TECHNOLOGY

Nitrogen: Industrial Cinderella

Nitrogen, the inert gas once discarded as valueless, has achieved great technological and scientific importance with wide applications ranging from surgery to space research.

By J. D. RATCLIFF

➤ FROM UNWANTED UGLY DUCKLING to glamorous money-maker—that's the story of one of today's most remarkable industrial products: nitrogen, both liquid and gaseous.

"We used to wonder what it would do," says Dr. Alfred L. Bayes of Union Carbide's Linde Division. "Now we are wondering what it won't do."

By the hundreds, new jobs are appearing for this substance once considered so valueless that it was simply thrown away. Today its uses cover an incredible range—from wart removal to surgery to the freezing of foods once considered commercially unfreezable, to simulation of conditions man will encounter in space.

Nitrogen has two things working in its favor. It boils at minus 320 degrees Fahrenheit. One of the laziest of the chemical elements, it does virtually nothing. This inertness, once considered a drawback, is now being turned to advantage. A blanket of gaseous nitrogen guards against explosion hazard in scores of places: in production of anti-knock compounds for gasoline, in grinding certain metals into powder, in airplane fuel tanks. Inactive nitrogen retards fermentation in wine, slows warehouse spoilage of fruits and vegetables.

Reliable Freight-Cooling

For years refrigerated trucks and railroad cars have faced the problem inherent in mechanical equipment—a breakdown often meant the loss of cargo worth thousands of dollars. Liquid-nitrogen refrigeration systems are virtually breakdown-proof and simple—a tank, a valve, a thermostat.

As super-cold liquid nitrogen boils and turns into gas when released from pressure by the opening of the valve, the resulting frigid gas expands to all parts of the truck, providing any degree of cold wanted. A trucker in Florida loads up with frozen orange juice, takes aboard perhaps 100 gallons of liquid nitrogen, and heads for Boston—knowing he will arrive with the wanted temperature maintained all the way.

Inevitably, nitrogen filling stations are beginning to spring up. At the Richfield station on Main Street, Las Vegas, for example, a trucker can get a hundred gallons of Diesel fuel and 100 gallons of liquid nitrogen at one stop. The liquid nitrogen is clear and can be pumped or poured like any fluid. With small losses it can be stored for a considerable period in super-insulated vessels under slight pressure.

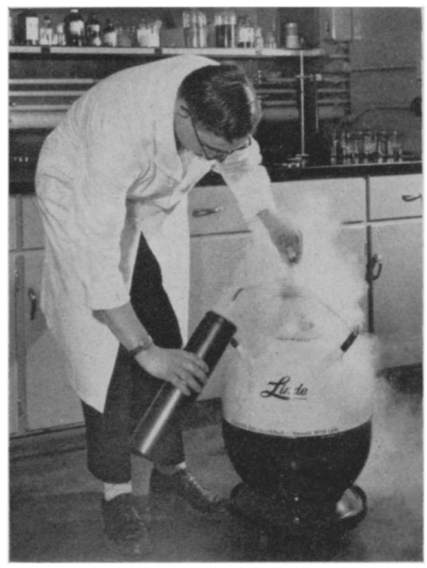
Ice cream delivery has always posed problems—frequent opening of truck doors permitted temperatures to rise, melting to take place. Now, liquid nitrogen produces instant frigidity. Once a truck door is closed only seconds are required for the temperature to return to the desired level.

Until recently, dozens of foods could not be wholesomely frozen by conventional methods which did not drop temperature fast enough. During slow freezing, frost needles formed to puncture fragile cell walls. Tomatoes went mushy, strawberries lost color, onion rings became rubbery. Dipped in liquid nitrogen, these and other foods freeze instantly, retaining original texture and garden freshness.

Another interesting possibility is on the horizon — shipping without refrigeration. Frozen foods are merely packed in insulated containers and cooled to minus 320 degrees Fahrenheit. The warm-up is so slow that enormous distances can be covered. Not long ago an experimental shipment was made by train and ship from Chicago to Venezuela — a 20-day journey. When the package arrived it was in perfect shape, still at minus 80 degrees Fahrenheit.

Random uses cover an amazing range. Not long ago Boulder, Colo., was switching from a flat water rate charge for water tax to individual meters in homes. To close mainline valves while meter installation was underway would have meant hundreds of homes without water. Nitrogen provided a novel solution. At each home a jacket was placed around pipes. Liquid nitrogen in the jacket instantly produced a stoppering plug of ice—big enough to shut off water, not extensive enough to burst the pipe.

French engineers found a striking application of nitrogen's super-coldness. Installation of a three-foot sewer in a Paris suburb came to a halt when water seeped into the excavation more rapidly than it could be pumped out. Solution: liquid nitrogen poured into pipes driven into adjacent soil. Soon the soil was frozen rock hard. Seepage stopped and work proceeded.



Union Carbide Corp.

BOILING NITROGEN—Liquid nitrogen, shown being poured into a dewar by a Union Carbide chemist, requires special containers, such as this refrigerator built by the Linde Division, because its temperature is 320 degrees below zero Fahrenheit.

Preservative for Breeding

Approximately half the calves in America's dairy herds are produced by artificial insemination, which greatly extends the usefulness of prize bulls.

Liquid nitrogen is the most successful preservative for semen, doing little damage to individual cells and extending life almost indefinitely. Bull semen has been preserved as long as ten years and still produced live calves—long after the father was rendered into hamburger.

Nitrogen is one of the most plentiful of the earth's substances. It comprises 78% of the atmosphere. There are some 36,000 tons of it over each acre of the earth's surface.

Half a century ago German researchers found how to use catalysts and tremendous pressures to wed hydrogen to nitrogen, producing the ammonia that is the base substance of the modern fertilizer industry. Until a decade ago, uses of nitrogen just about ended here.

