

Hydrogen Fuel Cells

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The biggest problems with fossil fuels are that they release large quantities of carbon dioxide when they are burned. However, fuel sources like hydrogen produces no carbon dioxide. Hydrogen is a flammable gas, when burned with oxygen, produces harmless water vapour. Combining oxygen with hydrogen is a clean, efficient way to make huge amounts of both heat and electricity!

Instead of burning the hydrogen in the presence of oxygen, fuel cells allow the two gases to pass near each other on opposite sides of a thin membrane. The chemical interaction of oxygen and hydrogen across this membrane produces an electric charge, similar to that produced by a regular alkaline battery. But unlike the battery, which goes dead after the chemicals inside it are used up, the fuel cell continues to produce electricity as long as it receives fresh supplies of air and hydrogen. The only by-product of the process is water, which the fuel cell releases as steam.

A Toyota Hydrogen Fuel Cell Concept Vehicle



Source: Halstead 2019, retrieved from Unsplash
<https://unsplash.com/photos/yhXcqS-f-X4>



Did you know?



- The amount of solar and wind energy produced is weather dependent (Ex: more energy is produced on a windy day)
- Compared to hydrogen fuel cells, the same amount of energy is produced every time.

Technical Problems with Hydrogen Fuel Cells

Problem 1: Handling and Storage of Hydrogen

The biggest difficulty faced by engineers designing fuel cells is figuring out how to store and handle the hydrogen safely. Hydrogen is composed of extremely tiny molecules that can squeeze out of most materials normally used to contain gases. Hydrogen is highly explosive and flammable. For efficient storage, it must be compressed and cooled to minus 253°C to form a liquid. Liquid hydrogen must be stored in specialized containers and pumped through high-tech valves and tubes, all of which make hydrogen expensive and tricky to handle.



Hydrogen storage tank. Source: Bakshi., retrieved from Unsplash <https://unsplash.com/photos/a-group-of-blue-and-white-solar-panels-on-display-UvEGqjSlxME>

Problem 2: How Hydrogen Gas is Produced

Currently, hydrogen is made by ‘stripping’ methane or natural gas- a fossil fuel. This process produces carbon dioxide, one of the greenhouse gases associated with climate change. In the future, hydrogen gas may be manufactured in large quantities from ordinary water at solar-powered production facilities. The only by-product of this process would be oxygen, a gas with many practical uses and is already present in the atmosphere in large amounts.

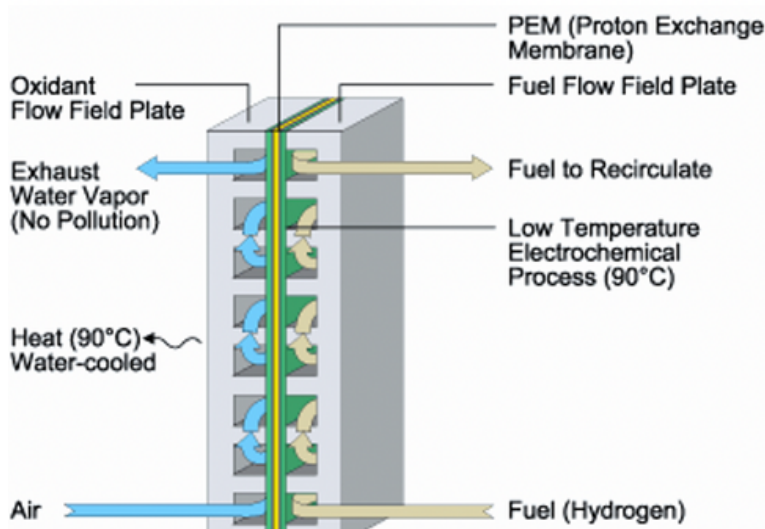


Figure 1. Cooling systems in a hydrogen fuel cell.

Source: Science Direct. Retrieved from

<https://www.sciencedirect.com/topics/physics-and-astronomy/coining>



Did you know?



Fuel cells require complex systems for cooling, and for containing hydrogen gas, which leaks freely from most ordinary containers.

Hydrogen Fuel Cells in Canada

Canada has played a very important role in testing and improving the hydrogen production, storage, distribution, and fuel cell technology for more than 40 years. As one of top 10 hydrogen producers in the world, Canada's breakthroughs in the hydrogen fuel cell technology include the first patent for electrolysis technology developed in 1915, and the first major breakthrough in proton exchange membrane fuel cell power density, developed in early 1900s, which proved that this technology is a viable alternative for transportation (Natural Resources Canada, 2020).

Uses of Hydrogen Fuel Cells in Canada

1. Hydrogen can be used as fuel for transportation and power production
2. Hydrogen can be used for heating in various industrial applications and/or burned directly in commercial buildings
3. Hydrogen can be used as feedstock for various products and chemicals



(Natural Resources Canada, 2020).

Canada's Plan for Hydrogen in Future



Source: (Natural Resources Canada, 2020).

For additional information on the future of hydrogen in Canada, visit the link below:

https://www.nrcan.gc.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen%20Strategy%20for%20Canada%20Dec%202015%202200%20clean_low_accessible.pdf

Additional Resources

1. Canadian Hydrogen Association:
 - a. <https://canadah2.ca>
2. Canada's leadership advantage in hydrogen and fuel cell technology:
 - a. https://octia.ca/wp-content/uploads/2021/03/CLA-Hydrogen-Fuel-Cells_en.pdf
3. Hydrogen and fuel cell buses, trains, and heavy-duty vehicles:
 - a. https://octia.ca/wp-content/uploads/2021/03/CGL-Vehicles_en.pdf
4. Hydrogen and fuel cell comic:
 - a. <https://canadah2.ca/wp-content/uploads/2024/04/CHA-official-comic-book.pdf>

Questions

1. Currently, the hydrogen used in fuel cells comes from natural gas. What are the environmental problems connected with using natural gas as a source of hydrogen? What is an environmentally friendly alternative?
2. What are some applications of hydrogen technology?
3. How does hydrogen fuel cell technology compare with zero-emissions electric vehicles? Are they better for the environment? Why or why not? What are some factors that determine this comparison? (Hint: think about the source of electricity powering the electric vehicles)

References

1. Natural Resources Canada. (2020). Hydrogen Strategy for Canada. Retrieved from Natural Resources Canada:
https://www.nrcan.gc.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen%20Strategy%20for%20Canada%20Dec%2015%202200%20clean_low_accessible.pdf