Fuel cells Application -1

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Outline

- **Introduction**
- **Application**
  - Type of Fuel cell used is PEM
  - The structure of Fuel cell systems of the vehicle
  - The structure of a Fuel cell in the fuel system
  - How Fuel cells work in the system

Introduction

- Fuel cells is an electrochemical device that convert hydrogen and oxygen into electricity without combustion. Fuel cells have been around since the mid 19th century, and the space program has used them since the early 1960s.
- Up to now, there are many applications used by Fuel cells with many type of fuel cells. One of them is being used in the transportation sector to power cars, trucks, and buses. A fuel cell will be very similar to electric car, but with a fuel cell and reformer instead of batteries.

Introduction

- They are intended to operate on pure hydrogen, which eliminates the need for an on-board reformer.

Application

- This report introduce an application about industrial vehicles. Depending on the choice of the fuel, the design of the vehicle can be quite different, with each design having advantages and disadvantages. The most important vehicle difference between methanol and gasoline is in the design of the reformer, the device that converts the fuel to hydrogen on-board the vehicle
- One of them is Sport car that product of GM company. (GM is a famous company that manufacturing many types quality vehicles and the company has many branch different areas around the world).

  That is vehicle by a name The HydroGen3

Application

- The HydroGen3 fuel cell vehicle marks another important milestone along the way to fitting passenger cars with an environmentally compatible, resource-saving, fuel cell propulsion system. The vehicle, the latest in the HydroGen series, is based on the Zafira, a popular five-passenger vehicle from our Opel division in Germany

Application

- **Type of Fuel cell used is PEM** (Proton Exchange Membrane**)**
  - Proton-exchange membrane (PEM) fuel cells are the most common type of fuel cells for light-duty transportation use, because they can vary their output quickly (such as for startup) and fit well smaller application. Chef advantages of PEM are that they react quickly to changes in electrical demand, will not leak or corrode, and use inexpensive manufacturing materials (plastic membrane)

Application

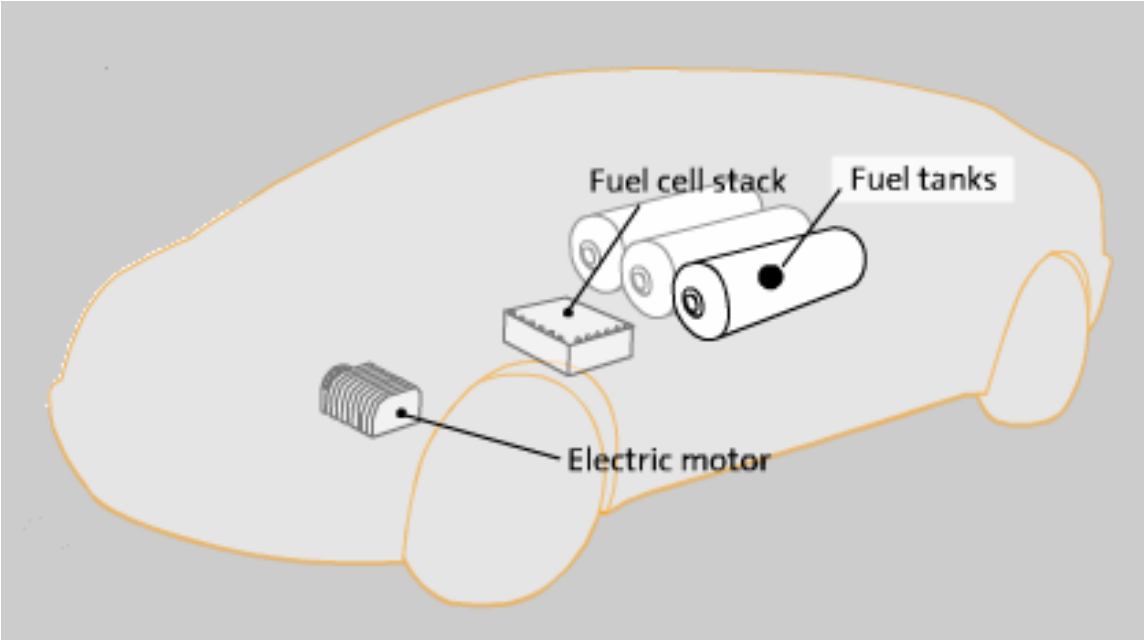
- A PEMFC fuel cell employs a solid organic polymer polyperfluorsulfonic acid electrolyte membrane and operates at temperatures of 60-100° C. PEMFC applications include electric utilities, portable power, and transportation. Its main advantages are that the solid electrolyte reduces corrosion, operates at low temperatures, and delivers quick start-up. Its disadvantages are that the cell requires expensive catalysts and the cell has high sensitivity to fuel impurities

