HYDROGEN VEHICLE

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Summary. *The aim of this article is to highlight the interest in hydrogen as an alternative transportation fuel systems and its ability to power fuel cells in zero-emission FCEVs, its potential for domestic production, its fast filling time, and the fuel cell's high efficiency. In fact, a fuel cell coupled with an electric motor is two to three times more efficient than an internal combustion engine running on gasoline. Hydrogen can also serve as fuel for internal combustion engines.*

Key words: FCEVs(Fuel cell electric vehicles), water , hydrogen gas , vehicle, fuel , engine

Introduction

One of the most essential approaches of all times in mechanics and car construction is to develop new motor-vehicle engines with more power and less fuel consumption. By increasing fuel efficiency motorists save money and reduce CO2 emissions, a goal of the humanity in an era of technological advance and global warming. Automobiles, buses, forklifts, trains, PHB bicycles, canal boats, cargo bikes, golfcarts, motorcycles, wheelchairs, ships, airplanes, submarines, and rockets can already run on hydrogen, in various forms. NASA used hydrogen to launch Space Shuttles into space. One day there will be a complete rejection of gasoline internal combustion engines –a need so required by the environment, and support the idea of hydrogen engine, the engine of progress and of the future. Therefore, many motorists have a natural question - what will happen next? Not everyone is willing to switch to electric vehicles, because despite their environmental friendliness, they have many obvious shortcomings and reservations. In addition, as an alternative, you could consider fuel cell electric vehicles.

Fuel cell electric vehicle

Fuel cell electric vehicles (FCEVs) are powered by hydrogen. They are more efficient than conventional internal combustion engine vehicles and produce no tailpipe emissions—they only emit water vapor and warm air. FCEVs and the hydrogen infrastructure to fuel them are in the early stages of implementation.

FCEVs use a propulsion system similar to that of electric vehicles, where energy stored as hydrogen is converted to electricity by the fuel cell. Unlike conventional internal combustion engine vehicles, these vehicles produce no harmful tailpipe emissions.

FCEVs are fueled with pure hydrogen gas stored in a tank. Due to the fact that hydrogen has a low volumetric energy density, it is stored onboard a vehicle as a compressed gas to achieve the driving range of conventional vehicles. Most current applications use high-pressure tanks capable of storing hydrogen at either 5,000 or 10,000 pounds per square inch (psi). Similar to conventional internal combustion engine vehicles, they can fuel in less than 4 minutes and have a driving range over 300 miles. FCEVs are equipped with other advanced technologies to increase efficiency, such as regenerative braking systems, which capture the energy lost during braking and store it in a battery. The energy in 2.2 pounds (1 kilogram) of hydrogen gas is about the same as the energy in 1 gallon (6.2 pounds, 2.8 kilogram) of gasoline [1-2].

Fuel-cell systems are much lighter and smaller than the battery packs that dominate plug-in electric drive systems.

So, while battery-electric vehicles tend to be compact and subcompact models with limited range and lengthy recharging times, fuel-cell electric vehicles are quick and easy to refuel. Fuel-cell systems could power everything from minicars to large pickups.

For all the volatility of a gas like hydrogen, which combusts with one-tenth the energy required for gasoline, hydrogen fuel cell vehicles are safer than cars with internal combustion engines, according to industry experts [2].

The operating principle of Fuel Cells

The most common type of fuel cell for vehicle applications is the polymer electrolyte membrane (PEM) fuel cell. In a PEM fuel cell, an electrolyte membrane is sandwiched between a positive electrode (cathode) and a negative electrode (anode). Hydrogen is introduced to the anode, and oxygen (from air) is introduced to the cathode. The hydrogen molecules break apart into protons and electrons due to an electrochemical reaction in the fuel cell catalyst. Protons then travel through the membrane to the cathode.

The electrons are forced to travel through an external circuit to perform work (providing power to the electric car) then recombine with the protons on the cathode side, where the protons, electrons, and oxygen molecules combine to form water [1].

