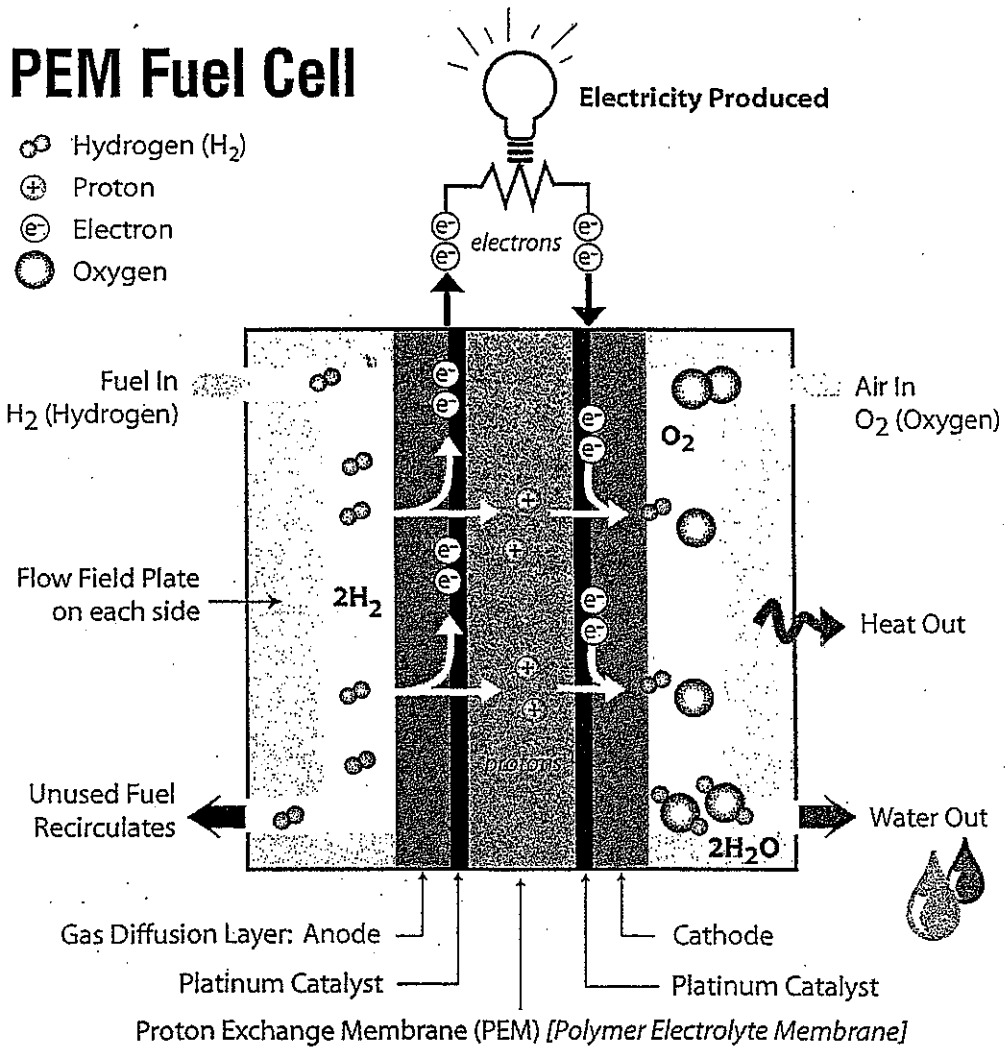


Source: *HYDROGEN - Hot Stuff Cool Science* book

Fuel Cells

Fuel cells are a kind of battery that is continuously fed fuel from an external source. Since they receive fuel from an outside source they do not run down like normal batteries. They are also about 40-90% efficient at converting chemical energy to electrical energy depending on the type of fuel cell and how it operates. Most fuel cells use hydrogen gas as their fuel. The hydrogen gas is reacted with oxygen to make water. The water is the only byproduct of this process and is clean enough to be used for drinking. The half-reactions and overall reaction are shown below.

