CHEMISTRY

Breath of Life for Defense

The oxygen in ordinary air has become the single most important chemical for defense. Man has improved on nature by concentrating and collecting it in its liquid form.

By DAVID PURSGLOVE

➤ THE AIR we breathe is today the most important single chemical used by industry and in national defense.

Just as most of nature's own important chemical reactions involve the combination of substances with oxygen from the air, the push for a guided missile, the conversion of iron to high grade steel, the creation of a chemical explosion, the conversion of otherwise useless gases and liquids to valuable materials, all depend on a combination of substances with oxygen.

Oxidation processes in nature generally are slow. However, scientists believe that when the earth was in its earliest days and abounded with many highly reactive chemicals that today are found only in laboratories, reactions between these elements of the earth's crust and oxygen of the atmosphere took place rapidly, with the liberation of heat and light.

Liberating Energy

Today we deliberately foster combustion between gasoline and oxygen in the automobile engine and between alcohol or other fuels and oxygen in the rocket engine. The energy thus liberated is put to work for us.

In many important oxidation processes we steal a march on nature by concentrating our oxygen as the pure element, undiluted by nitrogen and inert gases of the atmosphere, for more efficient use.

Sometimes it is compressed in steel cylinders—familiar red or green "bottles" found in hospitals and some factories.

The trend in industry now, however, is to store the greatest amount of oxygen in the smallest space by compressing and cooling it until it becomes a liquid.

Liquid oxygen used at steel mills and in chemical processing is the same famous LOX found near many missile launching sites.

It is easy to see why industry and the armed forces are devoting millions of dollars and countless hours of scientists' time to develop increasingly better facilities and techniques for producing oxygen as a liquid. To store or ship one pound of the gas compressed at a pressure of 2,400 pounds per square inch requires a container weighing more than five pounds. However, the same pound of oxygen stored or shipped as a liquid needs a container weighing only about three-quarters of a pound.

Besides the saving in container weight, liquid oxygen also saves considerable space as contrasted to gaseous oxygen. A container of a given size will hold 800 times as much oxygen in liquid form as in gaseous form.

Since the liquid boils at 297 degrees below zero Fahrenheit, it must be shipped in a constantly refrigerated container called a Dewar flask. These, on a larger scale, resemble the common vacuum bottles sold under the trade name of Thermos flask.

Because liquid oxygen always expands to 800 times its liquid volume, pipelines and pumps used to transfer LOX from storage to its point of use must be capable of withstanding very high pressures as the oxygen "warms" up to its sub-zero boiling point.

The chief interest in liquefying oxygen is to facilitate its storage and transportation. With the exception of very small quantities for low-temperature laboratory experiments, oxygen is used as a gas. However, in most operations it becomes gaseous only in the last instant before use.

Oxygen, whether stored as a liquid or as a gas, has hundreds of important uses in national defense and commerce. Chief among them is its role as the more important half of the oxygen-acetylene torch for welding metal together and cutting it apart. Many fuels besides acetylene will work in a torch, but oxygen almost always is present on the team.

Huge quantities of oxygen are consumed each year in the production of synthetic sapphires for industry and in the preparation of hydrogen peroxide. Some processes for manufacturing ammonia, ethylene for plastics and other important "starting-point" chemicals depend upon oxygen.

One of the fastest growing uses for oxygen is in the processing of steel by the comparatively recent oxygen converter process.

