Debottlenecking HCGO Filtration

Niels van der Horst, Düsseldorf, Germany, October 2011
Agenda

• Company Profile
• HCGO Filtration
  - the problem
  - design principles
  - operations
• Testing facilities
• Reference project
• Questions
• Head offices in Maassluis, The Netherlands
  - Management
  - Sales
  - Engineering
  - Production
Dahlman world wide II

• Riffa (Bahrain)
  - Sales ME, Gulf Area
  - Consultancy

• Elsloo (The Netherlands)
  - Spare Parts & Consumables
  - Total Supply Frame Agreements
  - Maintenance
  - After Sales Services
Dahlman world wide III

- The Netherlands (Head Office)
- Elsloo (Warehouse)
- United States
- Hungary
- Spain
- Italy
- Kuwait
- Czech Republic
- Turkey
- China
- South Korea
- Bahrain (Office)
- Qatar
- Malaysia
- UAE
- Oman
The problem with filtration

- Penetration of contaminants in filter medium
  -> Short cycle times

- Element cleaning not powerful and effective
  -> Backwashing with filtered product shows bad results

Result:
- High backwash frequency  -> excessive product loss
- Ex situ cleaning required  -> downtime causing production losses
HCGO Filtration Design Principles

• Minimize penetration of contaminants in filter medium
  - > Surface filtration

• Optimal use of filter area at high solids content
  - > Filtration from inside-to-outside

• Element cleaning needs to be powerful and effective
  - > Gas-assisted backwash (steam, nitrogen or (sweet) fuel gas)

• Effective way of sludge disposal
  - > Sludge removal gas-driven or by pump(s)
Minimize penetration of contaminants in filter medium

**Not depth filtration ...**

<table>
<thead>
<tr>
<th>Filtration Cycle</th>
<th>Cleaning Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
</tbody>
</table>

A very fine particle penetrates in the media

The particle gets stuck in the media
Minimize penetration of contaminants in filter medium

But surface filtration!

<table>
<thead>
<tr>
<th>Filtration Cycle</th>
<th>Cleaning Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Filtration Cycle Diagram" /></td>
<td><img src="image2" alt="Cleaning Cycle Diagram" /></td>
</tr>
</tbody>
</table>
Filter media used for pilot testing

DAHLMAN CLASSIC SINTERED POWDER, WIRE MESH & DAHLMAN (NEW DEVELOPED) WEDGED WIRE ELEMENTS

- Surface filtration
- Shape stability
- Suitable for high differential pressure
- Easily cleanable using gas assisted back flush technology
- Wide variety of sizes and materials
- High permeability with low pressure drop
- Chemical and heat stability, also for ex situ cleaning

**Demonstrated technology for HCGO filtration**
Dahlman Filtration Philosophy I

• Filling
Dahlman Filtration Philosophy II

• Filtering

Inside to outside!
Dahlman Filtration Philosophy III

• Cleaning

Gas-driven

- Close inlet/outlet
- Pressurize
- Open bottom valve

Dp
• Sludge discharge
Testing Facility

Semi Automatic Backflush Test Filter with FCV

Test unit in place

Different elements are tested

Convincing results
## Process Specifications

- **Fluid**: HCGO
- **Particles**: Coke fines
- **Flow rate**
  - Normal: 70 m$^3$/hr
  - Maximum (design): 76.6 m$^3$/hr
- **Temperature**
  - Operating: 240 °C
  - Design (mechanical): 310 °C
- **Density**: 801.5 kg/m$^3$
- **Viscosity @ operating temperature**: 0.22 cP
- **Pressure**
  - Operating: 8.5 bar
  - Design: 35 bar
- **Maximum allowable pressure drop**: 3 bar
Testing

Questions:
- Which filter media is best able to filter HCGO?
- Will these filter elements be cleaned effectively?
- What are the expected cycle times?
- What is the effect of gas assisted backwashing, can we reach initial clean delta P?

Dahlman Test Rig
Problem Analyses Sintered Powder

Fracture surface
SEM-imaging: Device Tescan TS5130MM

Work-Nr.: 2009110040
Magnification: 215 : 1

EDX Analysis results

<table>
<thead>
<tr>
<th>Element</th>
<th>Massen%</th>
<th>Atom%</th>
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<tbody>
<tr>
<td>O K</td>
<td>38.11</td>
<td>55.26</td>
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<tr>
<td>Na K</td>
<td>0.62</td>
<td>0.63</td>
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<tr>
<td>Mg K</td>
<td>24.68</td>
<td>23.55</td>
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<tr>
<td>Al K</td>
<td>1.28</td>
<td>1.10</td>
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<tr>
<td>Si K</td>
<td>4.24</td>
<td>3.50</td>
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<tr>
<td>S K</td>
<td>1.36</td>
<td>0.98</td>
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<tr>
<td>Cl K</td>
<td>9.25</td>
<td>6.05</td>
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<tr>
<td>K K</td>
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<td>0.46</td>
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<tr>
<td>Ca K</td>
<td>1.40</td>
<td>0.81</td>
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<tr>
<td>Cr K</td>
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<tr>
<td>Fe K</td>
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<td>5.33</td>
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<tr>
<td>Ni K</td>
<td>1.98</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Insgesamt</strong></td>
<td><strong>100.00</strong></td>
<td></td>
</tr>
</tbody>
</table>
Problem Analyses Sintered Powder

Work-Nr.: 2009110040
Magnification: 1000 : 1

Image comment:
Foreign material in pores

EDX Analysis:

<table>
<thead>
<tr>
<th>Element</th>
<th>Massen%</th>
<th>Atom%</th>
</tr>
</thead>
<tbody>
<tr>
<td>C K</td>
<td>15.90</td>
<td>33.68</td>
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<tr>
<td>O K</td>
<td>18.56</td>
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<tr>
<td>Si K</td>
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<td>9.80</td>
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<tr>
<td>S K</td>
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<td>2.87</td>
</tr>
<tr>
<td>Cr K</td>
<td>25.05</td>
<td>12.26</td>
</tr>
<tr>
<td>Mn K</td>
<td>7.53</td>
<td>3.49</td>
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<tr>
<td>Fe K</td>
<td>16.32</td>
<td>7.43</td>
</tr>
<tr>
<td>Ni K</td>
<td>2.23</td>
<td>0.97</td>
</tr>
<tr>
<td>Insgesamt</td>
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</tbody>
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Analyses of Sintered Wire Mesh

Cut section

Microscopic detail
Analyses of Sintered Wire Mesh

Before cleaning

After cleaning
Filtration Test Results

HKGO
23-11-2009

Graph showing filtration test results for HKGO on 23-11-2009.
Conclusion of the testing

- A significant amount of very small coke particles is present
- Lower operational temperatures than indicated; temperature drops during drum switch (8h-16h operation)
- Improved back flush results using LCGO
- Some filter media is not useful for HCGO filtration
Dahlman HCGO Reference Project

Detailed picture of the special discharge valve

Quick opening valve (< 0.5 sec)
Dahlman HCGO Reference Project
Today’s performance

Corrected delta P curve for flow fluctuations
Conclusion

• Gas assisted backwash cleaning is today a demonstrated and **proven** technology for HCGO filtration
• Wear resistant, use of the best components
• Easy operation, no operator intervention required
• Lower use of utilities compared to other technologies resulting in lower operational costs
• Demonstrated in the field, up and running today
Thank you!

Questions?

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