Is hydrogen the fuel of the future?

Some scientists are predicting that hydrogen will be an effective replacement for fossil fuels before the end of the century

by Robert J. Trotter

Shrinking fossil-fuel resources and rising environmental concerns have made imperative, as all the world must now be aware, the development of new power sources. Alternatives such as nuclear, hydroelectric, solar, geothermal, tidal and meteorological power will all be used to a greater extent to produce electricity. But they can also be used to produce nonfossil chemical fuels.

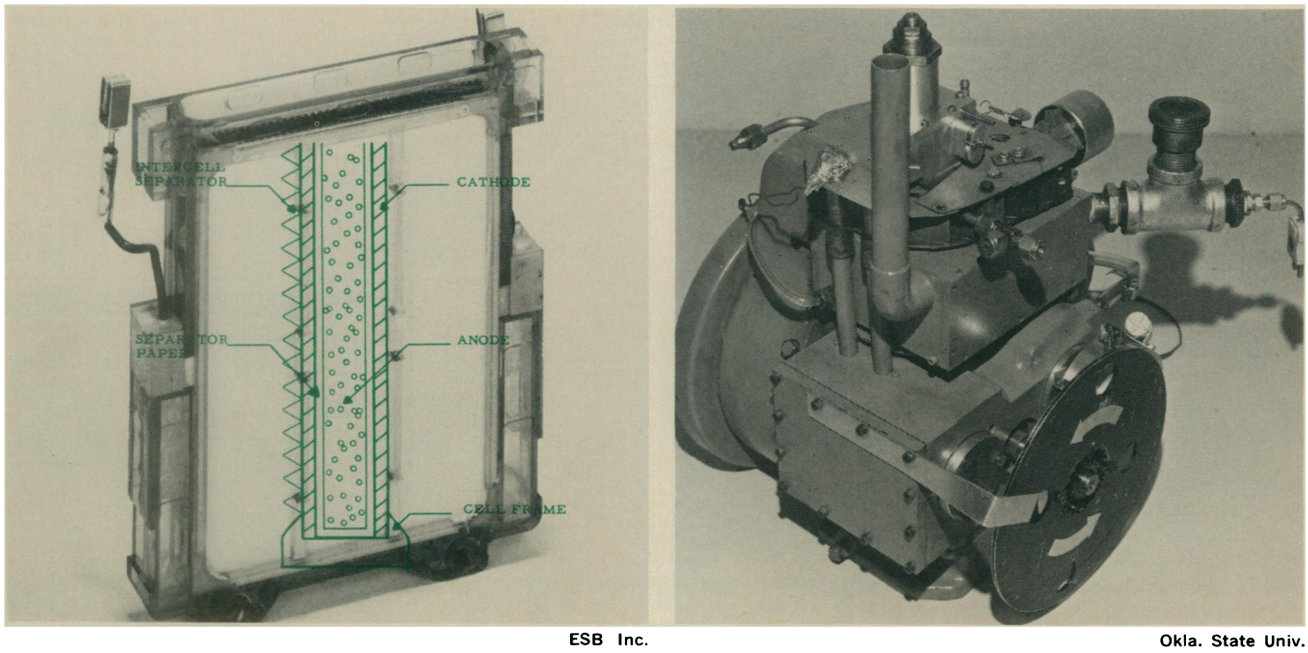
One such fuel, hydrogen, is being examined with increasing interest as a possible major fuel of the future.

The primary use of nuclear reactors is to generate electricity. This electrical power could be used to electrolytically decompose water to hydrogen and oxygen. The hydrogen could be used as a primary source of fuel or could be converted to a number of other fuels including ammonia, methanol, methane, hydrazine, acetylene and other hydrocarbon fuels. The by-product oxygen could be used in many ways. Some suggest it be used for gasification of coal or in a basic oxygen furnace for the production of steel. Depending on this utilization of oxygen and the cost of electrical power from large nuclear reactors, this system will become economically competitive as the cost of fossil fuels increases.