Then in the mid-50's steelmakers began using oxygen by the thousands of tons to hoist temperatures and speed reactions in open-hearth furnaces. Most of the oxygen was distilled from liquefied air. But the air, remember, is nearly four-fifths nitrogen. And the nitrogen was discarded as a waste.

Waste Prompted Research

This troubled research men. Modern economy cannot tolerate waste on such a scale. Could not something be done with the nitrogen? Scientists at Linde, Air Reduction Company, Air Products and Chemicals, National Cylinder Gas and others began scratching heads.

Refrigeration of food trucks was an obvious application. Early experiments indicated the great flexibility of nitrogen—in four minutes it could drop truck temperature from 60 degrees Fahrenheit to zero. Further, because of such rapid change, there was no frost formation. Ordinarily trucks must be defrosted like some home refrigerators. Temperature could be held exactly at any desired point. Further, cost of cooling

equipment was low—about one-half the cost of mechanical equipment of comparable capacity. And daily costs for nitrogen stood at reasonable levels of $8-$12 per truck.

Economy is important, but dependability is perhaps the greatest virtue of nitrogen refrigeration. This is a particular advantage in piggyback haulage of trailers on railroad cars where breakdown of unattended mechanical equipment can cost thousands.

Space Conditions Simulated

Many other areas of use have been opened. In space, temperatures dip close to the greatest cold obtainable, absolute zero, minus 459.72 degrees Fahrenheit. At this point all molecular motion would cease. What will happen to metals and instruments in space vehicles at such temperatures? In vast test chambers tons of liquid nitrogen are helping provide answers.

Similar test chambers are being used to simulate arctic conditions to test paints, storm windows and such that will have to withstand temperatures 50 degrees below zero Fahrenheit.

"Controlled atmospheres," in which nitrogen replaces oxygen, are opening enticing possibilities. Farmers long ago discovered that stored apples lasted longer when kept in barrels. It remained for chemists to discover why. As apples "breathe" they produce carbon dioxide. As this gas accumulates in barrels it slows oxidation and, therefore, rotting. Might not inert nitrogen do an even better job?

Today the storage life of apples and pears is being greatly extended by piping nitrogen into warehouses. Preliminary evidence indicates that it will be similarly useful in extending freshness of lettuce, beans, celery and other vegetables, as well as flowers.

Food Spoilage Prevented

The hiss that you hear when you open a can of coffee is probably nitrogen. It keeps coffee oils from turning rancid. Used in bottling salad oil, it drives out the oxygen that would lead to spoilage. It also helps preserve peanut butter, mayonnaise, packaged cheese, bacon and a host of other foods.

Liquid nitrogen is opening dazzling vistas in biology. Its super-coldness confers potential immortality on any tissue or microorganism. In normal laboratory methods of culture, bacteria and viruses have an unfortunate tendency to mutate. Thus, a virus may be one thing today, quite another next year. Deep-freezing with nitrogen extends life unchanged indefinitely, thus providing constant reference points.

Storage of frozen blood is another rapidly expanding field. While normal bank blood must be discarded after 21 days, blood frozen by liquid nitrogen appears to keep indefinitely. Programs for large-scale preservation are underway in England, France, Sweden, Italy, elsewhere. New York's Community Blood Council plans to bank rare blood-types for genetic research.

Cryosurgery — surgery utilizing extreme cold—is a glamorous new field. Freezing simplifies removal of cataracts. Liquid nitrogen is offering new hope in one of the most horrid of human maladies, Parkinson's disease, which is marked by tremor, mask-like face, muscle rigidity.

With this disease the source of trouble is a small group of cells in the base of the brain. Might they not be destroyed by extreme cold? Dr. Irving S. Cooper of New York's St. Barnabas Hospital thought so. He sought the help of the Linde Company in designing a small, insulated cannula which could be inserted directly into the brain. Liquid nitrogen circulates inside, produces extreme cold at the silver tip.

Hundreds of patients, so badly incapacitated that they could not walk and could not feed themselves, have been dramatically relieved of tremors and rigidity. Nine out of ten who have received this remarkable treatment have obtained significant relief—enough to encourage more than 100 hospitals scattered around the world to buy the equipment.

Retina Not Scarred

In eye surgery, liquid nitrogen is being used to pin down detached retinas that may cause blindness unless reattached. For years retinas were welded into place with pinpoint shots of electricity, an operation which must be repeated several times during a patient's life, but the scar that formed at the weld spots made successive operations more difficult.

Dr. Harvey Lincoff of New York Hospital-Cornell Medical Center thought a liquid nitrogen probe might produce tiny sealing adhesions that would heal without leaving a scar. His idea worked. A two-to-five second touch with a probe cooled as low as minus 40 degrees Fahrenheit does the fastening job.

"Nitrogen has a fantastic future," says A. L. Matter of Linde. Figures support this statement. A decade ago barely two billion cubic feet of nitrogen were being used a year outside the fertilizer industry. Today the figure is 67 billion cubic feet, and it is expected to rise to 150 billion by 1970. Not bad, everything considered, for a substance that is not supposed to do anything.

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PUBLIC HEALTH

Gases in Demonstrations Hazardous to Health

➤ BRITISH CHEMISTRY teachers are alarmed at an occupational hazard, the effect upon their health of obnoxious gases breathed during chemistry demonstrations. One teacher credited his asthma to allergies incurred through exposure to chlorine, sulfur dioxide, sulfur trioxide, hydrogen sulfide and other gases used in chemistry teaching.

He contends that his chest damage cannot be attributed to smoking because he has not smoked, and industrial fumes are not present in the small town school where he has taught.

Improvement in the arrangements to ventilate the hoods for conducting chemical experiments is being planned by science education authorities.

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