A Simulink Library for PEM Fuel Cell System

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The purpose of this research is to provide the industrial partners with control-oriented models of electrochemical powertrains. The focus of this work is on implementing a fuel cell model (found in the litterature) as a streamlined, reusable simulink library.

System Overview

The fuel cell system is designed to efficiently supply the reaction:

$$\mathrm{H_2} + \frac{1}{2}\mathrm{O_2} \rightleftharpoons \mathrm{H_2O},$$

On the anode side:

1. Hydrogen is stored in a tank at high pressure.
2. A valve controls the pressure in the supply manifold to reasonable levels.
3. A humidifier supplies the dry hydrogen with water vapor.
4. Hydrogen/water mixture diffuses into the GDL and reacts/adsorbs on the membrane.
5. The purge valve is normally closed but can open to remove excess water.

On the cathode side:

1. Dry air enters at atmospheric pressure.
2. The air is humidified.
3. Oxygen and water vapor diffuses through the GDL and reacts/adsorbs on the membrane.

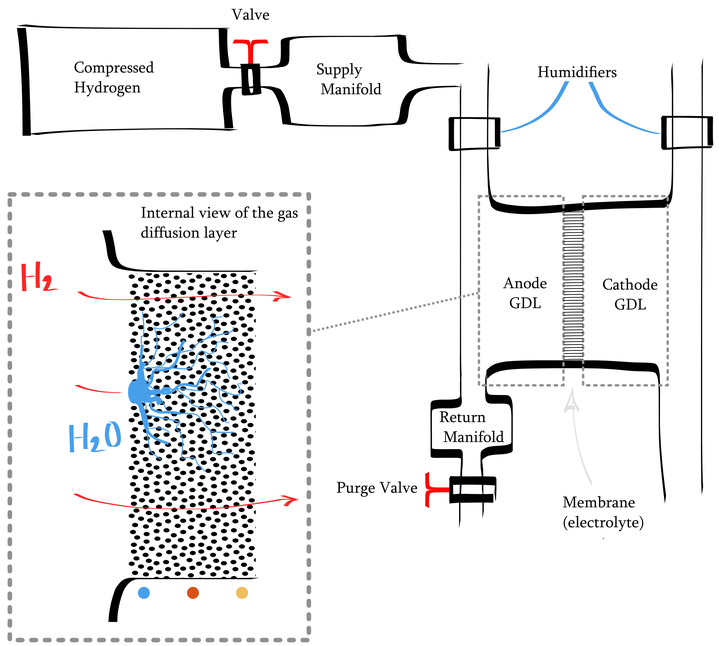

Figure 1: An overview of the fuel cell system components.

Water Management & Voltage Response

The following procedure results in the zig-zag phenomenon shown in Fig. 2.

1. The purge valve is closed.
2. Water vapor and liquid (Fig. 3) is transported to the anode.
3. Liquid droples form at the GDL surface.
4. The voltage output drops as water accumulates.
5. The voltage quickly returns as the water is discharged through the purge valve.

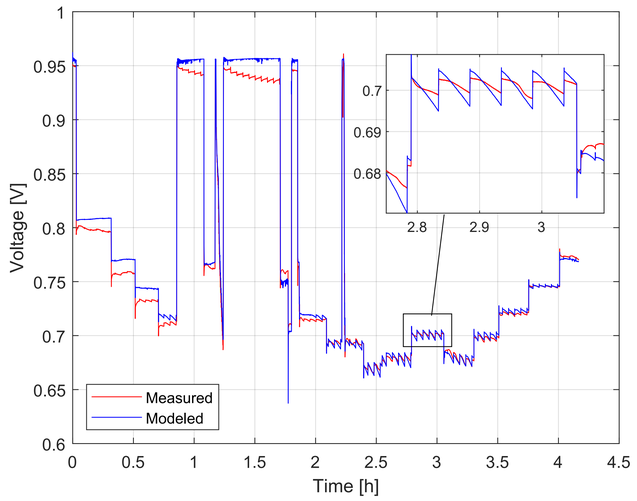

Figure 2: Modeled versus measured voltage data.

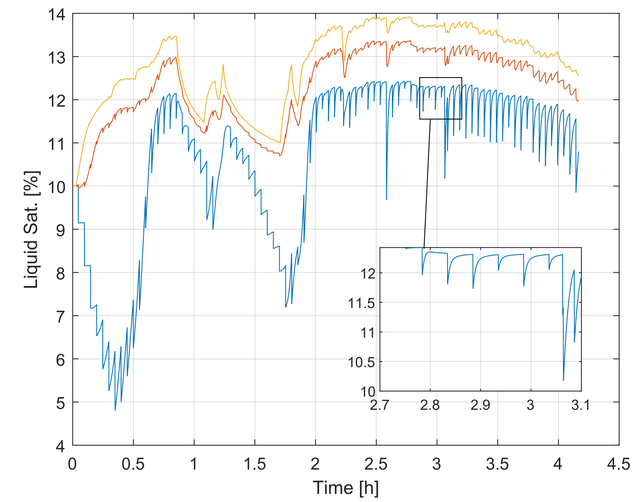

Figure 3: Pore volume saturation of liquid water at various depths (marked by color in Fig. 1).

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