The Common Market's Joint Research Center, for instance, sees hydrogen as a suitable fuel of the future. Euratom scientists G. DeBeni and C. Marchetti, speaking for the research center, claim that electricity, the usual form of marketing nuclear energy, will meet only 10 percent of the energy needs for a technologically developing society. Hydrogen, they feel, could penetrate the remaining 90 percent of that market. They are attempting to produce hydrogen, not by electrolysis, but by using the heat from a high-temperature gas reactor to crack water directly. In a closed system, hydrogen would be produced from water by a heated chemical reaction. This method, says Marchetti, is more direct than the steam-electricity-electrolysis process. A pilot plant, probably in Ispra, Italy, could be in operation within two years, he says. With the present technology it would run at 40 to 50 percent efficiency. Electrolysis under pressure can operate at up to 85 percent efficiency.

William C. Gough and Bernard J. Eastlund of the Atomic Energy Commission, who two years ago proposed using plasma leakage from a thermonuclear fusion reactor to reduce trash to its chemical elements (SN: 3/7/70, p. 249), now suggest using ultraviolet light generated by this plasma to dissociate hydrogen and oxygen from water.

Another method of hydrogen production utilizes solar energy. William J. D. Escher of Escher Technology Associates in St. Johns, Mich., says an



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The hydrogen battery (left) or the hydrogen-fueled internal-combustion engine could power an automobile.

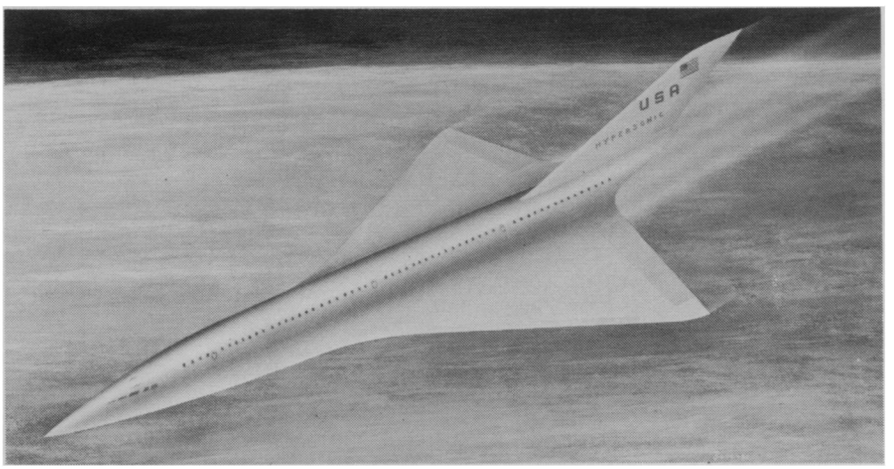
ocean-based plant could collect and use the sun's energy to convert seawater into hydrogen and oxygen (SN: 4/29/72, p. 284). Still in the conceptual stage, the complete economics of this plan have not been worked out.

Eventual economic competition with fossil fuels is not the only issue. A hydrogen fuel would have other advantages. Derek P. Gregory of the Institute of Gas Technology in Chicago says hydrogen, as a synthetic chemical fuel, would be cheaper and easier to transmit, deliver and store. Electricity cannot be readily stored, is expensive and ugly to transmit over long distances via overhead cables and towers and even more expensive to transmit in underground cables. The combustion products of hydrogen are compatible with the atmosphere and, says Gregory, the changeover from the present system to a hydrogen economy does not present any technical roadblocks. For example, hydrogen can now do all of the jobs done by natural gas with no new technology.

But new technology is being developed that will enable hydrogen to do more than just replace natural gas. K. F. Blurton and H. G. Oswin of Energetics Science, Inc., in New York City say metal-air batteries, refuelable with power from hydrogen, could become important for medium power users such as commuter cars, boats and motorcycles. Currently available lead-acid batteries give much less power and take longer to recharge than hydrogen batteries would. With cadmium plates, Blurton says, it may be possible to regenerate the battery merely by passing hydrogen through the plates. Except for the initial cost of the battery (platinum is used as a catalyst), it could cost as little as half a cent a mile to run a car this way.

