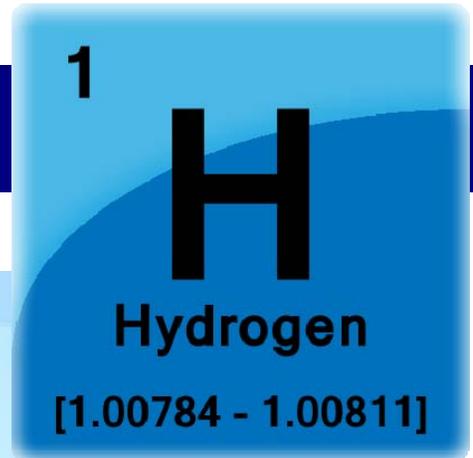
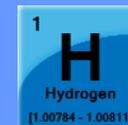


Hydrogen Vehicles



Information from: <http://auto.howstuffworks.com/fuel-efficiency/hybrid-technology/hydrogen-cars.htm>



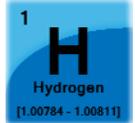
The car of the future is here today. Of course, you can't buy one yet; but if you live in California you can lease one. It doesn't use gasoline and it doesn't pollute the air. In fact, it produces steam instead of exhaust. So what's the mystery fuel? Hydrogen -- the simplest and most abundant element in the universe. And some people think that in 20 to 30 years, we'll all be driving these hydrogen-powered, fuel-efficient vehicles.





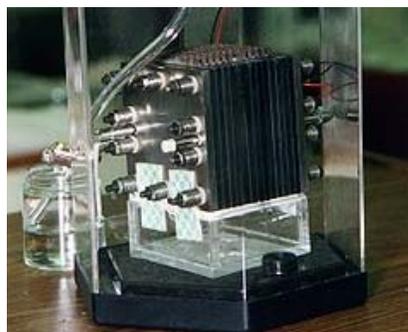
GM's Hydrogen Fuel Cell Vehicle, part 1

<http://youtu.be/wVlleDcMdsE>



Although hydrogen-powered cars have a science fiction quality to them, the idea isn't really new. Actually, the technology for using hydrogen to generate power has been around since the first part of the 19th century -- that's longer than cars have been around. What's new is that you might actually see a hydrogen-powered car on the road, with steam coming out of its exhaust pipe instead of foul-smelling gases. Several hydrogen cars are now in existence, but most of them are concept cars. These eco-friendly driving machines include the Chevrolet Equinox, the BMW 745h and the one that's currently available for lease in California, the Honda FCX.



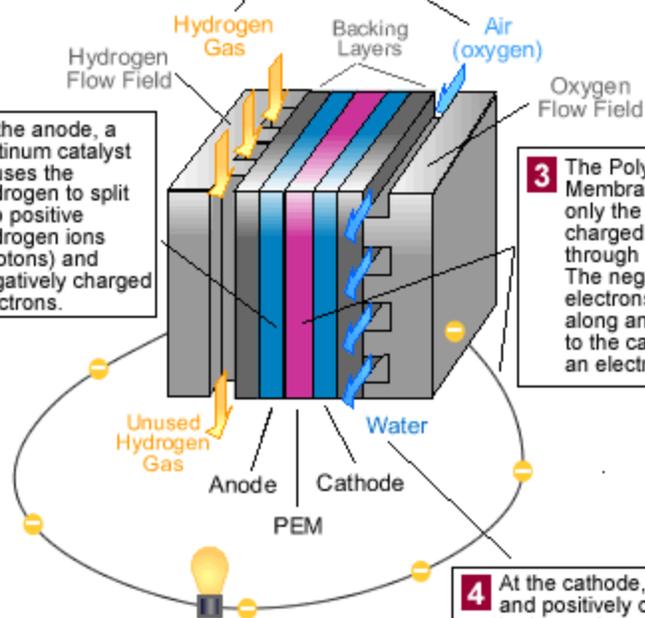


1 Hydrogen fuel is channeled through field flow plates to the anode on one side of the fuel cell, while oxygen from the air is channeled to the cathode on the other side of the cell.