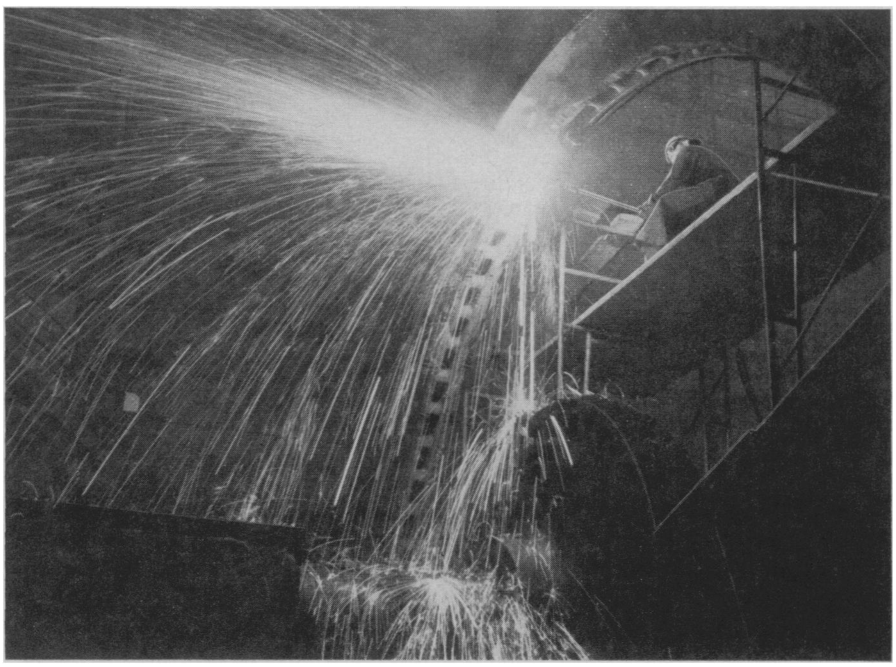
Although this new technique of steelmaking is accountable for only a small portion of the steel produced in the U. S., it is rapidly coming into favor. It was developed in Europe. Its fundamental difference from the Bessemer converter process is that a jet of pure oxygen is blown directly down on the molten charge of iron to literally "burn out" carbon and other impurities. In the Bessemer process, a stream of ordinary air is blown up through the iron bath.

Oxygen Converter Process

The oxygen converter makes high-quality, low-carbon steel as rapidly and as economically as the Bessemer process does. In addition, the oxygen converter offers the quality of steel that is produced by the open hearth process.

The producing, cutting and welding of iron and steel is the chief use of compressed or liquid oxygen today in the U. S., the most glamorous is in missiles.

Whereas air-breathing engines, as their name implies, draw oxygen for combustion from atmospheric air, rocket engines operating far above our normal atmosphere must carry their own oxygen with them. Even rocket engines designed for use at low altitudes carry concentrated oxygen for per-



OXYGEN AT WORK—Oxygen finds its biggest role in the oxygen-acetylene blowtorch used either for welding metal together or cutting it apart. Such a torch is shown being used to scrap a powerhouse in New York.

formances far superior than could be expected with the diluted oxygen in ordinary air.

In the missile field and some industrial operations, oxygen has become so important that it is produced or separated from the atmosphere at the launching site or industrial plant rather than being shipped from an air-reducing facility.

For example, Air Reduction Company, Inc., New York, is building a new 120-ton-per-day oxygen facility at Armco Steel Corporation's new Butler, Pa., plant to provide the vast amount of high purity oxygen needed for that operation. It would be too costly, time-consuming and almost foolhardy to ship such vast quantities of oxygen long distances from production centers when a plant can be built adjacent to the factory.

Supreme Chemical

Oxygen's supremacy in the chemical industry has not been without a struggle against older, "traditional" ways of doing things. And, it appears its supremacy could just as easily be lost as oxygen in turn bows to further progress.

In the missile field, as an example, some more powerful or easier-to-handle oxidizing agents than oxygen itself are being developed.

"Oxidizing agent" and "oxidation" are terms arisen from the early days of chemistry that now describe a type of electron transfer to certain chemical reactions. Fluorine, for instance, is representative of several powerful oxidizing agents that may see wide use in missiles.

Nitrogen tetroxide is another bidder to replace LOX in rockets. It is easier to handle, requires no refrigeration and reacts spontaneously upon contact with many fuels.

New processes for making steel might replace the recent oxygen converter process even before that technique gets its feet off the ground. Steel companies are looking into every research nook and cranny for means of reducing their costs and increasing production.

There was a time when production figures for all-important sulfuric acid were considered the single reliable bellwether of a nation's economy. A few people believe that ubiquitous oxygen has replaced sulfuric acid as the best single indication of national wealth and industrial progress.

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ASTRONAUTICS

U. S. Sends Rocket High Above Earth

➤ A UNITED STATES attempt to orbit a man-made satellite around the moon has resulted in a successful launching of a rocket that has broken through all past records for height, the U. S. Air Force reported.

On Saturday, Oct. 11, the Pioneer rocket was launched at Cape Canaveral, Fla., at 4:42 p.m. E.D.T. It soared to an altitude of 79,316 miles, more than a third of the distance to the moon, and then started falling back to earth. Scientists report receiving valuable information about outer space from the launching.

(See SNL, Aug. 16, p. 101, Aug. 23, p. 114 and May 24, p. 323.)

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