Application

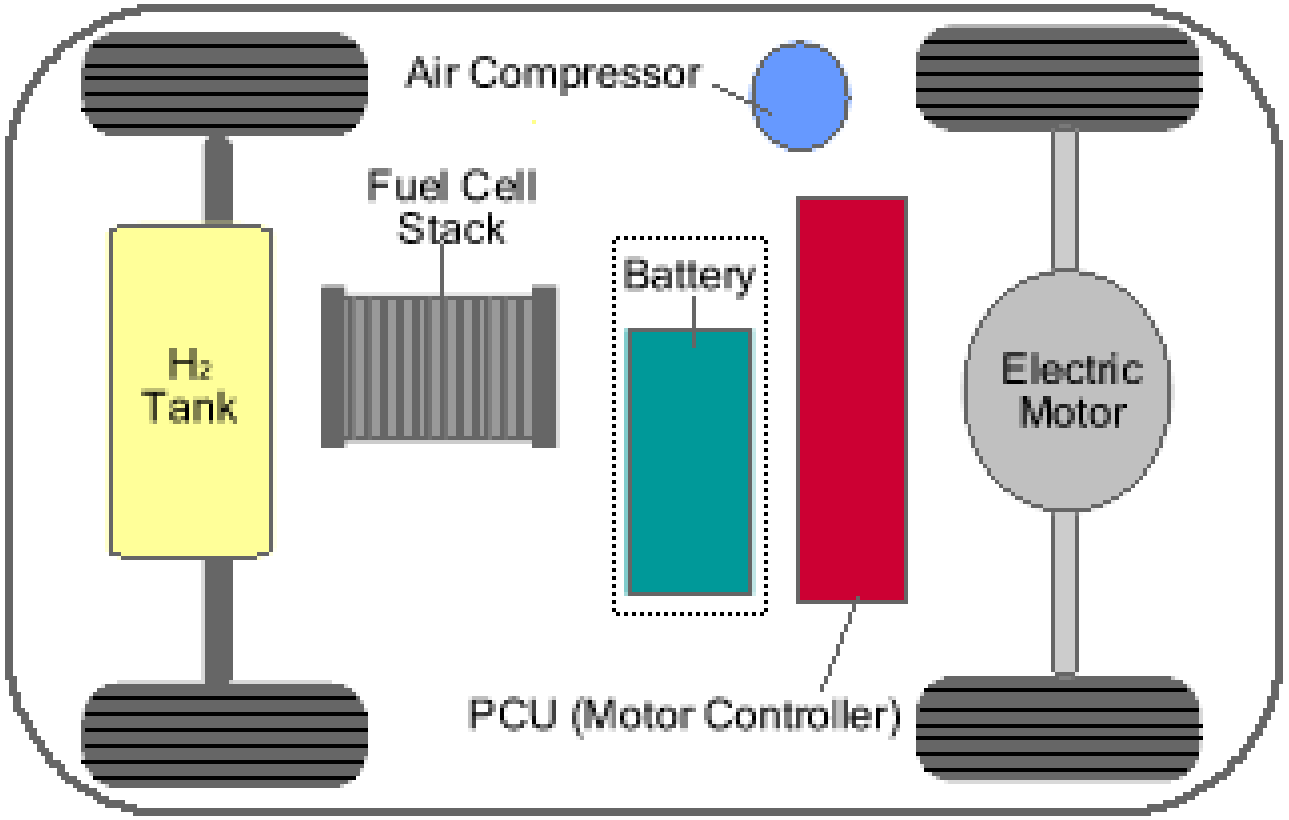
The HydroGen3

Application

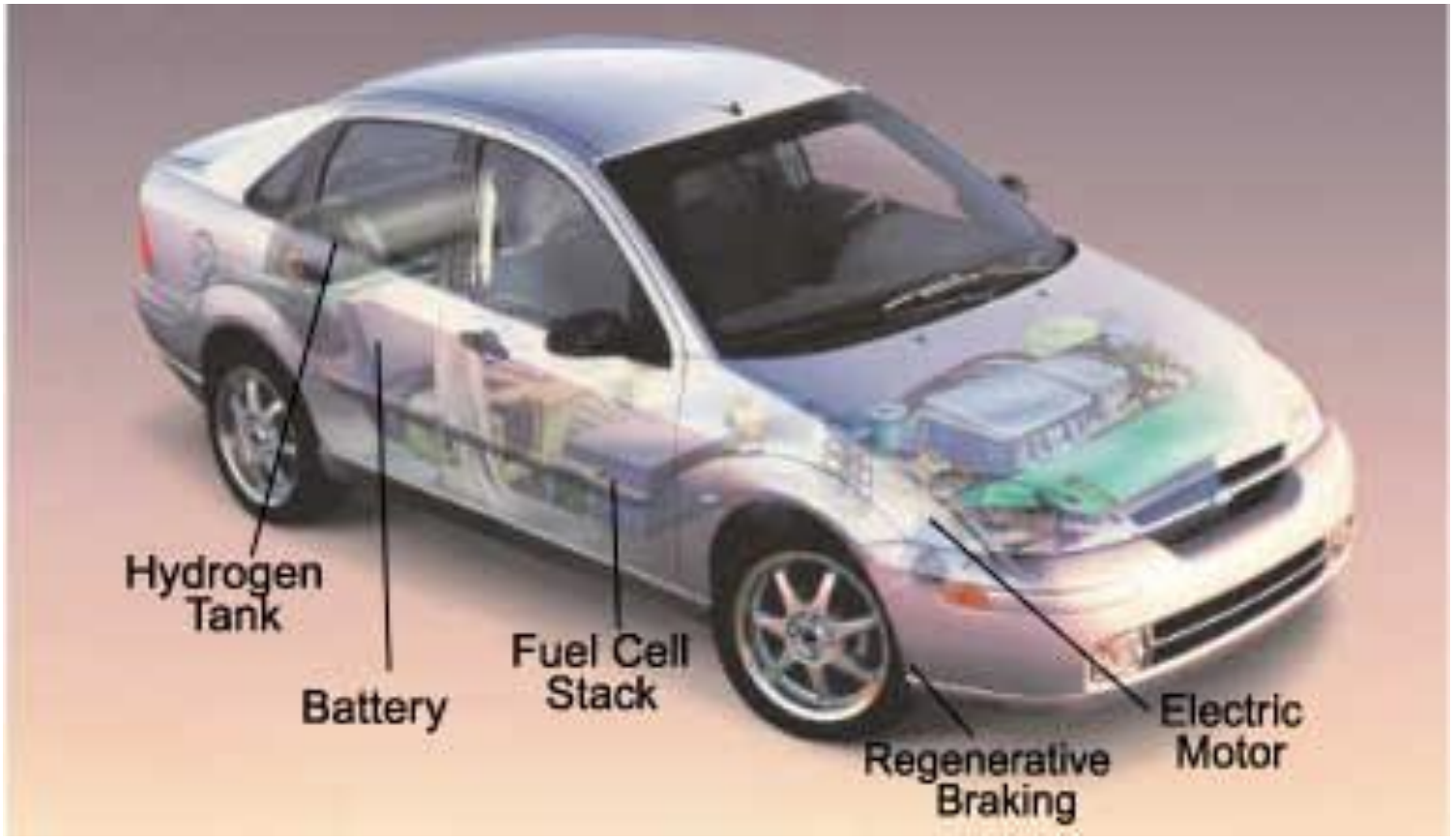
- **The structure of Fuel cell systems of the vehicle include:**



