

PEM Electrolyzer Types

Mars Workshop and ISRU tag-up

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Overview

Basic Electrolyzer Types and System Components

- Anode liquid feed
- Cathode liquid feed
- Cathode vapor feed

Applications

Challenges

Anode Liquid Feed

Cell characteristics:

Liquid water fed to oxygen side (anode)

Product O_2 and H_2 contain liquid water

Proton drag carries substantial water to H_2 side

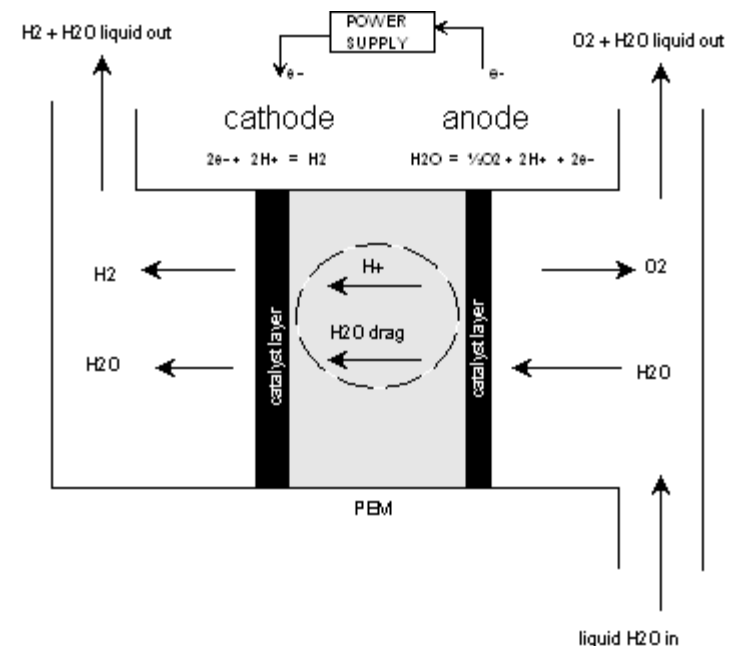
- ~2 moles H_2O per mole of H_2 (or more)

Protonic water is saturated with H_2

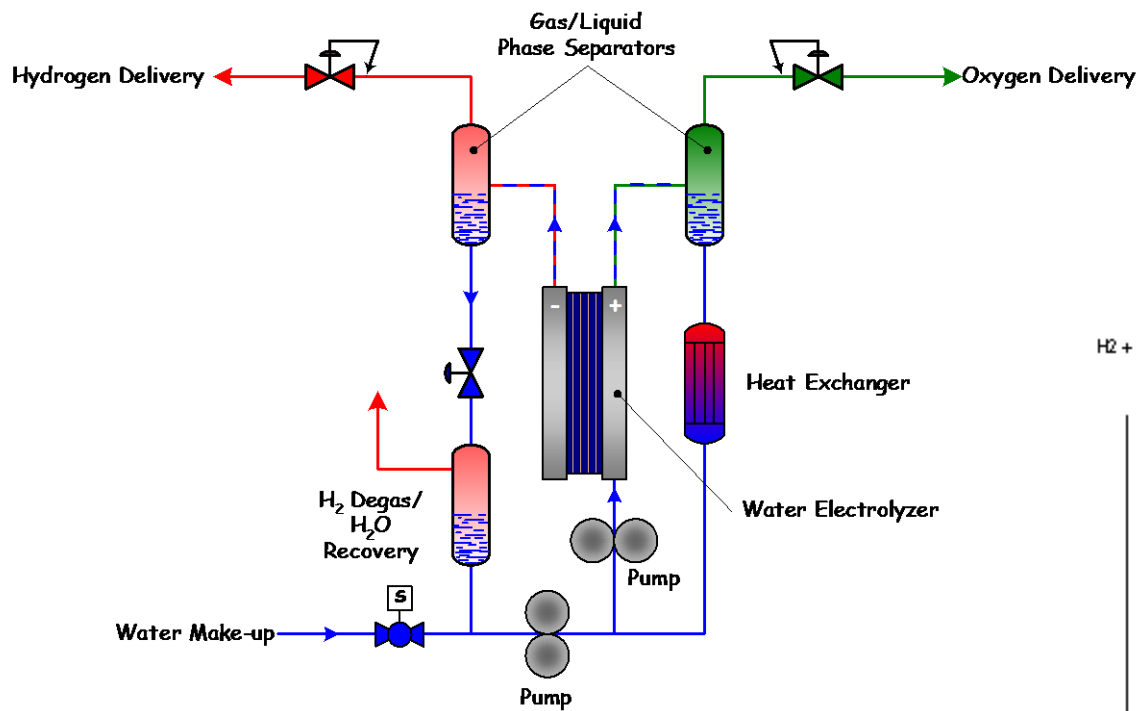
System characteristics:

Greatest rate capability

Most complicated system

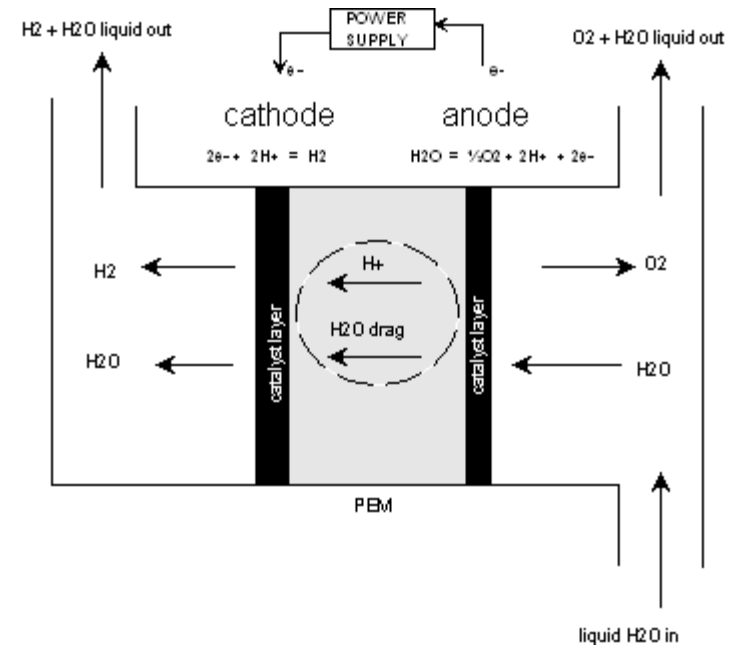


Anode Liquid Feed



Most complicated system

- 2 Pumps
- 2 phase separators
- H₂ degas / H₂O recovery



Cathode Liquid Feed

Cell characteristics:

Liquid water fed to hydrogen side (cathode)

Water diffuses to O₂ side through PEM

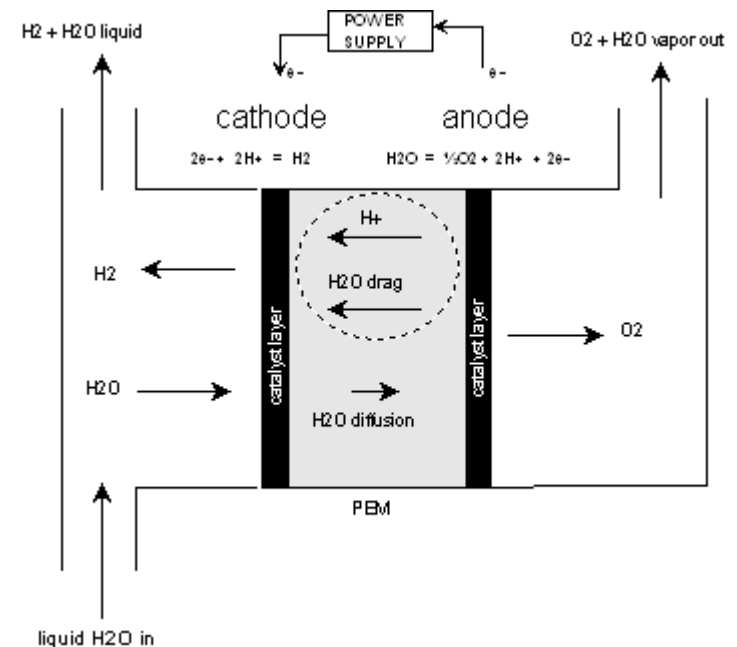
- H⁺ drag limits rate capability
- Keeps O₂ free of liquid water

