

Frequently Asked Questions About Hydrogen

ISN'T HYDROGEN EXTREMELY DANGEROUS?

If handled properly, hydrogen is just as safe as any other fuel such as gasoline, natural gas or liquid propane. If handled improperly, it is just as dangerous. If hydrogen leaks from its storage container into the atmosphere, it is much less dangerous than gasoline or oil, because it immediately disappears into the air rather than collecting in a flammable or explosive pool.

DIDN'T THE HINDENBURG BLOW UP BECAUSE OF THE HYDROGEN IT CARRIED?

When the Hindenburg catastrophe occurred, there were severe electrical storms in the area. As soon as the mooring lines were dropped to the ground, it became a giant lightning rod. Three groups of experts have all come to the conclusion that the airship would have been destroyed whether she was carrying hydrogen or helium. These groups included a number of German engineers who survived the crash, the German Aerospace Research establishment and the Smithsonian Institution, who analyzed samples of the ship's skin. They found that the airplane dope, fabric, and powdered aluminum (which provided the silver color) used in its construction was an extremely flammable, or even explosive combination. Powdered aluminum is used today in the space program as one of the components of solid rocket fuel.

IF USING HYDROGEN FUEL IS SUCH A GREAT IDEA, HOW COME EVERYBODY ISN'T DOING IT?

There are several reasons for this:

Although there is a growing interest in the scientific community, most people we speak to have not heard about this idea. Hydrogen has not appeared on most lists of alternative fuels.

In the U.S.A., a century of growing dependence on fossil fuels has built up a huge infrastructure for the production and delivery of inexpensive gasoline and fuel oil as well as a mindset in most people that fossil fuels are the only alternative. The concept of alternative fuels has been around since World War II and is just now beginning to catch on. A universal switch to hydrogen would constitute a major change in the way the economy works. Human civilization resists change.

HOW MUCH HYDROGEN DOES IT TAKE TO EQUAL A GALLON OF GASOLINE OR DIESEL FUEL?

The amount of energy in a gallon of gasoline is expressed approximately as 127,000 BTU's (British Thermal Units). Diesel fuel contains about 134,000 BTU's. Since Hydrogen is a gas, it isn't measured in gallons, but Hydrogen has about 74,000 BTU's per pound, or slightly more than half the energy of a gallon of gasoline or diesel fuel. Therefore, two pounds of Hydrogen (or about one kilogram) has about the same energy as a gallon of gasoline or diesel fuel. This is often referred to as one "Gallon Equivalent" and, coincidentally, is just about the quantity that can be produced by separating a gallon of water by electrolysis into its component parts. The volume of two pounds of Hydrogen depends on the pressure at which it is stored. At atmospheric pressure (standard air

pressure at sea level), a "Gallon Equivalent" of Hydrogen would take up 380 cubic feet. That's about twice the space of a standard family refrigerator and is far too impractical! However, at high pressure, the space needed for a gallon equivalent is far less. At 3,000 pounds per square inch (psi), a gallon equivalent would take up less than two cubic feet (less than the volume of two basketballs). At 6,000 psi, it would need less than the space of one basketball. As stronger materials are developed higher pressure tanks will become commonplace. Other forms of storage are also being investigated. For example, liquid Hydrogen and metal hydrides are two more concentrated methods of storing Hydrogen fuel.

HOW IS HYDROGEN PRODUCED?

Hydrogen can be produced in a number of ways:

Electrolysis: The simplest way is to use electricity to split water into oxygen and hydrogen, its component parts. The quality of the water is not critical.

Stripping of natural gas: Natural gas is Methane (CH₄). The hydrogen can be stripped away by using a source of heat, such as solar-heated steam. This method also produces carbon, which has many useful purposes and is a salable product.

Reduction of Plant and Animal Waste: This method not only produces hydrogen, but also makes use of solid waste, currently a neglected resource, and reduces the volume of greenhouse gases that, otherwise, would escape into the atmosphere. It is the most environmental friendly method of producing hydrogen and carbon. This would be one of the surest ways of starting the solar-hydrogen economy.

IF WATER WERE USED TO PRODUCE HYDROGEN ON A LARGE SCALE, WOULDN'T A WATER SHORTAGE BE CREATED?

Using Electrolysis to produce Hydrogen does not require prodigious amounts of water. It has been calculated that if water were used to produce enough Hydrogen to replace all the gasoline used in Arizona, it would only need one quarter of one percent of all the water currently used in that state.

HOW IS HYDROGEN STORED?

There are currently three ways of storing hydrogen:

High Pressure: Similar to any pressure tank like a SCUBA or welding gas tank. The tank must be capable of withstanding more than 3,000 psi of internal pressure.

Hydride: Carbon granules similar to activated charcoal are contained in an airtight tank. When exposed to hydrogen, they absorb and hold it. The hydrogen is released when the granules are heated. Naturally, a heat source is needed to release and use the hydrogen fuel.

Liquid: Hydrogen can be liquefied if it is lowered to about -425 Fahrenheit. The storage tank must be built similar to a thermos bottle to maintain the temperature. It must also be able to withstand internal pressure, although not as much as the high pressure tank.

HOW MUCH DOES HYDROGEN COST COMPARED TO GASOLINE?