Application



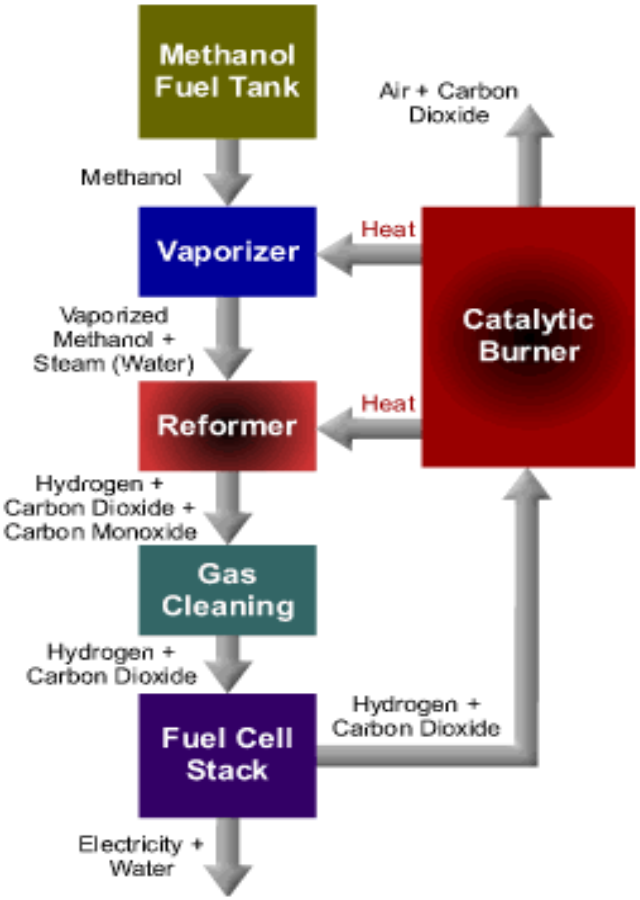
Application



Application

- Hydrogen sources:

  The PEM fuel cells in most FCV use hydrogen to produce electricity. The hydrogen, however, can be supplied in several ways. As Pure hydrogen and Hydrogen-rich fuels



Application

- **Part 1**: Fuel cell stack

  Most fuel cells designed for use in vehicles produce less than 1.16 volts of electricity-far from enough to power a vehicle. Therefore, multiple cells must be assembled into a fuel cell *stack*. The potential power generated by a fuel cell stack depends on the number and size of the individual fuel cells that comprise the stack and the surface area of the PEM.

Inside a fuel cell stack: electricity is created the chemical reaction that occurs when hydrogen and oxygen are combined. To power a vehicle, hundreds of fuel cell are “stacked” together in a series, combining their individual

electrical outputs

A fuel cell stack

Application

- **Part 2**: Electric motor

  The stack sends electricity to the electric motor. The motor created the mechanical power that turns the wheels to propel the vehicle.

Application

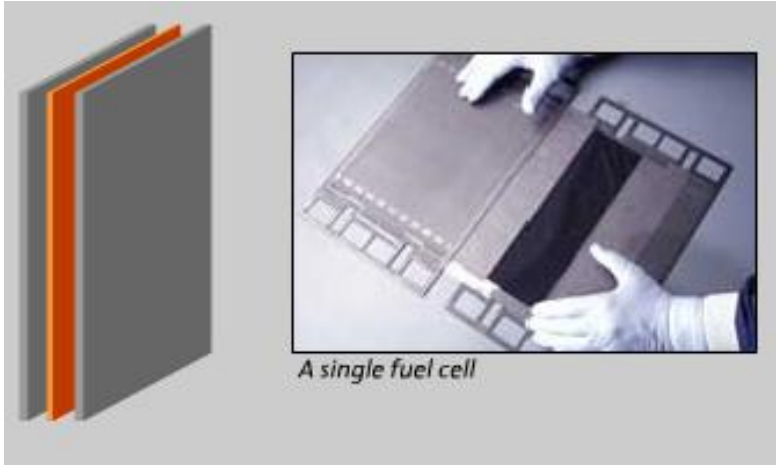
- **Part 3**: Fuel tank

  A fuel tank stores hydrogen as fuel. GM's Hy-wire uses compressed gaseous hydrogen. Other fuel cell vehicles use liquid hydrogen fuel.