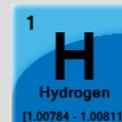
2 At the anode, a platinum catalyst causes the hydrogen to split into positive hydrogen ions (protons) and negatively charged electrons.

3 The Polymer Electrolyte Membrane (PEM) allows only the positively charged ions to pass through it to the cathode. The negatively charged electrons must travel along an external circuit to the cathode, creating an electrical current.

4 At the cathode, the electrons and positively charged hydrogen ions combine with oxygen to form water, which flows out of the cell.



What makes a hydrogen car possible is a device called a **fuel cell**, which converts hydrogen to electricity, giving off only heat and water as byproducts. Because it's non-polluting, hydrogen seems like the ideal fuel for the 21st century. A lot of people in the government and the auto industry are excited about its potential. Hydrogen cars have the potential to be fuel-efficient and offer the hope of eco-friendly, green driving.



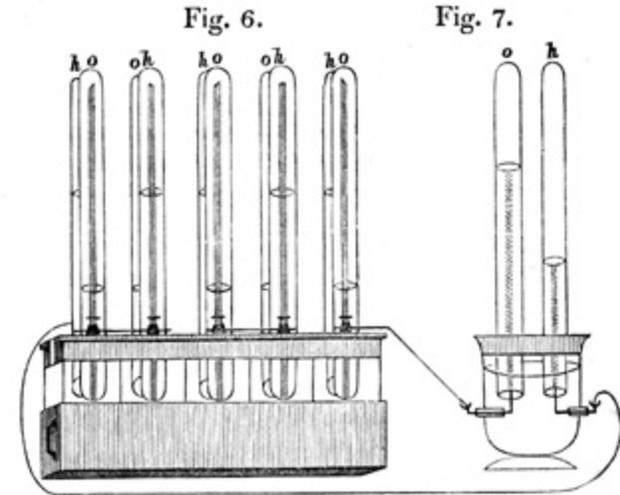
But there are still a lot of problems that need to be overcome and questions that need to be answered before hydrogen becomes the fuel of choice for enough people to make much difference in our current use of fossil fuels. For instance, where will we get the hydrogen? How expensive will these fuel-efficient cars be to purchase? Will you be able to find a hydrogen fuelling station to refill your tank? And, perhaps most importantly, as a fuel, is hydrogen really as non-polluting as it seems?

These are questions we will have to look into but there one quick answer right now: Unless you happen to live in very specific parts of the country and have pockets lined with cash, don't expect a hydrogen car in your driveway within the next decade.

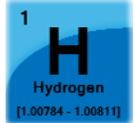


Hydrogen Fuel Cells

In 1839, the Welsh scientist Sir William Robert Grove took the familiar electrochemical process of electrolysis, which uses electricity to produce hydrogen from water, and reversed it, generating electricity and water from hydrogen. He called his invention a gas voltaic battery, but today we know it as a hydrogen fuel cell. Much later, in the middle of the 20th century, the technology was further developed by the inventor Francis Bacon. The technology that these two inventors devised is essential to the operation of a hydrogen car.



Hydrogen Fuel Cells

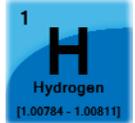


The first practical fuel cell system was developed in the early 1960s by General Electric for use in orbital space capsules. And then, in the 1990s fuel cells began appearing in city buses. so we know that powering vehicles with fuel cells is feasible. You can think of a fuel cell as a kind of battery, except that while a battery keeps its fuel inside itself, a fuel cell needs to be refilled. The fuel for a hydrogen fuel cell is, as the name suggests, hydrogen.

