Efficient CFD-Modeling of Regenerative Heat Transfer in a Rotary Kiln

Aim
Model the Regenerative Heat Transfer in a CFD (Computational Fluid Dynamics) model of a simplified rotary kiln.

Rotary Kilns are commonly used for lime reburning – a recycling process in kraft pulp mills. The kiln is a slowly rotating 60-90 m long cylinder where lime mud is heated by a flame.

Regenerative Heat Transfer refers to the transport of heat from the rotating refractory to the lime mud.

Modeling of the Rotation
1. Transient – with a moving refractory region. Requires time resolved solution methods with small time steps and therefore takes a long time.
2. Stationary – with modified heat conduction. All regions are stationary and the rotation is modeled by imposing a motion on the heat conduction of the refractory.

Conclusions
• Stationary solvers can be used to accurately model the regenerative heat transfer in a computationally feasible way.
• A fine mesh is crucial in the refractory region when using stationary solvers.

Results
Less than 2% temperature difference at the investigated points. 94% less computational time for the stationary model.

Mesh
The stationary model required more cells in the refractory due to the added complexity of the convective heat velocity.

<table>
<thead>
<tr>
<th>Model</th>
<th>No. Cells</th>
<th>Solver Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient</td>
<td>82 000</td>
<td>65 hrs</td>
</tr>
<tr>
<td>Stationary</td>
<td>162 000</td>
<td>4 hrs</td>
</tr>
</tbody>
</table>

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