OBJECTIVE & MOTIVATION

- The objective of this work is to model, dimension, and optimize a SOFC system for cogeneration efficiency.
- The system comprises of SOFC (solid oxide fuel cell) technology.
- The aim is to maximize electrical and cogeneration efficiency.
- The system comprises of a SOFC (co-flow) with an innovative method of recirculation.
- The basic SOFC electrochemical reactions are:
  - Cathode: $\frac{1}{2}O_2 + 2e^- \leftrightarrow O^{2-}$
  - Anode: $H_2 + O^{2-} \leftrightarrow H_2O + 2e^-$
- The final fuel cell voltage $V$ is given by the following equation:
  $$V = E_{rev} - R\eta_{act} - \eta_{diff}$$
- The maximum energy that can be obtained from a fuel cell at a given temperature and pressure is given by the Gibb’s free energy and is expressed as:
  $$\Delta G = -nFE_{rev}$$
- The results show the effect of one particular decision variable on the system performance while all the others are kept constant.

RESULTS

- Configuration 1 best in terms of cogeneration efficiency and number of heat exchangers.
- Present work based on co-flow fuel cells, entire work can be re-done for counter flow fuel cell.
- Some design factors like burner exhaust temperature to be analyzed for improving performance.

SENSITIVITY ANALYSIS: The results show the effect of one particular decision variable on the system performance while all the others are kept constant.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>External reforming fraction</td>
<td>[0.2 0.5]</td>
</tr>
<tr>
<td>(CO+H2) fraction in anode exhaust</td>
<td>[0.1 0.2]</td>
</tr>
<tr>
<td>Oxygen to carbon ratio (reformer)</td>
<td>[2.3]</td>
</tr>
<tr>
<td>Oxygen to carbon ratio (burner)</td>
<td>[2.68 4.45]</td>
</tr>
</tbody>
</table>

CONCLUSION & OUTLOOK

- Configuration 2 best in terms of cogeneration efficiency and number of heat exchangers.
- Present work based on co-flow fuel cells, entire work can be re-done for counter flow fuel cell.
- Some design factors like burner exhaust temperature to be analyzed for improving heat exchange network.

Table 1: Range of different decision variables used for carrying out the sensitivity analysis.

<table>
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<td>Oxygen to carbon ratio (burner)</td>
<td>[2.68 4.45]</td>
</tr>
</tbody>
</table>

Table 2: Comparison of performance indicators for both the configurations 1 & 2.

<table>
<thead>
<tr>
<th>CASE</th>
<th>Electrical efficiency (%)</th>
<th>Cogeneration efficiency (%)</th>
<th>No. of heat exchangers</th>
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</thead>
<tbody>
<tr>
<td>CONFIG. 1</td>
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</tr>
<tr>
<td>Optimized Model</td>
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<tr>
<td>Optimized model including losses</td>
<td>65</td>
<td>69</td>
<td>7</td>
</tr>
<tr>
<td>CONFIG. 2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Optimized Model</td>
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<td>-</td>
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<tr>
<td>Optimized model including losses</td>
<td>64</td>
<td>87</td>
<td>6</td>
</tr>
</tbody>
</table>

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