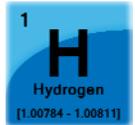
As you might recall from high school chemistry class, hydrogen is the simplest of all elements. An atom of hydrogen consists of a single electron and a single proton. The fuel cell generates electricity by stripping the electrons from the protons and using the electrons to create a pure stream of electricity. The ionized hydrogen atoms then combine with oxygen to form water. The other byproduct of this process is heat, so this water generally takes the form of steam. How's that for eco-friendly driving?



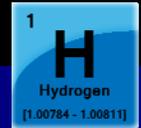
Hydrogen Fuel Cells



The type of fuel cell used in cars is the polymer exchange membrane (or PEM) fuel cell. PEM fuel cells have the advantage of being light and small. They consist of two electrodes (a negatively charged anode and a positively charged cathode), a catalyst and a membrane. Hydrogen is forced into the fuel cell at the anode in the form of H_2 molecules, each of which contains two hydrogen atoms. A catalyst at the anode breaks the molecules into hydrogen ions (the protons) and a flow of electricity (the electrons). The ions pass through the membrane, but the electricity has to go around. While it's doing so, it can be harnessed to do work. Just as hydrogen is forced into the fuel cell at the anode, oxygen is forced in at the cathode. The protons and electrons reunite at the cathode and join with the oxygen to form water, most of which become the fuel cell's exhaust. Fuel cells are designed to be flat and thin, mainly so they can be stacked. The more fuel cells in the stack, the greater the voltage of the electricity that the stack produces.



Many people think that fuel-efficient vehicles like hydrogen-powered cars will be crucial in meeting the energy demands of the 21st century. In 2003, President George W. Bush announced a \$1.2 billion Freedom Fuel Initiative in support of the development of fuel cell technology. Fuel cells have two major advantages over fossil fuels. First, they don't deplete the world's finite supply of oil, which helps us preserve the existing supplies and they could also reduce our dependency on foreign oil. Second, the only byproduct from a fuel cell's operation is heat and water, which means fuel cells don't produce pollution. This is vitally important in a time when carbon emissions from cars are believed to be promoting global warming.



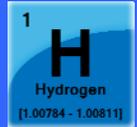
Hydrogen Car Production

So how do manufacturers actually build fuel-efficient vehicles, like fuel cell cars? Hydrogen car production is not vastly different from producing typical cars. Of course, the drive train, for instance, and the electrical systems will be somewhat unique because a fuel cell creates electricity. Therefore, a hydrogen-powered car and electric car have a lot in common in that respect. Perhaps a more important question is how the hydrogen itself will be produced?

Given that hydrogen is the most abundant element in the universe, constituting roughly 90 percent of the atoms in existence, you'd think that this wouldn't be a problem. However, hydrogen is also the lightest element in the universe and any uncontained hydrogen on the surface of the Earth will immediately float off into outer space. What hydrogen remains on this planet is bound with other elements in molecular form, most commonly in water (H₂O) molecules.



Hydrogen Car Production

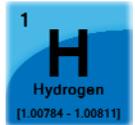


But how do we separate the hydrogen molecules in the water from the oxygen molecules? And if we don't use water as a hydrogen source, where else can we get hydrogen?

The simplest way of getting hydrogen from water is the one that Sir William Grove knew about more than 150 years ago: electrolysis. If you pass an electric current through water, the H_2O molecules break down. Similar to fuel cell operation, this process uses an anode and a cathode, usually made from inert metals. When an electric current is applied to the water, hydrogen forms at the cathode, and oxygen forms at the anode. Although this process is slow, it can be done on a large scale.

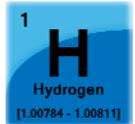


Hydrogen Car Production



An alternative source for hydrogen is natural gas, which consists of naturally occurring hydrocarbons. A process called steam reformation can be used to separate the hydrogen in the gas from the carbon. At present, this is the most common method of industrial-scale production of hydrogen and would likely be the first method used to produce the hydrogen for fuel-cell vehicles. Unfortunately, this process uses fossil fuels -- the natural gas -- so if the point of building cars that run on hydrogen is to avoid depleting fossil fuel reserves, natural gas would be the worst possible source of this fuel.