Oxidation: $2\ H_2\ (g) \rightarrow 4\ H^+\ (aq) + 4\ e^-$

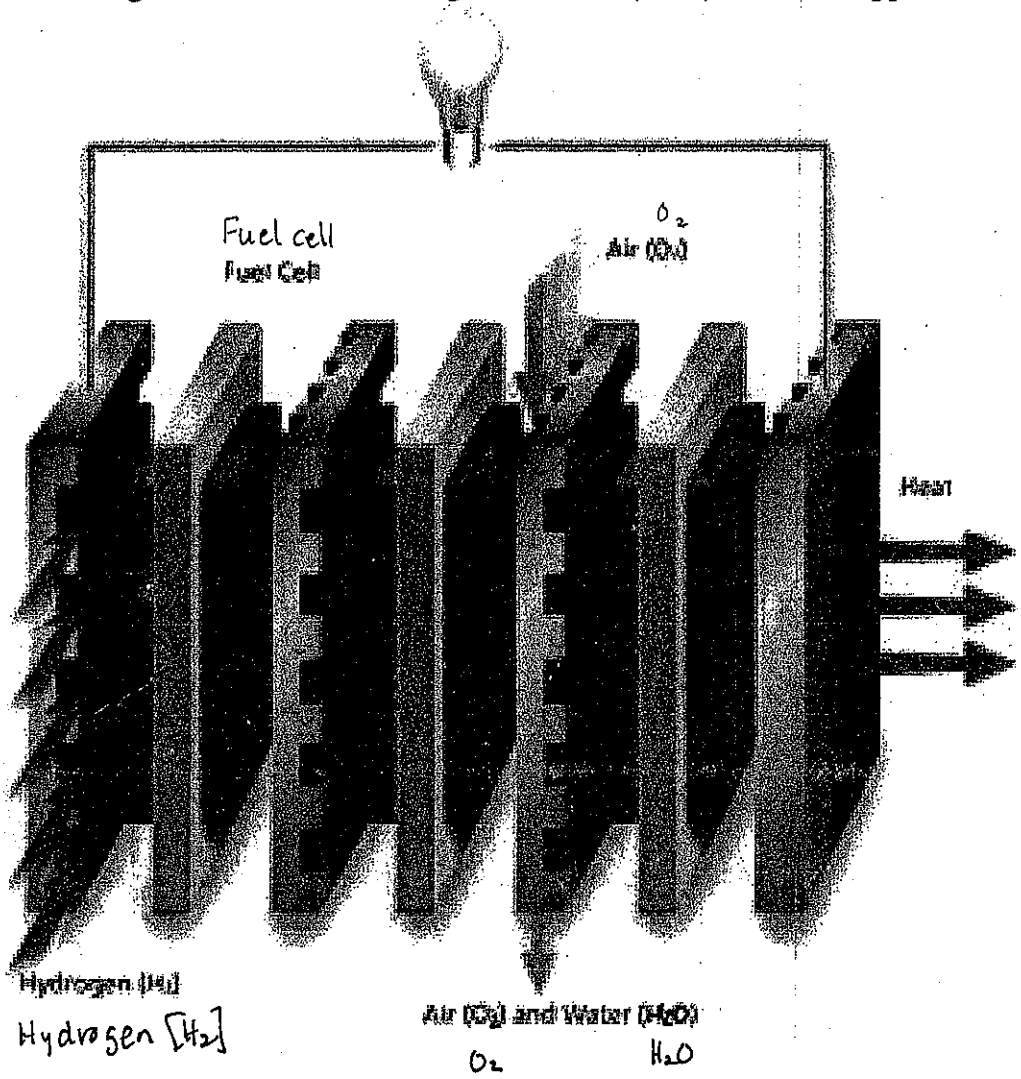
Reduction: $O_2\ (g) + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O\ (l)$

Overall: $2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (l)$

Spacecraft have used fuel cells for the past 30+ years to produce the electricity for their on-board computers. The astronauts drink the water produced by the fuel cells.

If you remember in *Apollo 13* the crew had to conserve electricity when two of their oxygen tanks were ruptured because they no longer had enough oxygen to make the electricity they needed to get back to Earth.

A diagram of a Proton Exchange Membrane (PEM) Fuel Cell appears below.



A typical fuel cell works in the reverse of an electrolysis cell. As you can see in the above diagram hydrogen gas (H_2) is injected in the lower left-hand corner of this diagram. When the hydrogen gas comes in contact with the anode it is oxidized to hydrogen ions (H^+) which are protons.

The lost electrons leave the anode through the wire at the top of the diagram to provide electricity for the load such as a computer or an electric motor.

The protons then penetrate the electrolyte. Electrolytes are solutions of ions and therefore they are good conductors of electricity. In a Polymer Electrolyte Membrane (PEM) fuel cell, the electrolyte is the Proton Exchange Membrane which acts as the "solution." When the protons reach the cathode they mix with oxygen atoms and electrons and make water molecules.

The water molecules are collected and expunged from the fuel cell.