Innovations on FLNG pre-treatment technologies: Acid gas removal for LNG production from on-shore to floating unit design

Christian Riemann, OASE® Gas Treating Excellence
Why is Gas Treatment important for LNG production?

- Gas Treatment is a “gas cleaning“ step upstream the liquefaction train
- Cleaning means removal of acid gas components, especially CO₂
- CO₂ is critical as it freezes out during natural gas liquefaction and may blocks lines – liquefaction train needs to be shut down for removal!
- Typical limit for CO₂ before liquefaction train: 50ppmv !!!
Onshore vs. Offshore
What is the difference?

- A vessel is moving according to sea motion
Typical LNG Acid Gas Removal Unit
Offshore ...
How to assess motion?

- Sea motion is of stochastic nature

How to treat stochastic information?
- Transform in harmonic motion
- Multiple harmonic waves $\rightarrow$ Spectrum
Offshore ... Frequencies

- VESSEL RESPONSE AMPLITUDEs as function of period time

The spectra are important for pitch and roll
- Short period times → Accelerations
- Long period times → Fluid Maldistribution
Model Development
Detailed Level Investigation
Motion Studies

Periodtime: 5 s 10 s 20 s 40 s

Column Height: 2.2 m
Column diameter: 1 m
Oscillation: +/- 8°
Long period times may lead to
- Change in characteristics of dynamic tilt (*quasi static*)
- Increase in design margins (*sizing of equipment*)

Example:
 Dyn. Tilt: $\alpha_{\text{dyn}} = 4.0^\circ$
 Stat. Tilt: $\alpha_{\text{stat}} = 0.5^\circ$

Graph showing CO$_2$ treated gas over period time [s]
Comparison of different configurations

- **Example**
  - Feed gas flowrate: 20000 kmole/hr
  - Feed gas pressure: 65 bara
  - Acid gas content: 10 vol% CO2
  - Hybrid process: 10 vol% → 3 vol%

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Absorber diameter [m]</th>
<th>Regenerator diameter [m]</th>
<th>LP Flash diameter [m]</th>
<th>Reboiler Duty [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abs / HP / Str</td>
<td>3.50</td>
<td>4.60</td>
<td>X</td>
<td>100</td>
</tr>
<tr>
<td>Abs / HP / LP / Str</td>
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<td>4.50</td>
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<tr>
<td>Membrane / Abs / HP / Str</td>
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<td>3.40</td>
<td>X</td>
<td>35</td>
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</tbody>
</table>
Findings

- BASF is able to design Acid Gas Removal based on Amines for FLNG
  - Reasonable motion pattern shall be taken into account

- Optimization of design with respect to
  - OPEX/CAPEX
  - Footprint/weight

- Hybrid processes – Bulk removal of acid gas by other technology
  - Lower energy consumption, but ...
  - High pressure parts of amine process the same
  - Additional high pressure equipment necessary
  - Additional pretreatment may be required, e.g. upstream dehydration
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