Fuel cell Fundamentals & Technology
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Influence of various operational parameters on cell performance

Contents

- Operational parameters of fuel cell
  - Pressure.
  - Temperature.
  - Gases flow rates.
  - Gases Relative Humidity.

Operation of Fuel Cell

Performance of fuel cells is affected by operating variables (e.g., temperature, pressure, gas composition, reactant utilization, current density), cell design and other factors (impurities, cell life) that influence the ideal cell potential and the magnitude of the voltage losses.

The following slides provide information about the effects of some operating parameters. Parameters considered are:

- Pressure.
- Temperature.
- Gases flow rates.
- Gases Relative Humidity.

Pressure

Increasing operating pressure has advantages:

- Reduced voltage losses.
- Reduced electrolyte loss by evaporation.
- Increased system efficiency.

But there are tradeoffs:

- Increase system cost.
- Increased hardware and material problems.

Temperature

Temperature impacts mainly on:

- **Electrode reaction rates**. These increase with temperature.
- **Ohmic losses**. The impact of temperature on cell resistance is different for different materials, however for high-temperature fuel cells the net effect of an increase in temperature is a significant reduction in resistance, while for low-temperature fuel cells the impact over the operating range is limited.

Gases flow rates

- The reactant's flow rate at the inlet of a fuel cell must be equal to or higher than the rate at which those reactants are being consumed in the cell. The rate (mol/s) at which hydrogen and oxygen are consumed is determined by **Faraday's law**:
- **dNH2/dt = I/(2F); dNO2/dt = I/(4F)**
- where dN/dt = **consumption rate (mol/s)**;
- I=**current (A)**;
- F= **farady's constant (C/mol).**

Gases flow rates

- The reactants may and in some cases must be supplied in excess of consumption. The ratio between the actual flow rate of a reactant at the cell inlet and the consumption rate of that reactant is called the **stoichiometric ratio: S = (dNact/dt)/(dNcons/dt)**
- **Higher flow rates result in better fuel cell performance.**
- **Higher flow rate helps remove product water from the cell.**
- **Higher flow rates keep oxygen concentration high.**

Gases Relative Humidity

- Because the membrane requires water to maintain protonic conductivity, both reactant gases typically must be humidified before entering the cell.
- Humidity ratio is a ratio between the amount of water vapor present in a gas stream and the amount of dry gas.
- Relative humidity is a ratio between the water vapor partial pressure, pv, and saturation pressure, pvs, which is the maximum amount of water vapor that can be present in gas for given conditions:
- j =pv/pvs.

Thank Yöu