Application

- **The structure of a Fuel cell in the fuel system of the vehicle:**

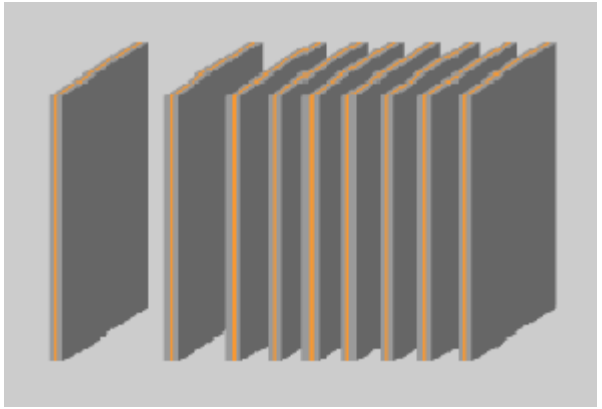
➢ A single fuel cell generates about 0.7 volts of electricity, so hundreds of fuel cells are combined in a ”stack” that generates enough electricity to power the electric motors.

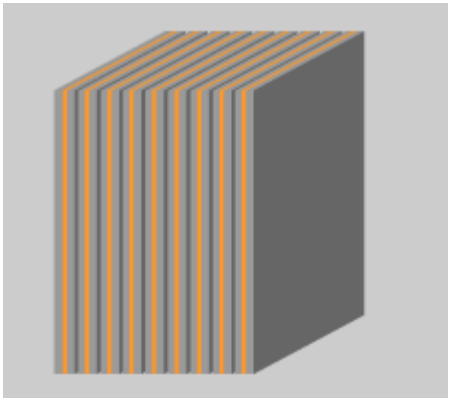


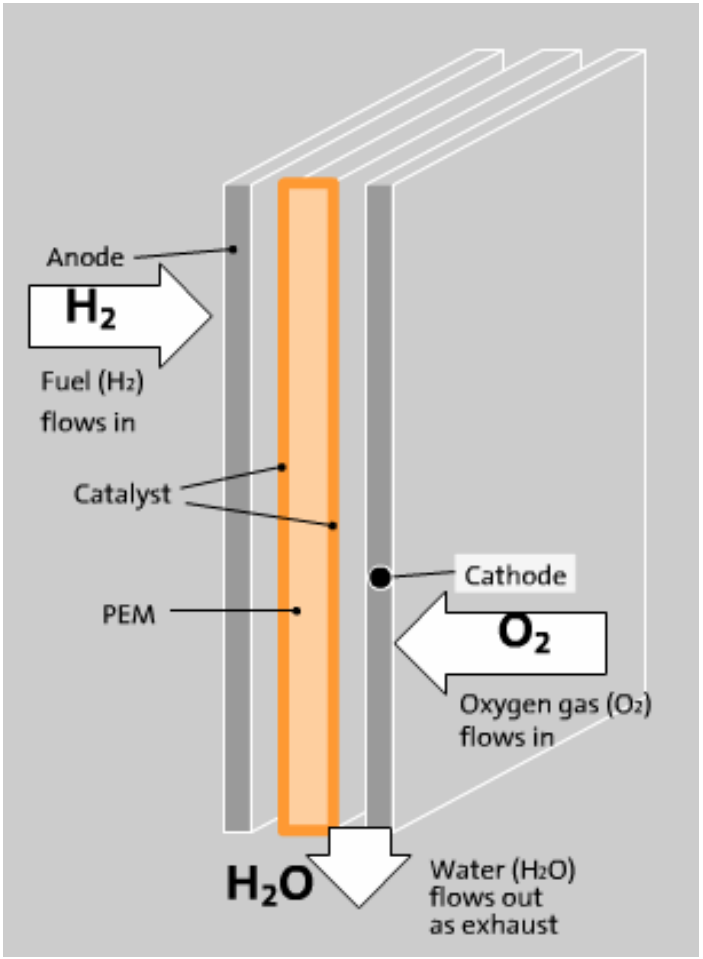
Application

- The fuel cell needs two substances to generates power: oxygen and hydrogen. Oxygen is readily available from the air, the pure hydrogen must be supplied. Hydrogen is an abundant and renewable fuel. It can be obtained from hydrocarbons (petroleum, natural gas, biomass) or water (using solar energy and other energy sources). A fuel cell's only emission is pure water.

Application







Application

- **Inside the fuel cell** :
- Anode

  The negatively charge anode has channels that disperse the hydrogen gas evenly over the surface of the catalyst.
- Catalyst

  A thin layer of a catalyst coats the proton exchange membrane (PEM). The catalyst is a precious metal, usually platinum pr palladium, which accelerates a chemical reaction between the oxygen and hydrogen. The catalyst layers are rough and porous so hat maximum surface area can be exposed to the hydrogen and oxygen.

Application

- Proton Exchange Membrane (PEM)

  The PEM, which looks something like plastic wrap, conducts only positively charged protons, The protons pass through the PEM electrolyte, but electrons do not.

- Cathode

  The positively charged cathode has channels that distribute the oxygen to the surface of the catalyst and remove the water produced during the reaction.

