INTRODUCTION

- Thermal cracking of hydrocarbons is one of the most important processes for manufacturing many base chemicals.
- A major influence on the energy efficiency and economics is the formation of coke on the walls of the reactors.
- Alumina-forming alloys (AFA) form a protective alumina-based oxide layer capable of protecting the base alloy in aggressive oxidizing environments.
- An AFA alloy was evaluated in coking/de-coking cycles to compare early-stage performance.
- Results were compared to a baseline Chromia-forming alloy (HP).

EXPERIMENTAL PROCEDURE

Table 1. Alloy composition in wt%.

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Al</th>
<th>Cr</th>
<th>Fe</th>
<th>Ni</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP</td>
<td>0</td>
<td>26</td>
<td>35</td>
<td>34</td>
<td>+additions</td>
</tr>
<tr>
<td>AFA</td>
<td>3.8</td>
<td>23</td>
<td>33</td>
<td>37</td>
<td>+additions</td>
</tr>
</tbody>
</table>

Fig 1. Samples after being exposed to each atmosphere are shown for each alloy.

Fig 2. Schematic representation of the cyclic performance for each alloy.

Fig 3. Optical microscopy images after coking cycle 10 for a) HP alloy and b) AFA alloy.

Fig 4. SEM cross sections after coking cycle 10 for a) HP alloy and b) AFA alloy.

Fig 5. SEM cross sections after decoking cycle 10 a) HP alloy and b) AFA alloy.

RESULTS

- Number of coking-decoking cycles
- Pronounced coking
- Thermal cracking reactions
- Carbide network
- Local carburization
- Coke layer
- Chromia layer
- Spinel layer
- Voids
- Nb-rich carbides
- Chromium-rich carbides
- Coke layer
- Spinel layer
- Carbides
- Alumina layer
- Chromium-rich carbides

Fig 6. Change of mass per area for each coking-decoking cycle. Filled markers denote coking and open markers denote decoking step. Reported values correspond to an average of three samples per material and are relative to the initial mass of the alloy after preoxidation.

CONCLUSIONS

- The HP alloy gained 85% more mass than the AFA alloy.
- Optical microscopy showed that carburization in the AFA alloy (~250 µm from surface) was not as severe as in the HP alloy (~800 µm from surface).
- SEM cross-section analysis showed a coke layer at the surface in both alloys with the layer being thicker for the HP alloy.
- With less mass gained during coking, no major microstructural changes, and a better integrity of the oxide scale after exposure to 10 coking-decoking cycles, the AFA alloy performed better than the HP alloy.

ACKNOWLEDGMENTS

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