H₂ contains liquid water

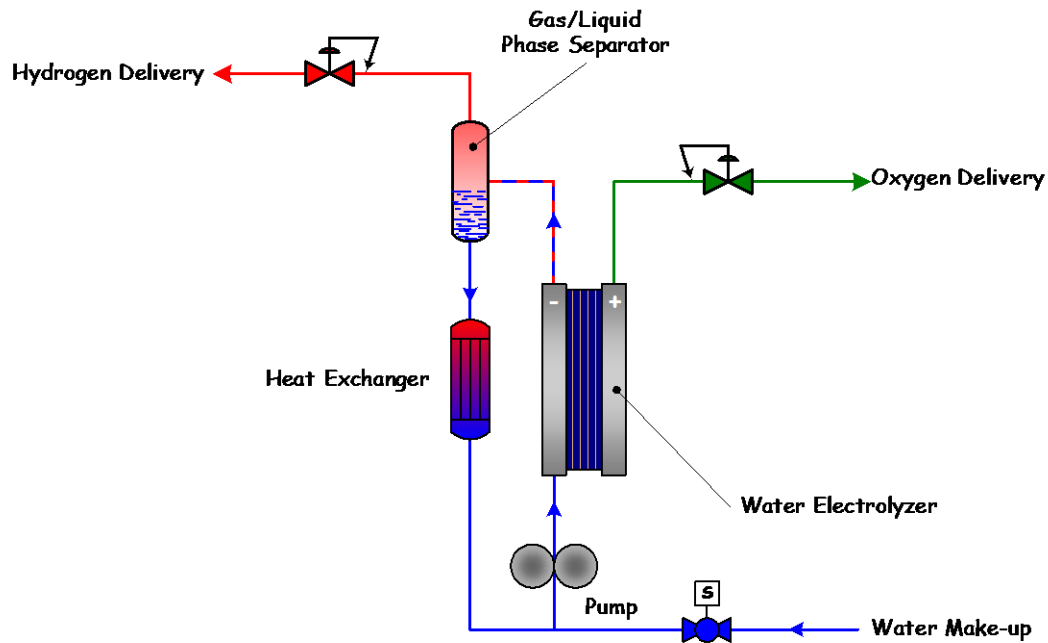
System characteristics:

Moderate rate capability

Less complicated system

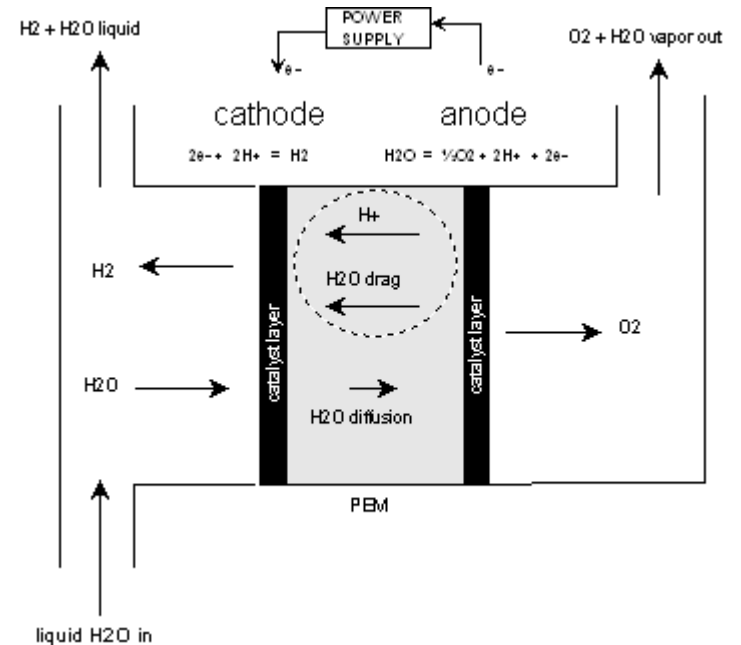


Cathode Liquid Feed



Less complicated system

- 1 Pump
- 1 phase separator



Cathode Vapor Feed

Cell characteristics:

Liquid water fed to water chamber (cathode side)

Water diffuses to O₂ side through H₂ cavity and PEM

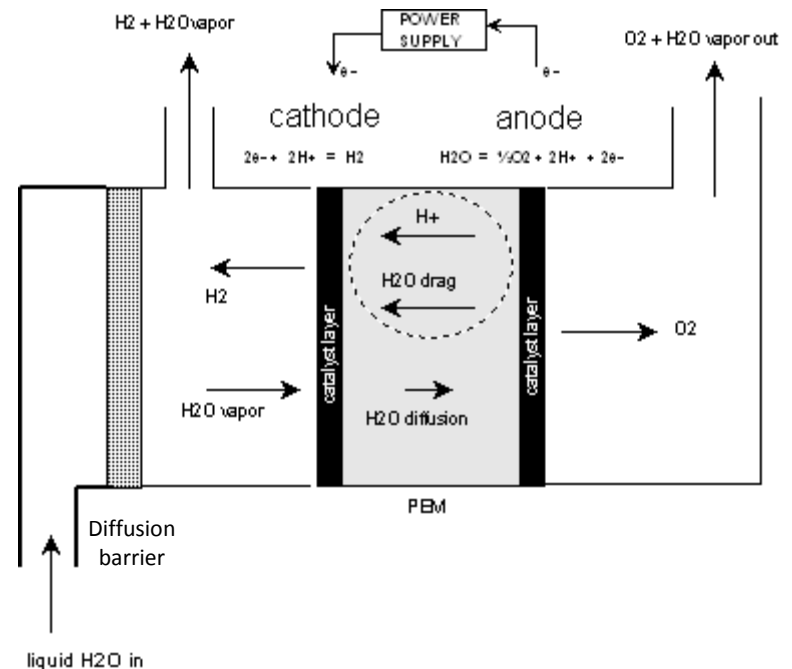
- H⁺ drag limits rate capability
- Keeps O₂ free of liquid water