Four one-cylinder engines are already running on hydrogen. Roger J. Schoeppel of Oklahoma State University in Stillwater has successfully converted four gasoline engines to engines fueled by hydrogen. Unlike the hydrogen-battery powered car, Schoeppel's engines burn hydrogen directly in a converted internal-combustion engine. Steam, unused air and nitric oxide (10 times less than the amount produced by an average gasoline engine) are the only combustion products. "There is no question of the technology now," says Schoeppel, "if I can convert one cylinder, I can convert six."

The hydrogen is ignited as it is injected into the cylinders and caused to burn as a jet only during the ignition period. This avoids pre-ignition and detonation problems encountered in earlier hydrogen engines. The gas could be stored as magnesium hydride in a 500-pound tank and will last as long as does 20 gallons of gasoline. By heating the magnesium hydride, hydrogen gas is released to the engine. Refueling is simple because magnesium quickly absorbs hydrogen gas.



NASA

The hypersonic aircraft could be fueled as well as cooled by liquid hydrogen.

Schoeppel says he so far has been able to get no response from Detroit. But, he adds, "opposition to the use of hydrogen as a motor fuel is expected from those who have vested interests in the methods of production of vehicles or in the present fuel supply, distribution and sales system. However, it is my opinion that unless these interests can meet the emissions standards schedule set by the Environmental Protection Agency, and on an economically competitive basis, or can muster enough political pressure to get the standards relaxed [SN: 5/20/72, p. 326], the hydrogen-fueled internal-combustion vehicle will make its debut before 1977."

A more exotic use of hydrogen as a fuel is proposed by Robert D. Witcofski of NASA's Langley Research Center in Hampton, Va. Research there is aimed at developing the technology for a new generation of commercial aircraft that might help alleviate the pollution and energy crises and also better serve the needs of future air travelers. He says this can be done by using liquid hydrogen to fuel a hypersonic aircraft capable of flying at more than 3,000 miles an hour.

The combustion of liquid hydrogen releases 2.75 times as much energy per pound as conventional jet fuel, allowing much greater ranges than present jets. When burned with air, the hydrogen produces only water vapor and less than a fourth the amount of nitric oxide produced by the supersonic transport. There would be no carbon dioxide, carbon monoxide or solid waste particles. The liquid hydrogen, at minus 423 degrees F., would also be used to cool a secondary fluid that would circulate through the skin of the aircraft to keep the air frame temperatures low enough to permit the use of conventional materials in an aircraft flying in the atmosphere at six or eight times the speed of sound.

Another advantage of liquid hydrogen is its cost. The space industry, which uses it as rocket fuel, has encouraged the development of large-scale liquid hydrogen plants utilizing advanced production techniques. The price of this fuel, says Witcofski, will soon be lower than the cost of conventional jet fuels.

Witcofski admits that there is no need for such a plane now, but he estimates there will be 24 million passengers per year flying to Europe from the United States by 1990. He concludes, "with a strong research program for development and demonstration of the technology, these aircraft could be operational by 1990."

All of the proponents of the hydrogen economy are optimistic about the future. The only shadow crossing their path is cast by the Hindenburg. When that 800-foot, hydrogen-inflated dirigible burst into flames in 1937, 36 persons died. A Hindenburg Syndrome, a fear of hydrogen, resulted, and hydrogen was considered too dangerous for use as a commercial fuel. But the hydrogen experts call this fear irrational. Most of the fatalities in the Hindenburg disaster were the result of jumping from the airship before it hit the ground, not from the hydrogen explosion.

When hydrogen burns it goes straight up and there is no danger of it spreading along the ground as in a gasoline explosion. Heat radiation is 10 times less than in a gasoline fire.

Gregory admits that hydrogen can be as dangerous as gasoline (one drop has the explosive power of three sticks of dynamite), but he says "now we know how to handle it." Besides, he says, I can heat my home with hydrogen for one-third the cost of conventional fuels, and "you can't make an electric airplane." □