As it stands now, hydrogen costs somewhat more than gasoline or fuel oil. This is primarily because of low demand and also because the hydrogen now available is a higher purity than is needed for fuel. Hydrogen production is far more simple than the manufacture of gasoline, requiring only water or natural gas and an energy source.

If hydrogen were mass produced and distributed, it would cost much less than gasoline. This is especially true if the ancillary costs such as maintaining the military establishment to protect our petroleum sources and the cost of cleaning up oil spills were also considered. These are part of the real cost of maintaining our petroleum-based economy. Arizona Public Service sells the Hydrogen it produces in Phoenix at just below the market price of gasoline.

If gasoline were produced in the minute quantities that hydrogen is now, it would cost hundreds of times more than its present price. The fact that gasoline is so cheap is because some of the costs mentioned above are not included in the price and also of the lucky coincidence that millions of years, thousands of tons of pressure, and thousands of degrees of temperatures created the complex molecules needed in gasoline. The chemistry involved in producing gasoline is far more complex than the chemistry involved in producing hydrogen.

HOW CAN I GET MY CAR CONVERTED TO HYDROGEN? HOW MUCH DOES IT COST?

The American Hydrogen Association offers classes in auto conversion. The cost of the class for non A.H.A. members is \$600. If you want your car converted by someone else, it runs about \$3,000. The time required and cost vary with the type of engine and conversion done. Vehicles already converted to natural gas operation are much less costly to convert to hydrogen, since the tank and piping are already in place. V-8 engines are more difficult and, therefore, somewhat more costly. The vehicle can be converted to run on hydrogen only, or to run on either hydrogen, gasoline, or a mixture of both.

WHAT DOES THE CONVERSION CONSIST OF?

If the capability to run on gasoline is to be maintained, a pressure tank is installed to hold hydrogen fuel (usually in the trunk) and a regulator reduces the pressure from over 2,000 psi to about 300 psi. New fuel lines are added to carry hydrogen to the cylinders. The conventional spark plugs can be retained, but better performance will be provided by replacing them with "Smart Plugs" and a small computer module. If a variable mixture of fuels is desired, the timing must be modified to allow manual adjustment of the spark. For each fuel individually, the timing can be set automatically depending on which fuel is being used.

IF I CONVERT MY CAR TO HYDROGEN, WHERE CAN I GET FUEL?

The number of Hydrogen filling stations is increasing all the time. California has launched a program to build a string of stations every 20 miles along major highways. There are also filling stations in Phoenix, Las Vegas, and Detroit. Right now, you can buy hydrogen from several sources including industrial gas or welding suppliers. Just check the Yellow Pages. As demand is established, inexpensive commercial hydrogen will be supplied by entrepreneurs with an eye for a market. Then hydrogen will begin to become widely available. We expect that filling stations that now carry gasoline and diesel fuel will eventually carry many other kinds of alternative fuels including hydrogen.

WHAT ABOUT ALL THE COST AND POLLUTION PRODUCED TO GENERATE THE ENERGY NEEDED TO SEPARATE WATER OR NATURAL GAS IN SUFFICIENT QUANTITIES TO POWER THE WORLD'S VEHICLES?

When Hydrogen burns in an internal combustion engine, the energy released is slightly less than the energy initially needed to separate the water or the natural gas in the first place. Energy is therefore only stored, not created by Hydrogen. The KEY to the economy and cleanliness of using Hydrogen as a fuel is to USE ONLY RENEWABLE ENERGY sources such as solar, wind, hydroelectric, etc in its production. These sources are totally nonpolluting, natural, and do not deplete the world's resources. This results in NO POLLUTION OR RESOURCE DEPLETION occurring during the production or the end use of Hydrogen as a fuel.

At present, these energy sources are more costly than conventional fossil fuels. But as they become more widely used, their price will come down. At the same time, the price of fossil fuels will continue to rise. Renewable power will eventually cost less than fossil fuels.

I WANT TO USE HYDROGEN, BUT I'VE READ AND TALKED WITH THE EXPERTS. THEY ALL SEEM TO BECOME EVASIVE WHEN I ASK FOR SPECIFIC DETAILS OR PRICES FOR EQUIPMENT. WHAT'S GOING ON? HOW CAN I GET THE INFORMATION I NEED?

In a free economy, the supply and the demand must grow up together. In order for that to happen, there will be periods of perceived inequities. It is certainly not the intent of the experts or manufacturers to be unwilling to provide information or sell to the open market. At present, what you are seeing is the development of a brand new industry that must first perfect the technology and the economics. Then there will be safety, performance, and manufacturing issues to address. Once that is accomplished, marketing strategies and distribution programs will have to be worked out. That is why it is so important to have close communication among Hydrogen producers, equipment manufacturers, and users. As new technologies enter the marketplace, it will be crucial to inform the public as to what is available, so that potential consumers can make informed decisions.

WHERE CAN I GET A FUEL CELL TO POWER MY HOME?

Residential Fuel Cells are still in the development stage. There are a few models available, but they are very expensive. It will be at least a couple of years until they are on the market at a competitive price. Keep your eyes open for news releases from United Technologies Co., Hydrogenics, or Ballard, three of the better-known Fuel Cell manufacturers. Currently, the best approach to residential renewable energy is Solar.