Application

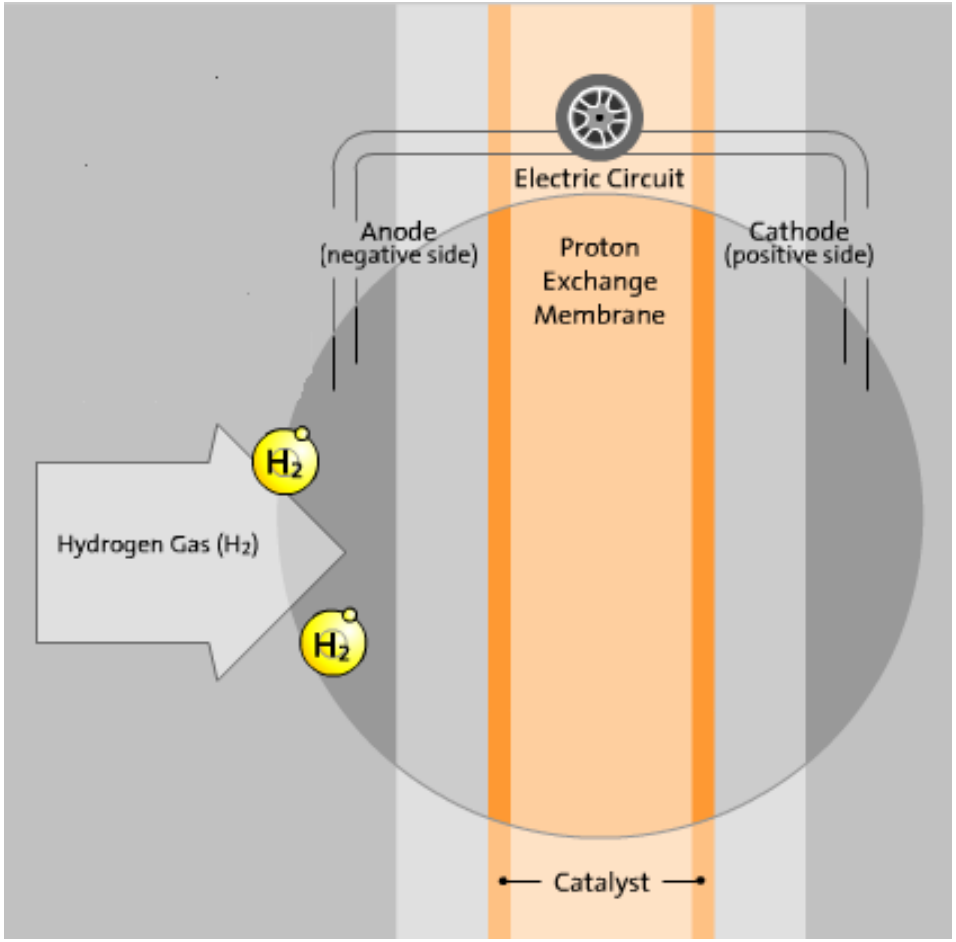
- **How Fuel cells work in the system:**

  Here we only concern about the basic operation of fuel cells in fuel system of the Vehicle, detail of The HydroGen3 car

Application

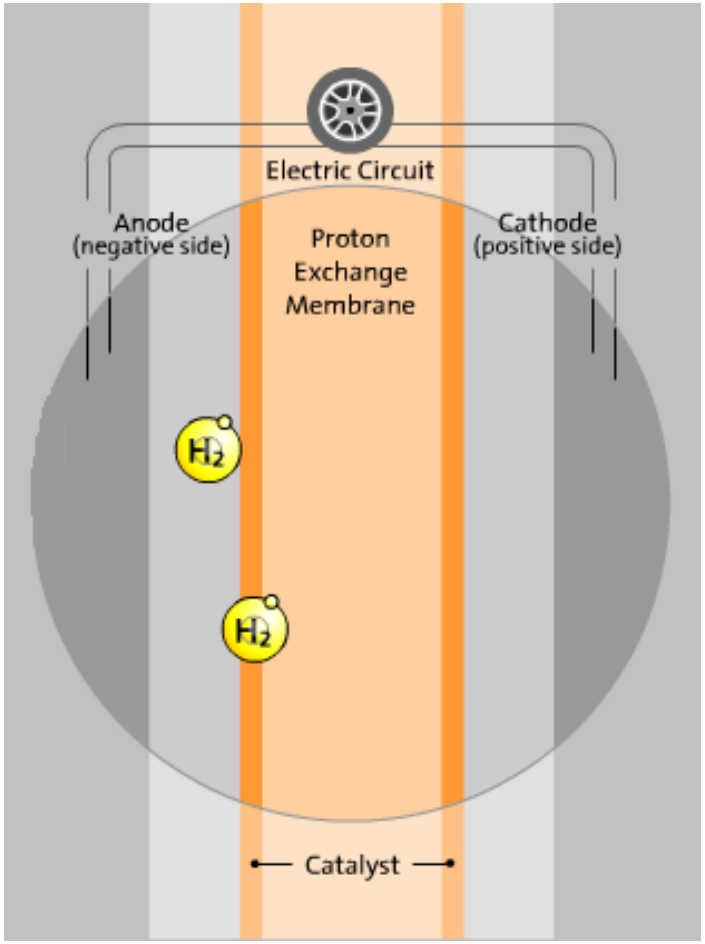
- On the anode:

1. Inside the fuel cell, pressurized hydrogen gas (H2) is pumped through the negatively charged anode. The gas is forced through the catalyst