Hydrogen Car Production



Some experts have suggested that it might be possible to build miniature hydrogen plants that will fit in the average person's garage, so it won't even be necessary to drive to the local fueling station to fill up the car's hydrogen tank.

The most extreme form of this idea has been the suggestion that electrolysis could be performed inside the car itself, which would make possible the astounding idea of a car that runs on water! However, the power for the electrolysis has to come from some sort of battery, so a water-powered car would need to be periodically recharged.

Are green driving machines like fuel-cell equipped vehicles really the cars of the future? Many people hope so, but there are several potential roadblocks on the way to a world where people get around in cars that run on hydrogen.

Lets look at this.



[Honda unveils home solar-powered hydrogen refuelling station](#)

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Monthly Archives: January 2010

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By Tim Beissmann | January 28th, 2010

8

Honda has taken one step closer to a fuel cell world today with the unveiling of its next-generation Solar Hydrogen Station prototype at its research and development facility in Los Angeles.



Designed as a single, integrated unit to fit in the home garage, the station produces enough hydrogen (500g) in an eight hour overnight fill to power a fuel cell electric vehicle for its typical daily commute (roughly 44km, or 16,000km a year). Refilling overnight lets owners take advantage of less expensive off-peak electrical power and removes the requirement of hydrogen storage.

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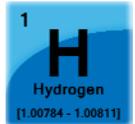
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Honda's FCX Clarity – currently available in small numbers in selected markets – is capable of being fast-filled in five minutes and has a driving range of 386km.



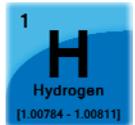
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Designed to support the needs of the future owners of fuel cell electric vehicles, Honda says the Solar Hydrogen Station was designed to complement a public network of fast-fill hydrogen stations.

"A key strategy in creating a solar hydrogen station for home use was to create a new lifestyle with convenient, clean, energy-efficient and sustainable home refuelling, by addressing the need for refuelling infrastructure that can advance the wider use of fuel cell electric vehicles by consumers.

"The combination of a fuel cell electric vehicle and the solar hydrogen station could help lead to the establishment of a hydrogen society based on renewable energy, resulting in a major reduction of CO₂ emissions and greater energy sustainability," Honda said in a statement.

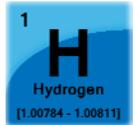
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Honda's previous solar hydrogen station system required both an electrolyser and a separate compressor unit to create high pressure hydrogen. The compressor was the largest and most expensive component and reduced system efficiency. By creating a new high differential pressure electrolyser, Honda engineers have been able to eliminate the compressor entirely – a world first for a home use system.

This innovation also reduces the size of other key components to make the new station the world's most compact system, while improving system efficiency by more than 25 percent (based on simulations) compared to the solar hydrogen station system it replaces.

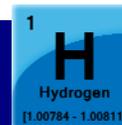
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The new Solar Hydrogen Station employs the same 48-panel, 6kW solar array that powered the previous system, utilising thin film solar cells composed of copper, indium, gallium and selenium (CIGS), which Honda says generate less CO₂ than conventional solar cells.

Hydrogen Car Setbacks

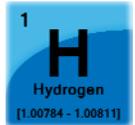


Many people believe that hydrogen fuel cells are the most important alternative fuel technology currently under development. We can roughly group the problems with hydrogen into three categories: the costs of developing the technology, difficulties and dangers with hydrogen storage and the possibility that this "non-polluting technology" isn't so non-polluting after all.



The costs of developing hydrogen technology are high. Not only do we have to design and develop the fuel cells and the cars, but we have to develop an infrastructure to support these fuel-efficient vehicles. Imagine if you currently owned a hydrogen car. Where would you go to fill your tank? Assuming you don't have a hydrogen production facility in your garage, you'll need a hydrogen refueling station, and the only place where any significant number of such stations exists at the moment is in the state of California. Some of the more pessimistic estimates have placed the cost of building an infrastructure that will allow a significant number of hydrogen cars to be as high as \$500 billion -- and the time to produce the infrastructure as long as four decades!

