Control-Oriented Model Improvements for Hydrogen Fuel Cells

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Motivation

• Proton-Exchange-Membrane (PEM) fuel cells are becoming more common
  o Toyota, Hyundai, and Honda all have plans for fuel cell vehicles

• Control of the fuel cell is challenging
  o High sensitivity to humidity and temperature changes
  o Need comprehensive control-oriented models
Current Modeling Techniques

- There are 2 major areas of research in fuel cell modeling
  - Computational Fluid Dynamics models
  - Lumped value models
- Lumped models lose key information
  - Inlet effects
  - Outlet flooding
  - Often these areas are limiting to performance
Hybrid Modeling Approach

- Relative Humidity can change significantly along the stack
  - Can have dehydration at the inlet, and flooding at the exit
  - A single control volume (CV) is not a good representation
- Use a series of control volumes
Effect of Using Multiple CVs

<table>
<thead>
<tr>
<th># CVs</th>
<th>CPU Time (s)</th>
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<tbody>
<tr>
<td>1</td>
<td>2.12</td>
</tr>
<tr>
<td>3</td>
<td>2.78</td>
</tr>
<tr>
<td>6</td>
<td>5.68</td>
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Questions?