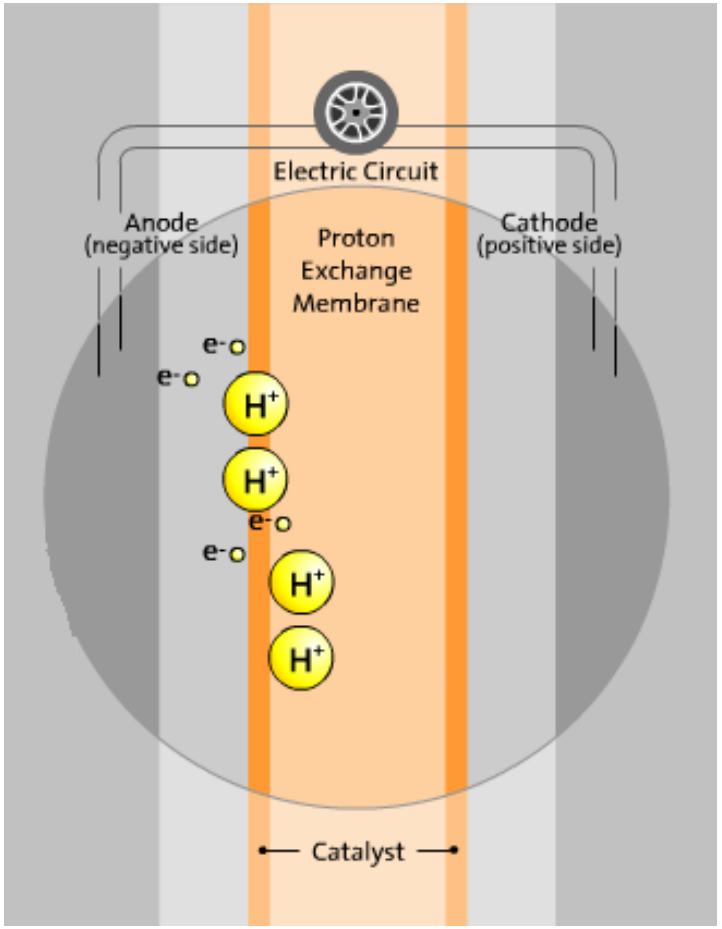
Application

2. When an H2 molecule touches the catalyst, it splits into two hydrogen (H+) ion and two electrons (e).



Application

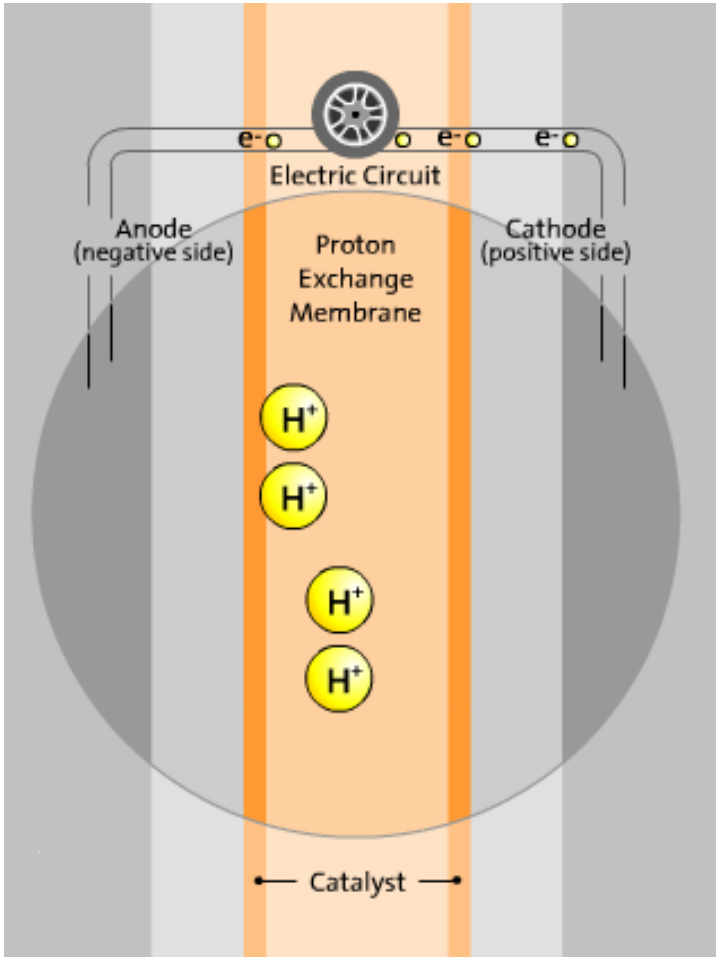
3. The electrons (e) are conducted through the anode. They bypass the membrane and go to through an external circuit (Where they help turn an electric motor in a vehicle), and return to the cathode side of the fuel cell.