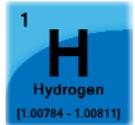
Hydrogen Car Setbacks



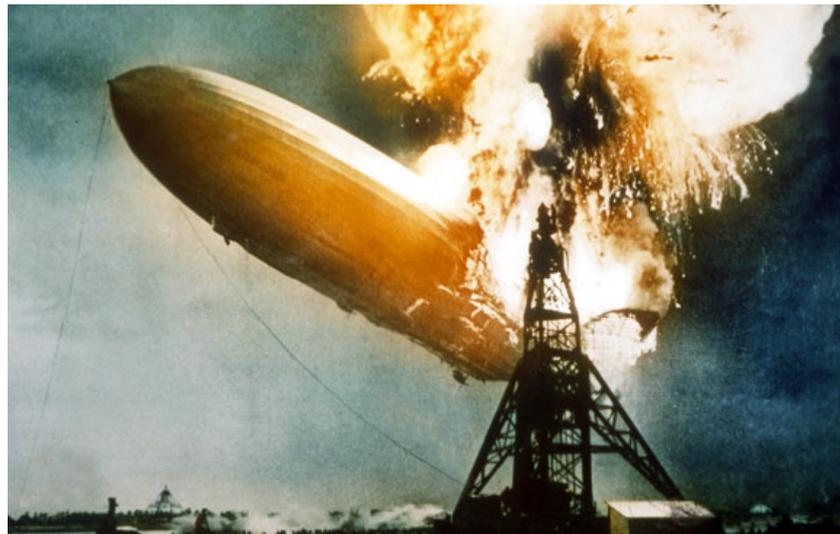
The cost of the cars is high, too. With platinum as the most widely used catalyst in the fuel cells, the price of a single fuel cell vehicle is currently more than \$100,000 and even perhaps considerably more, which is why the only hydrogen cars available for you to drive at the moment are for lease, not for sale. Few people are in a position to afford such an expensive car. Other catalysts are being developed which will probably be less expensive than platinum, but nobody knows how soon they'll be available for large-scale use.



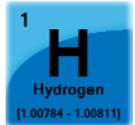
Hydrogen Car Setbacks



The storage of Hydrogen is also a problem. Hydrogen is a gas and it likes to spread out. Putting it in a car means squeezing it down to a reasonable size, and that isn't easy. Furthermore, hydrogen gets warm while it's sitting in the tank of a parked car, which causes the gas to expand. This means that the tanks have to vent the hydrogen periodically from the car. Leave a hydrogen car sitting around for more than a few days and all the fuel will be gone. Hydrogen is also highly flammable -- the spectacular explosion of the dirigible Hindenburg in the 1930s is believed by some to have been the result of a hydrogen fire -- so, if the hydrogen gets out of the tank, it has the potential to be dangerous. Fortunately, hydrogen fires aren't as hot as gasoline fires and are less likely to start secondary fires. And because hydrogen rises, most escaped hydrogen will float away before it can actually do any harm.



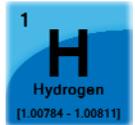
Hydrogen Car Setbacks



And is hydrogen really non-polluting? A fuel cell produces only heat and water as exhaust, but the processes used to create the hydrogen are not necessarily as clean. Electrolysis uses electricity and that electricity will often come from plants that burn coal, a highly polluting source. And when hydrogen is extracted from natural gas, it produces carbon emissions, which is exactly what we're trying to avoid by using hydrogen in the first place.

Many people think that we'll overcome these obstacles eventually, but it's going to be difficult. Others believe that our best bet for fuel efficiency and eco-friendly driving in the near future lies not in hydrogen but in hybrid electric vehicles, like the Toyota Prius, the Ford Fusion hybrid and other similar hybrid cars. Still, it's possible that within the next couple of decades, you just might own a hydrogen fuel cell car.

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