H₂ contains no liquid water

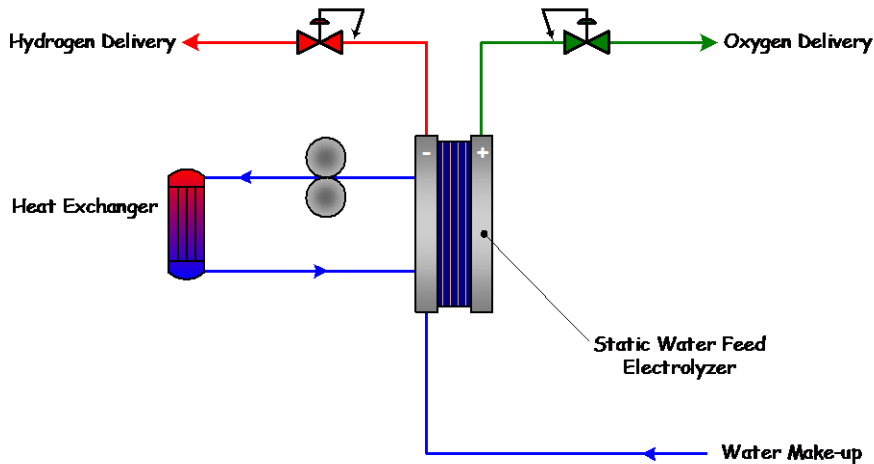
System characteristics:

Lowest rate capability

Simplest system

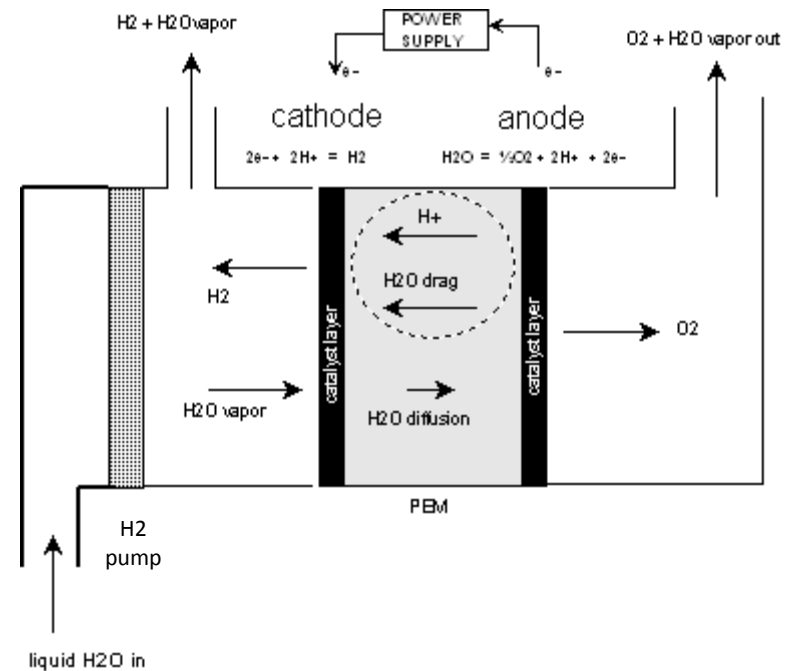


Cathode Vapor Feed



Simplest system

- 1 Pump (for cooling)
- no phase separators



Electrolysis Applications

Hydrogen Generation for Electric Vehicles

Oxygen Generation for Life Support

- Navy Submarines
- International Space Station

Regenerative Fuel Cells

- High-Altitude Long-Endurance (HALE)
Unmanned Aerial Vehicles
- Surface Power Systems

ISRU

System-Level Challenges

Accumulation of impurities feed water

MEA degradation

Corrosion/shunt currents

Drying of product gases

Degassing (in anode feed systems)

Gas/liquid separation

Gas crossover/purity

Complexity