Application

Chemistry:

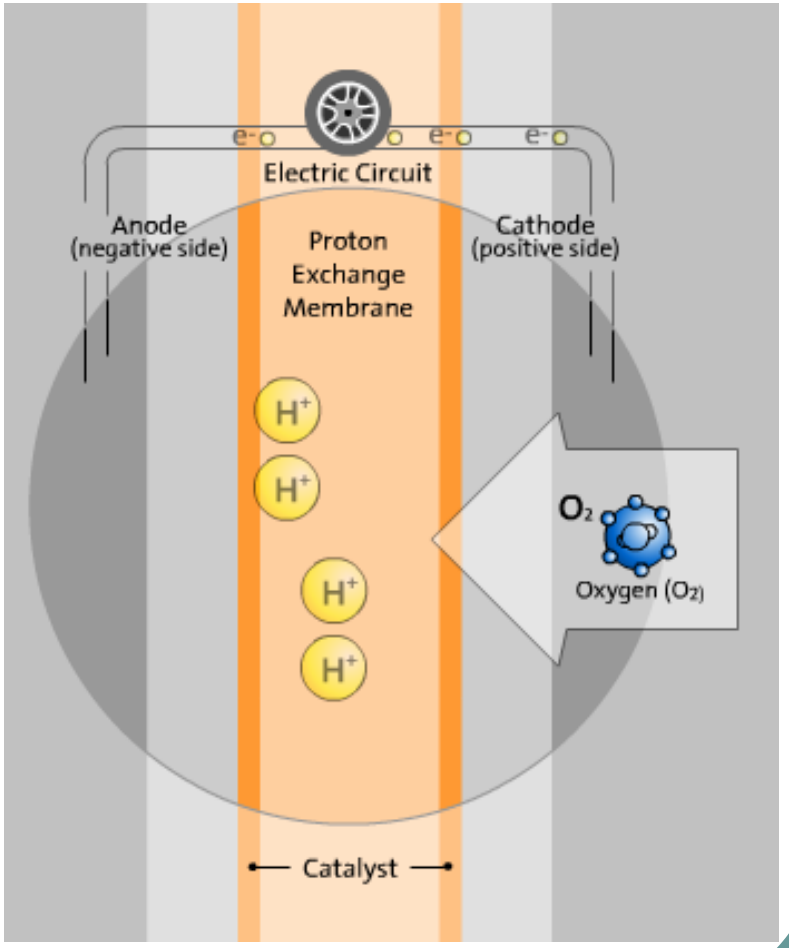
$$2H_2 = 4H^+ + 4e^-$$



Application

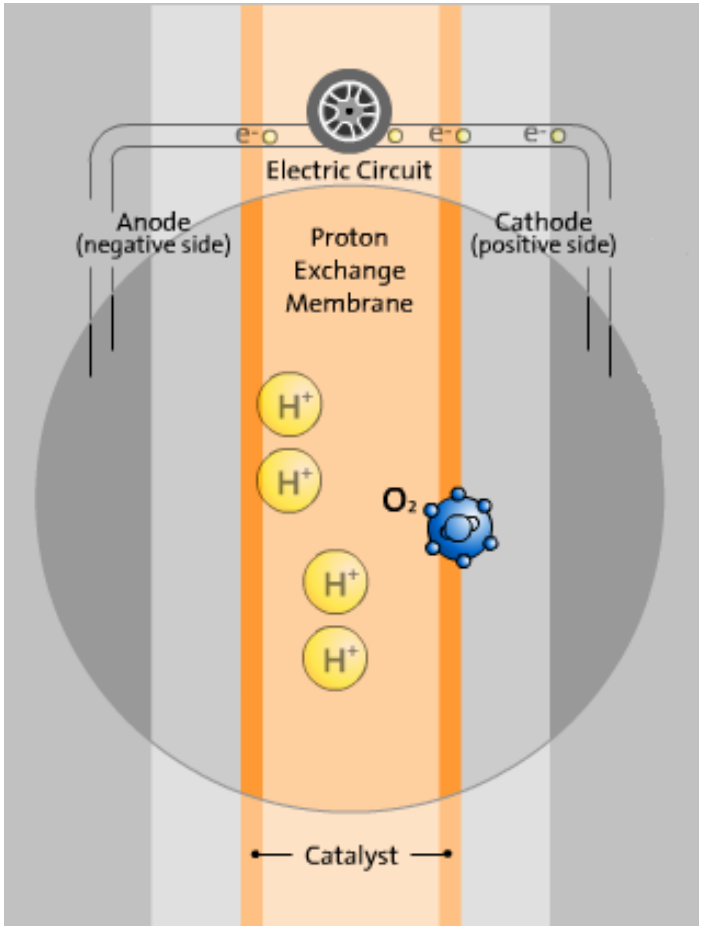
- On the cathode:

1.Oxygen (O2), from the air, enters the fuel cell on the cathode side. This gas is forced through the catalyst.



Application

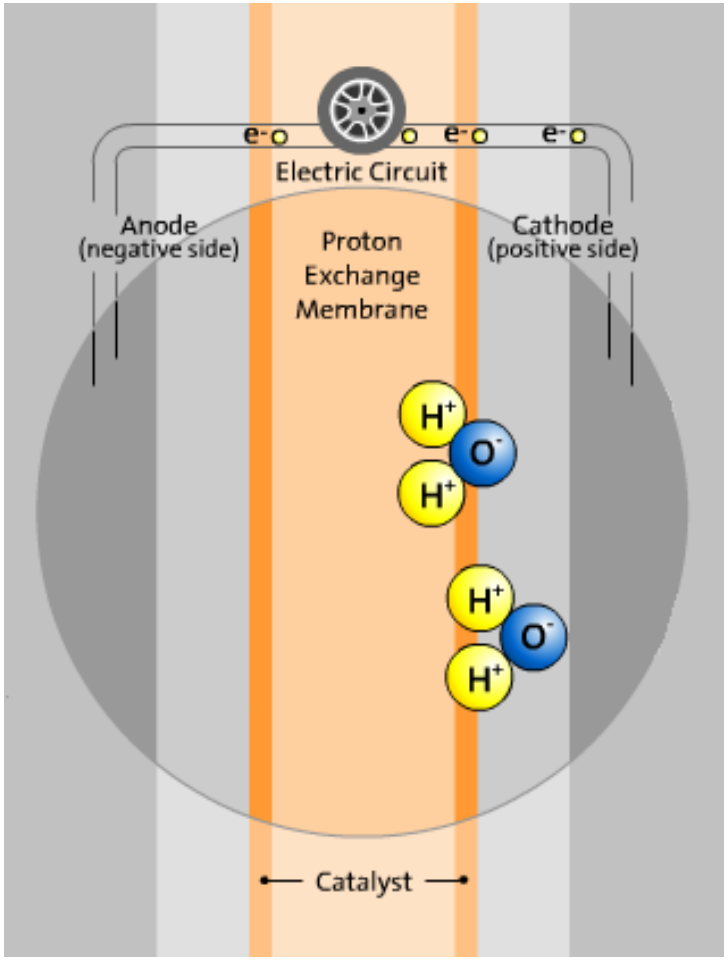
2. The catalyst splits the O2 into two oxygen atoms.



