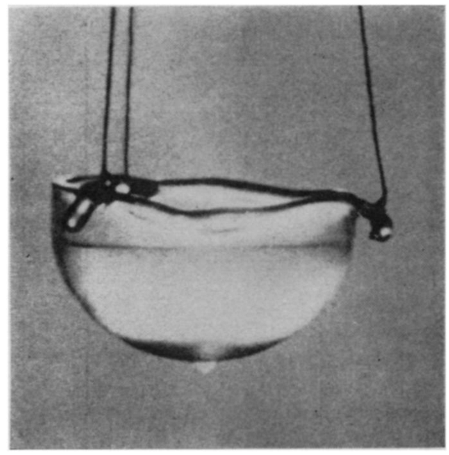
Tools of Science

Helium

An Elemental Centenary

A hundred years after its discovery, needs for helium are forcing more conservation.



Michigan State University

Liquid heilum creeps to form drop.

Helium is the second most prevalent element in the universe, as it results from the thermonuclear fusion of hydrogen atoms in our sun and the other stars. But supplies on earth are very limited as only small amounts have gathered near the surface from the radioactive decay of certain minerals.

The gas weighs only about a seventh as much as air, will not burn or explode, and has the ability to seep into places where other substances cannot go. It is tasteless, odorless, colorless and nonpoisonous. It is chemically inert, and so will not combine with any other element or compound.

Indeed, because of these rather negative properties, scientists say it is "noneverything—very close to nothing." But they are quick to point out that it is precisely this nonthingness that makes the gas so useful to researchers in science and industry.

Next year is the one-hundredth anniversary of the discovery of helium, and plans are underway for a Helium Centennial in 1968 to commemorate the birthday.

Actually 1968 will mark a double anniversary. It is the one-hundredth year since Joseph Lockyer, the English scientist, discovered the element in the sun's corona, and it is the fiftieth year since the Department of Interior's Bureau of Mines began extracting helium in volume from natural gas for use in defense, research and industrial applications.

"Celebration of a Helium Centennial is both appropriate and highly desirable," Secretary of the Interior Stewart L. Udall says. "This unique element symbolizes in many ways our problems and our ideals in the field of natural-resource conservation."

Before the conservation program began, according to the Secretary, about 8 billion cubic feet of helium was being wasted each year, when natural gas containing the element was burned for fuel. Now, the Secretary believes, this needless loss has been cut in half. By the end of 1966, more than 11 billion cubic feet of helium was in storage, valued at more than $110 million. Current demand for helium is about one billion cubic feet per year.

Realizing that demand for helium was continuing to grow rapidly, the Bureau of Mines launched a major effort in 1962 to conserve helium that was being needlessly wasted. Under this program, several private companies have built plants in the Southwest where they extract relatively small percentages of helium from natural gas that is being piped to fuel markets. The recovered helium is sold to the Bureau, which is storing it underground in a partially depleted natural gas reservoir outside Amarillo, Tex. Most of the costs of this conservation program are offset by charges made on users of the helium.

The biggest single use for helium right now is in the nation's space program where the properties of inertness, low solubility, nonflammability and lightness suit it ideally for a variety of applications.

It is, for example, pumped into the liquid-fuel tanks of missiles and spaceships and provides pressure that forces the fuel into the rocket motor. Then, the helium expands and fills the part of the tanks formerly occupied by the fuel. Thus, it provides strength and rigidity needed by the missile as it soars through space.

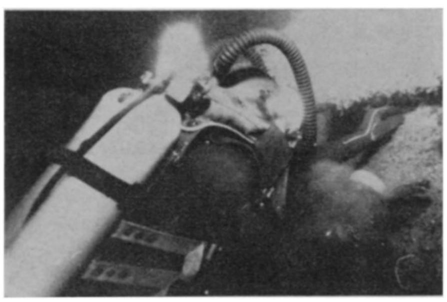
In shielded arc-welding of such materials as stainless steel and titanium, and various other metals and alloys, helium acts as an inert barrier or shield for the weld, preventing contamination by such substances as oxygen, nitrogen and hydrogen.

Similar shielding is also provided in the processes used for growing transistor crystals of silicon and germanium. The helium protects them from exposure to and contamination by air during their development.

Another use for helium is in the analytical method known as gas chromatography. Here, gases are passed through a column of sensitive materials that selectively absorb the various substances in the gas, enabling an analyst to determine the kind and quantity of substances it contains. Because helium is inert and will not be absorbed, it makes an excellent vehicle for carrying other gases through the column.

During World War II, helium's biggest use was as a lifting agent in blimps and various kinds of balloons used to guard allied ships against attack by enemy submarines.

Today, demand for this purpose has dwindled, but helium is still the only gas considered safe for blimps used in advertising. Only hydrogen is lighter,



Navy

Helium-oxygen mix 200 feet down.

and it is extremely explosive. Helium also carries aloft the meteorological balloons that weathermen rely on in charting the daily weather patterns.

Because it is nontoxic and diffuses readily through tiny passageways, helium is often combined with oxygen and used in breathing atmospheres for persons suffering from asthma and other respiratory diseases.

Similar helium-oxygen mixtures are also breathed by divers in deep-sea rescue, salvage and undersea exploration to prevent the possibility of nitrogen narcosis—the dizziness and loss of mental agility that occurs when breathing air containing nitrogen under pressure.

As oceanographic operations increase in the future—as in undersea exploration and mining—it is anticipated that such helium-oxygen mixtures will be in much greater demand for safe breathing purposes.

Helium's ability to diffuse through tiny holes makes it a valuable aid in detecting leaks in pressure and vacuum systems such as vessels used for nuclear energy investigations and sealed refrigeration units.

Unaffected by radioactivity and superior to any gas except the explosive hydrogen in heat conductivity, helium can be used in atomic power plants to transmit the heat energy from the nuclear reactor to the boiler that generates steam to turn the turbines.

Not long ago, a new type of gas laser using a mixture of helium and neon was developed. This is now being used as an extremely accurate distance determiner and has potential as a gyroscopic direction finder.

Helium liquefies only at the fantastic temperature of 452 degrees below zero F., and it will freeze solid only when under pressure and cooled to the even more fantastic temperature of minus 458 degrees F.

When it is cooled to minus 455 degrees F., which is only four degrees from absolute zero, it assumes a physical state unlike any other known to science. Helium then becomes a superfluid with zero viscosity and is even capable of flowing up hill. Precisely why this happens scientists still don't know, but it is a fascinating phenomenon and it happens only with liquid helium.

Research on the molecular fragments known as free radicals has been aided measurably by liquid helium. Normally, these charged pieces of molecules have a life of only a few thousandths of a second, as they quickly combine with others. But freezing them with liquid helium extends their life indefinitely and permits closer examination and study.

At the temperature of liquid helium, some metals become superconductors —that is, they exhibit zero resistance to the flow of electricity. Besides opening up the prospect of powerful but small magnets, this phenomenon has led to the development of the cryotron—a device which is no thicker than a human hair but which, in a bath of liquid helium, can perform the functions of transistors and vacuum tubes.

Use of cryotrons could lead to the development of a new generation of computers—small shoe-box sized—but highly reliable devices for extremely rapid calculations and analysis.

So-called ruby masers and other low-noise amplifiers operating at ground stations in baths of liquid helium provide tremendous gains in sensitivity over conventional communication systems of equivalent size and power requirements.

Supercooling the maser with liquid helium quenches extraneous noise or signals generated in electronic equipment, and thus ground stations with masers can pick up and amplify the very weak signals from communication satellites like Early Bird.

Michael J. Walker