

## Hydrogen and its Uses

*By Louis P. Solomon with Dick Van Orden*

Hydrogen is the lightest element in the universe. It has only one proton and one electron; thus is the only element that has no neutrons. Because of its simplicity, there are no isotopes (atoms with slightly different weights). For example, if we add a neutron to hydrogen ( $H_2$ ) we get a new element,  $H_3$ , called tritium.

Hydrogen is also the most abundant element in the universe (think water,  $H_2O$ ) comprising approximately 75% of all matter. It is an odorless gas that oxidizes (burns) readily; we call that being easily combustible. The burning (combustion) of hydrogen with oxygen has as its output two products: heat and water vapor. Thus, burning of hydrogen gives off no noxious gases. In a reverse of the combustion process, pure hydrogen (and pure oxygen) can be obtained by splitting the molecules of water with an electrical current. This technique is called electrolysis.



Hydrogen would make (and in the future will make) a superior fuel for automobiles and trucks, because an engine made to use hydrogen as a fuel would not pollute the atmosphere with greenhouse gasses and other noxious gases that cause SMOG. The flame of hydrogen burns cooler than gasoline and so would make engines using it easier to cool and easier to keep well lubricated. Best of all, extensive use of hydrogen would free the U.S. from dependence on oil-producing countries of the world for a major portion of our fuels.

Since hydrogen is very combustible, the danger of using hydrogen as a fuel is always a concern. In truth, hydrogen is considerably less dangerous than gasoline or other hydrocarbon fuels, because, it being much lighter than air, disperses rapidly, thus lessening the danger of accidental fires.

Can we produce an engine that uses hydrogen for propulsion? It turns out that there are, today, modified internal combustion engines that can run on hydrogen fuel. Such engines have been known since the 1930s, but have not been in general use because of the ready availability and low cost of gasoline and diesel fuels. Most of the major automobile companies are working today on cars that run on hydrogen. Once these engines are perfected, and hydrogen fuel is readily available, we will see them offered to buyers, much as the ethanol-using engines and hybrids are now being offered.

One of the major objections to internal combustion engines that use hydrocarbons (gasoline and diesel fuel) is that the emissions are quite harmful to the atmosphere and to the people who breathe them. As you can see, hydrogen has no injurious combustion products, since it produces only  $H_2O$ , water vapor. It is both people friendly and atmosphere friendly.

The cost of hydrogen today is rather high, at about \$4 to \$5 for an amount that is equivalent to a gallon of gasoline. It is clear, however, that with the increasing costs of petroleum products, and the expected decreasing costs of hydrogen, they will soon be equivalent. Eventually, hydrogen will be much cheaper than gasoline. And, as we have noted, the supply of hydrogen is essentially unlimited.

There are thousands of gasoline stations all over the United States. But, are there any hydrogen stations? Surprisingly, there are. There are 13 in California (and another 17 expected there next year), two in Maryland, two in Virginia, and two in the District of Columbia.

What is astonishing is that you can already purchase a unit called a Personal Energy Station (PES), which is about the size of a household washer/dryer, and which will generate hydrogen for your personal use. The General Electric company has developed such a PES (they call it an Electrolyzer) that can be mass-produced and is inexpensive to buy. Plug it into your home electric circuit, and it can generate about one kilogram per hour of pure hydrogen from water. The cost of the electricity is about \$3 to produce one kilogram of hydrogen.

But here is a grand idea. Inexpensive solar panels that turn the sun's rays into electric current are becoming available. Why not put solar panels on the roof of your house to generate enough electricity to run one or two Electrolyzers? The big problem with solar panels today is the need to store the electric power produced until it is needed, and storage batteries are costly and a pain to maintain. So, store the power as hydrogen, and keep a tank of hydrogen to run your furnace, your car, even a small motor generator to power your refrigerator, AC, lights, and cookstove if electric power is lost or diminished.

The federal government is determined to have a hydrogen car produced. The car people and other technical experts are certain that such a car can be built, but current predictions are that such cars will not be in common use for some 25 years. That's too long. Even so, Toyota and Honda are working on the problem and plan to bring out small experimental test models that run on hydrogen within a year.

Hydrogen may also be used as fuel for fuel cells, which, among other uses, can be used to run cars. Such uses of fuel cells, however, are in the more distant future. Fuel cells and their potential will be discussed in a future column.