Application

3.Each oxygen atom attracts two H+ ions through the membrane.

4.Two H+ ions combine with an oxygen atom and two of the electrons from the external circuit to form a water molecule (H2O), which is emitted as exhaust.

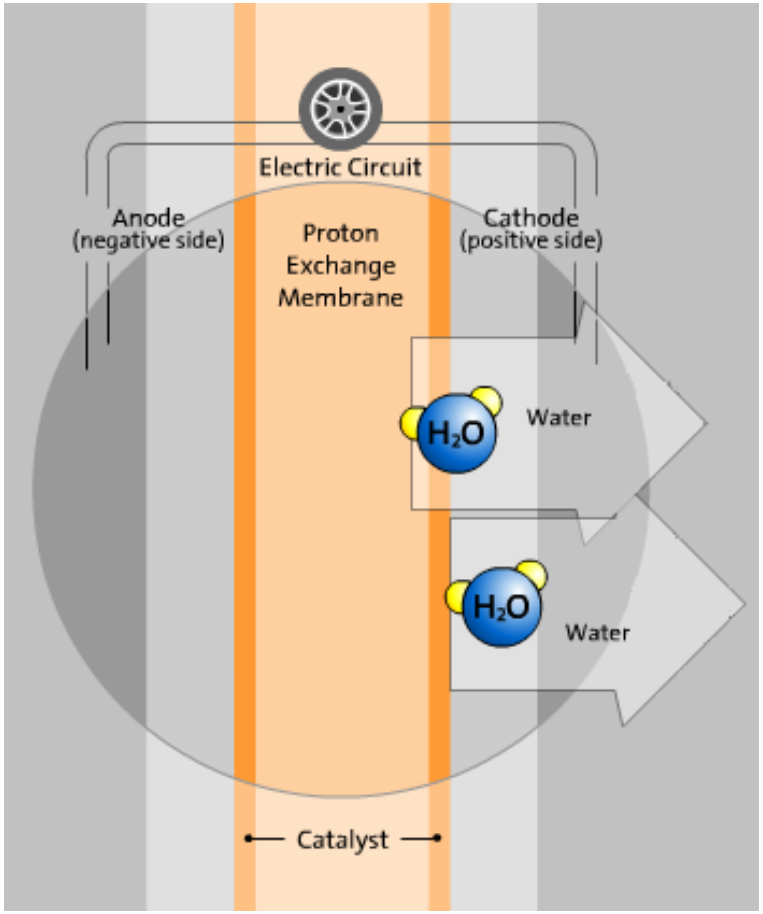


Application

Chemistry:

$$O_2 + 4H^+ + 4e^- = 2H_2O$$

The process repeats and generates electricity to move the electric motors and propel the vehicle.



Application

Some parameter of Fuel cells system of The HydroGen3:

- **Fuel Cell Propulsion System**
  - Fuel cell propulsion system packaged as a single unit (similar to today's production models)
  - 200 individual fuel cells wired in a series
  - Self humidifying stack
  - Continuous output: 94 kilowatts
  - Three-phase asynchronous electric motor

Application

- Maximum power output: 60 kilowatts/215 Newtonmeters
- Efficiency: 36 percent.
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- Efficiency: 36 percent.
- **Fuel Storage System**
- The HydroGen3 is equipped with either a liquid or a compressed hydrogen fuel storage system. GM is adopting a dual approach to conduct further development work and determine the most suitable hydrogen storage system for future commercial applications

Application

- **HydroGen3 compressed 700**
  - Two carbon composite tanks
  - Service pressure: 700 bar/10,000 psi
  - Capacity: 3.1 kilograms of compressed hydrogen
  - Driving range: 270 km (170 miles)
- **HydroGen3 liquid**
  - Vacuum insulated stainless steel tank
  - Capacity: 4.6 kilograms of liquefied hydrogen (temperature of minus-253 degrees C)
  - Driving range: 400 kilometers (250 miles)

Application

- Detailed specification:

Specs:	
Vehicle:	Opel Zafira minivan with hydrogen fuel cell propulsion system
Seating capacity:	5
Fuel storage system:	The liquid tank can store 4.6 kg of hydrogen (-423 degrees F/253 degrees C)
	The compressed tank (10,000-PSI) (700 bar) can store 3.1 kg of hydrogen
Range:	249 miles/400 km (liquid storage)
	168 miles/270 km (compressed)
Top speed:	99 mph/160 km