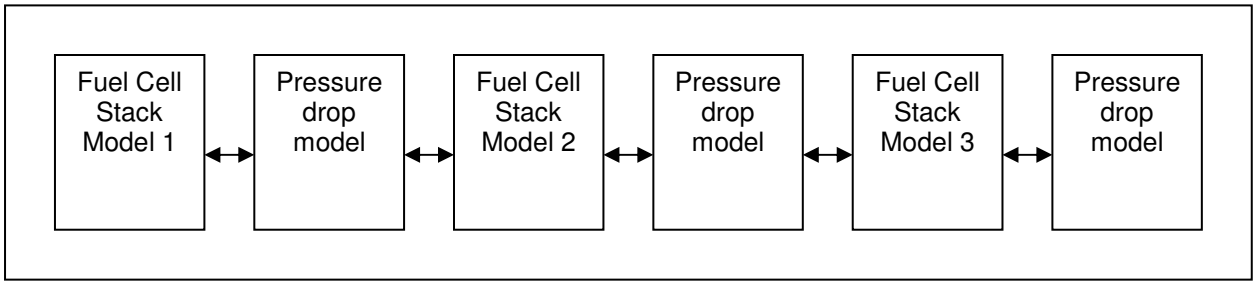
Frequently Asked Questions

1. Can the model predict the various physical and chemical properties at a particular location in the stack?

   No. The mskFcStack model is a lumped parameter model and does not consider the spatial dependence.

   But spatial dependence can be captured by dividing the fuel cell stack into "n" number of smaller stacks, which are connected in series. The overall fuel cell stack model consists of "n" number of mskFcStack models connected in series as shown. This configuration can capture only the axial dependence of the properties.



2. Can the model be used to simulate the performance of fuel cells with different membranes (Nafion, Dow etc.,)?

   No. Currently the mskFcStack model can simulate only the performance of the fuel cells using Nafion membranes.

   But if you are working with a membrane other than Nafion, Emmeskay can work with you to provide a customized mskFcStack model. To customize the mskFcStack model for a membrane other than Nafion, the following data is required.

   a. Membrane physical & chemical properties (Membrane dimensions including thickness, Equivalent weight, dry density, dependence of the membrane resistance on the water content and temperature etc.,)
   b. Diffusion coefficient to determine the back diffusion through the membrane.
   c. Drag coefficient to determine the electroosmotic drag.

   Note the above list is not very exhuastive.

3. Can the model be used to simulate reformer based fuel cell stack systems?

   Yes. The mskFCstack model is a component model and simulates the performance of the fuel cell alone. So one needs to create a component model of the reformer and then build a system level model containing the reformer & mskfFcStack models.

   MskFcStack has provision to include five species (N_2, O_2, CO_2, CH_4, H_2O) in the anode inlet stream . So the reformer output stream can have these five species and to include more species mskFcStack model requires to be customized.

4. How is humidification of the inlet flows handled? Are there any assumptions in the modeling of the humidification?

   MskFcStack model assumes that humidification (if required) is done outside the stack. So the mskFcStack model does not model the humidifcation phenomena. To simulate a fuel cell

stack sytem consiting of humidifed inlet flows, one has to create a system model consisting of mskFcStack model and a humidifier model.

5. How can one simulate the fuel cell stack performance at a very low temperature ambient conditions.

   In general the PEM fuel cell operating temperature is around $70^{O}C$ and hence in the low temperature ambients one has to warm up the system to the operating temperature before drawing current from the fuel cell stack. The warm up of the fuel cell can be achieved in different ways such as using electrical heaters to heat the system.

   The mskFcStack model has a cooler model to remove the heat generated in the stack during operation. For warm ups this cooler model can be used to simulate the behavior of an electric heater.

6. Does mskFcStack model include any power conditioner model to smooth the output of the fuel cell stack to a steady bus voltage?

   No. The mskFcStack model does not include power conditioner model and the stack output voltage varies depending on the current request, flow rates of the input streams, temperature of the stack and etc.

7. How does the CO (carbon monoxide) poisioning of the electrodes handled?

   Presence of CO in the inlet streams adversely affects the performance of the PEM fuel cell. Carbon monoxide occupies the catalyst sites in the electrode due to its affinity to platinum which is the widely used catalyst in the PEM fuel cells. Because of this, hydrogen will not reach the catalyst sites and exits the fuel cell as unreacted thus reducing the performance of the fuel cell.

   The current version of the mskFcStack model does not take into account the CO poisioning of the electrodes. Also, the current version of the mskFcStack model assumes that the anode inlet stream is free of carbon monoxide.

8. How does the model handle the water generated in the cathode?

   The mskFcStack model takes into account the water generated in the cathode due to the electrochemical reactions. It is assumed that the water generated in the cathode is in liquid form. Also depending on the relative humidity part or full amount of water present in the cathode evaporates or condenses.

9. Can we simulate the model using a fixed step solver?

   Yes. The regular model (which comes on the CD) works only with variable time step solvers in Simulink©. In order to obtain the model which works with fixed step solvers in Simulink© one need to contact Emmeskay.

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