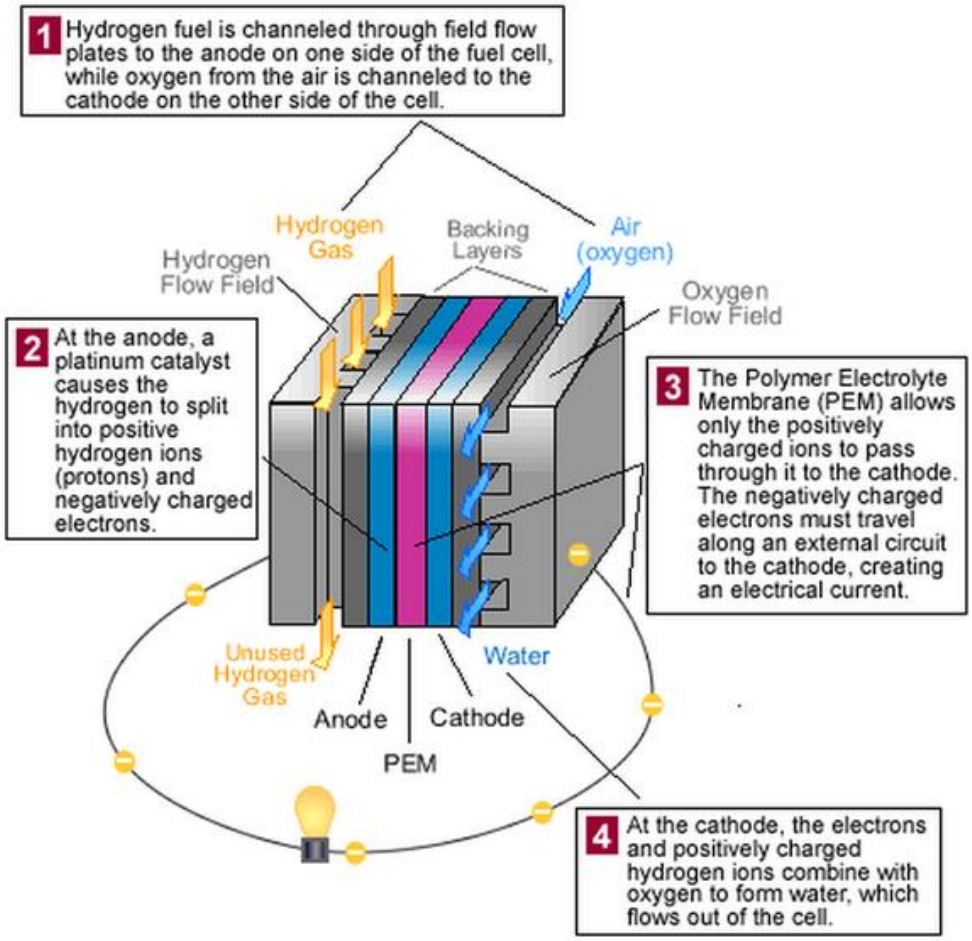

Figure 1. Operating principle

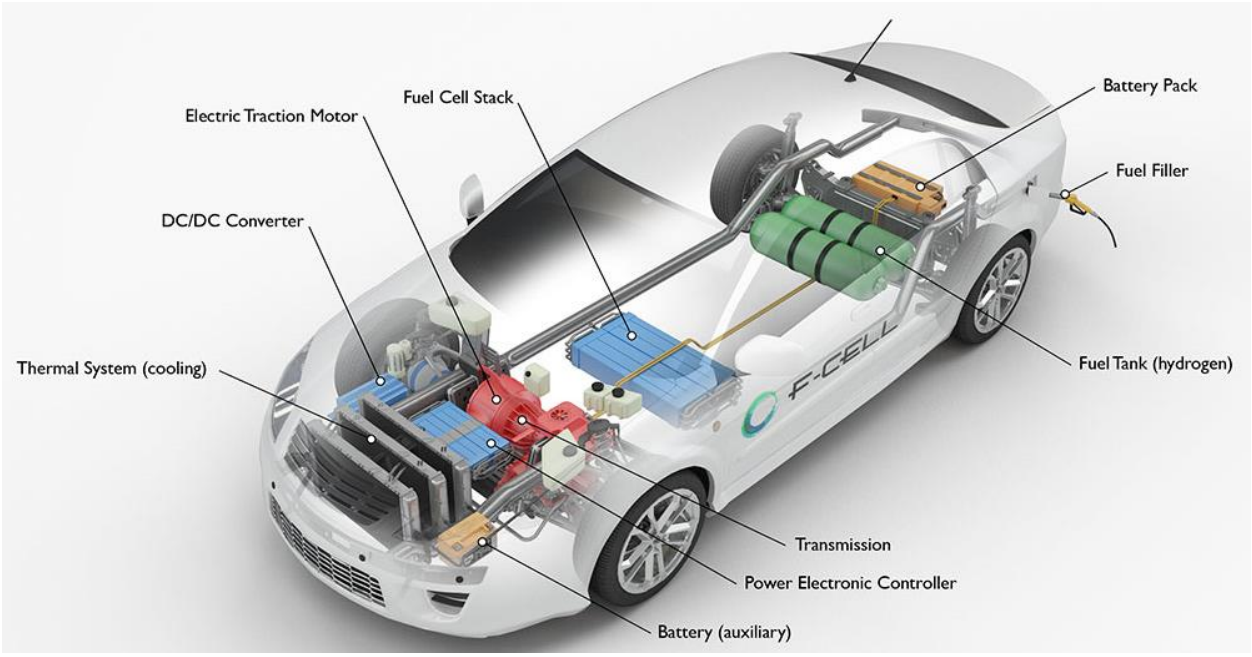

Figure 2. Key components of a Hydrogen Fuel Cell Electric Car

Battery (auxiliary): In an electric drive vehicle, the auxiliary battery provides electricity to start the car before the traction battery is engaged and also powers vehicle accessories.

Battery pack: This battery stores energy generated from regenerative braking and provides supplemental power to the electric traction motor.

DC/DC converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

Electric traction motor (FCEV): Using power from the fuel cell and the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.

Fuel cell stack: An assembly of individual membrane electrodes that use hydrogen and oxygen to produce electricity.

Fuel filler: A nozzle from a fuel dispenser attaches to the receptacle on the vehicle to fill the tank.

Fuel tank (hydrogen): Store's hydrogen gas onboard the vehicle until it's needed by the fuel cell.

Power electronics controller (FCEV): This unit manages the flow of electrical energy delivered by the fuel cell and the traction battery, controlling the speed of the electric traction motor and the torque it produces.

Thermal system (cooling) - (FCEV): This system maintains a proper operating temperature range of the fuel cell, electric motor, power electronics, and other components.

Transmission (electric): The transmission transfers mechanical power from the electric traction motor to drive the wheels [3-4].

Production and Distribution

Hydrogen is the simplest and most common molecule known to exist. And because of that, it is a part of almost every other substance, such as water and hydrocarbons. Hydrogen is also found in biomass, which includes all plants and animals.

There are several methods for creating hydrogen fuel, but the most common nowadays is via steam-methane reformation, a process by which high-temperature steam (1,000 degrees Celsius) creates a reaction with methane gas in the presence of a catalyst to produce hydrogen,

carbon monoxide and a relatively small amount of carbon dioxide. The carbon dioxide and other impurities are then removed through a process called "pressure-swing adsorption," leaving essentially pure hydrogen. Steam reformation can also be used with ethanol, propane or even gasoline to produce hydrogen.

