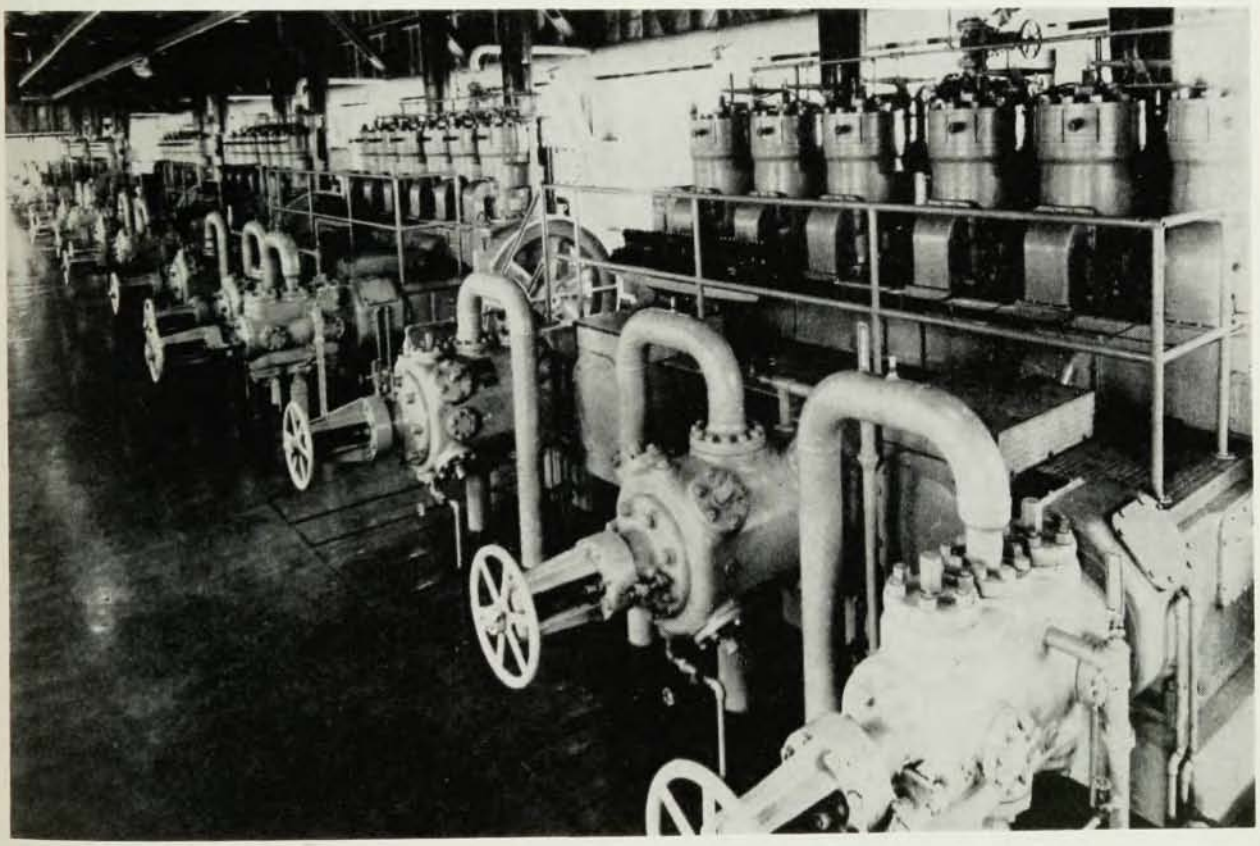
In the meantime the Bureau of Mines is constructing its fifth helium separation plant—a new plant at Keyes, Oklahoma—at a cost of 12 million dollars. It is scheduled for completion and start of operation sometime this month. This will relieve the existing critical shortage of the available supply of helium.

While there is a shortage of helium, the US Bureau of Mines has the responsibility for allocating the government supply. The Bureau of Mines gives special consideration to requests for authorization for purchases that are recommended to the Bureau by other agencies of the government. Dr. Ernest V. Hollis, Director of College and University Administration, Office of Education, Department of Health, Education and Welfare, Washington 25, D. C., has helped colleges and universities get helium by recommending to the Bureau of Mines their request for authorization to purchase it. Dr. Hollis will consider requests for a year's supply,

and requests by colleges and universities for more than one department needing helium, but then the needs for each department should be separately explained and justified. The name of the supplier of helium should be included with a request for authorization to purchase, as the Bureau of Mines authorizes a particular supplier to fill an order. Robert D. Newton, of the National Science Foundation, has offered to assist NSF grantees needing helium, and the Foundation will also consider making recommendations to the Bureau of Mines with regard to applications from university laboratories requiring helium for research purposes even in cases where NSF does not support the research financially. Wesley Koster, head of the Chemical and Rubber Division, Business and Defense Service Administration, Department of Commerce, Washington 25, D. C., will consider requests for helium from industrial research laboratories.

It is hoped that the temporary relief from the present critical shortage of helium that the new Keyes plant will provide will not diminish the urge to conserve for the future the helium that is now being wasted in furnaces. A primary responsibility rests with the Department of the Interior and the Administration to press for the necessary legislation in Congress for conserving helium. Active interest in this on the part of scientists is important and really necessary for getting action. The letter sent by the Solid-State Physics Division of the American Physical Society to the Honorable Fred A. Seaton, Secretary of the Interior, and to Dr. J. R. Killian, Jr., who was then the President's Special Assistant for Science and Technology, expressing concern about the conservation of helium is a kind of action needed. The resolution adopted by the American members of the Fifth International Conference on Low-Temperature Physics and Chemistry (held in 1957 in Madison, Wisconsin) urging conservation of helium, in which the foreign delegates concurred, was an important spur to action. The interest of the National Academy of Sciences—National Research Council has supported action.

It is important to keep up the interest and pressure for long-range conservation of helium until Congress acts.



Helium extraction equipment at Bureau of Mines' Otis Helium Plant in Kansas. In foreground, one set of compressor cylinders increases pressure of helium-bearing natural gas to accommodate pressures required for the extraction process; another set returns gas, from which helium has already been extracted, to supplier for transmission to fuel markets. Similar compressors (background) compress nitrogen in three stages to 600 psi. The nitrogen is used in a refrigeration cycle of the Claude type to sustain the helium extraction process.