Innovation in Materials Development for LNG Dehydration

Dr. Tobias Eckardt
Global Technology Manager Natural Gas
BASF
LNG Market

• Natural Gas production growing from 3.6 Bm$^3$ in 2017 to 4.0 Bm$^3$ in 2022$^1$
• China driving natural gas consumption growth
• United States driving natural gas production growth
• After the US, Australia and Russia are the main contributors to export growth
• Long distance LNG trade growing at 4.4% p.a.$^2$

References: $^1$IHS Markit, $^2$Cedigaz Summary Medium and Long Term Natural Gas Outlook 2017, Long distance LNG trade, 2015-2035
Dehydration units are designed for 3-year change-out interval, to align with the compressor maintenance schedule.

Plants are working to extend compressor maintenance schedule from 3 to 5 years, requiring longer adsorption bedlife.

Issues with the adsorbent bed can cause plants to replace the Molecular Sieve prematurely.
Reasons for Molecular Sieve Bed Failures

- Coking
- Liquid carryover
- Regeneration reflux
The Solution to Regeneration Reflux
Options for longer bed life

- Ramping of regeneration gas heater
  - Slow heat-up minimizes reflux, but requires time
- Improved Molecular Sieve materials
  - Hydrothermal resistance
  - Reflux Stability
  - Mechanical strengths
- Improved bed design
Custom-Tailored Combination Bed Design

- Durasorb™ Dehy is a combination of two products into a single solution to capitalize on the benefits from each product

- Durasorb HD (High Durability): liquid water resistant adsorbent based on the Sorbead platform
- Durasorb HR (High Resistant): reflux resistant molecular sieve
- Customized bed configuration based on innovative design software and decades of experience
The Initial Concept – North Morecambe, UK

- 550 MMSCFD plant producing pipeline gas
- Requiring both hydrocarbon and water dewpoint control
- Part of the gas is treated in a cryo-operation (Nitrogen-rejection)
Extremely long bed life of the Molecular Sieve bed

- Sorbead plant is producing lean and dry gas to pipeline specifications
  - 30 ppmv $\text{H}_2\text{O}$
  - $-10\, ^\circ\text{C}$ CCT (C6+ removal)
- Molecular Sieve bed has only H$_2$O polishing duty to 0.1 ppmv spec for cryogenic processing
  - Lifetime of the Molecular Sieve bed 15+ years!
Dominion NGL Extraction Plant Optimization

- 200 MMscf/d plant producing 50,000 BPD NGL
- Using a newly developed Durasorb design, BASF increased bed life from 6 months to 24 months
  - Previous bedlife was 6 months, due to hydrocarbon liquid carryover and regeneration reflux problems
- Increased lifetime results in 3 less turnarounds and saves operations $1.5 MM USD
- In addition, avoided $19 MM production loss

<table>
<thead>
<tr>
<th>Turnaround Cost Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$40K Subcontractor Unloading/Loading</td>
</tr>
<tr>
<td>$30K Adsorbents Disposal</td>
</tr>
<tr>
<td>$20K Nitrogen for Purging</td>
</tr>
<tr>
<td>$10K Misc. Maintenance &amp; HSE Cost</td>
</tr>
<tr>
<td>$400K New Adsorbents Cost</td>
</tr>
<tr>
<td>$500K TOTAL for a 4-day turn around</td>
</tr>
</tbody>
</table>

| Loss of Production Estimate:       |
| 50K BPD x 4 days x $7/MBtu x 4.6 MMBtu/Bbl | $6.4 MM |
First Application in an LNG Plant

- **Africa LNG Facility**
  - Plant Design:
    - Flow Rate: 684 MMSCFD
    - Standard 3 Towers configuration
  - Previous Bed-life: 2 years
    - “Donut” ring formation due to reflux
  - Durasorb Solution
    - 30 % Durasorb HD
    - 70 % Durasorb HR3 (COS minimization)
    - Durasorb split is based on proprietary design software
  - Plant Benefits:
    - Optimized cycle lengths, heating profile
    - Guaranteed Life: 4 years

Molecular sieve clumping caused by reflux during regeneration resulted in shorter bedlife
Summary

Durasorb is
• based on long-term industry experience with Sorbead
• an innovative adsorbent design combining two products for cryogenic applications
• a tailored and customized solution for existing and new projects
• the answer to common problems in dehydration units
  – Solves regen reflux and liquid carryover problems
  – Eliminates retrograde condensation (coking)
• A possibility to reduce the footprint of dehydration units (floating units)