Hydrogen can also be produced through electrolysis, or using electricity and a catalyst to create a chemical reaction that separates the hydrogen molecules from oxygen. Solar power can also be used in combination with water and a catalyst (typically a metal) to generate hydrogen fuel by splitting hydrogen molecules from oxygen. Most often, the catalysts are expensive metals, such as platinum (iridium) [3-4].

Currently, hydrogen is distributed through three methods:

- **Pipeline:** This least-expensive way to deliver large volumes of hydrogen is limited as only about 1,600 miles of U.S. pipelines for hydrogen delivery are currently available. These pipelines are located near large petroleum refineries and chemical plants in Illinois, California, and the Gulf Coast.
- **High-Pressure Tube Trailers:** Transporting compressed hydrogen gas by truck, railcar, ship, or barge in high-pressure tube trailers is expensive and used primarily for distances of 200 miles or less.
- **Liquefied Hydrogen Tankers:** Cryogenic liquefaction is a process that cools hydrogen to a temperature where it becomes a liquid. Although the liquefaction process is expensive, it enables hydrogen to be transported more efficiently (when compared with using high-pressure tube trailers) over longer distances by truck, railcar, ship, or barge. If the liquefied hydrogen is not used at a sufficiently high rate at the point of consumption, it boils off (or evaporates) from its containment vessels. As a result, hydrogen delivery and consumption rates must be carefully matched.

Conclusion

Emissions from gasoline and diesel vehicles—such as nitrogen oxides, hydrocarbons, and particulate matter—are a major source of this pollution. Hydrogen-powered fuel cell electric vehicles emit none of these harmful substances—only water (H_2O) and warm air.

The environmental and health benefits are also seen at the source of hydrogen production if derived from low- or zero-emission sources, such as solar, wind, and nuclear energy and fossil fuels with advanced emission controls and carbon sequestration. Taking advantage of hydrogen as fuel, the usage of petroleum is reduced considerably, by nearly 100%, regardless of fuel production pathway.

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