Gazprom’s Helium Facility in Orenburg
Supply & Start-Up of a Linde Liquefier

Klaus Ohlig
Twente, July 9th, 2014
# Table of Contents

1. Introduction  
2. Linde’s Helium Product Portfolio  
3. Key Components  
4. Worldwide Helium Applications  
5. The Orenburg Helium Facility  
6. Summary
Linde Engineering provides all capabilities for execution of He & C_{2+} recovery projects worldwide.

1. Design & EPC of some of the world's largest C_{2+} Plants
2. Leading NRU Process Portfolio & References
3. Helium purification and liquefaction
4. In-house manufacturing of key cryogenic equipment
5. Worldwide EPC-Experience
6. Leading in production, distribution & application of Helium
Linde Engineering provides all capabilities for execution of He & C$_2$+ recovery projects worldwide.
Linde’s Helium Product Portfolio

Standard Liquefiers (> 600 units sold)

- 150 Turbine Machines
- 450 Piston Machines

Standard Engineered Liquefiers

- 1200 l/h 277 mmscf/y
- 1500 l/h 346 mmscf/y
- 1800 l/h 415 mmscf/y
- 2200 l/h 508 mmscf/y
- 2400 l/h 554 mmscf/y
- 3500 l/h 808 mmscf/y

Customized Plants

- 20 kW refrigeration capacity equivalent to 6000 l/h or 1385 mmscf/y
Key Components
Coldboxes and Heat Exchangers for Helium Applications

Cold box for Liquefaction of Helium in Skikda
- 3,500 l/h of helium
- 99.999% (5.0)
- 3 MW_{el}
- 2,000 l/h LIN

1 Vacuum-insulated cold box
2 Heat exchanger blocks
3 20 K adsorbers
4 Turbo expanders
5 Gaseous He inlet
6 Liquid He discharge
7 Liquid N₂ inlet (pre-cooling)

18 kW Helium Refrigerator at CERN's Large Hadron Collider
Linde’s dynamic gas bearing turbines provide highest efficiency combined with unsurpassed reliability hence ensuring lowest operating costs.

<table>
<thead>
<tr>
<th></th>
<th>Power [kW]</th>
<th>Max. Rotational Speed [rps]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TED 16</td>
<td>0.1 to 5</td>
<td>5’600</td>
</tr>
<tr>
<td>TED 22</td>
<td>0.2 to 10</td>
<td>4’200</td>
</tr>
<tr>
<td>TED 32</td>
<td>0.5 to 25</td>
<td>3’200</td>
</tr>
<tr>
<td>TED 45</td>
<td>5 to 50</td>
<td>2’200</td>
</tr>
</tbody>
</table>
Linde’s provides liquid helium storage tanks and transport containers with excellent thermal performance and low maintenance requirements.

<table>
<thead>
<tr>
<th></th>
<th>Standard Tank</th>
<th>Large Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross volume (warm tank)</td>
<td>128 700 litres</td>
<td>230 000 litres</td>
</tr>
<tr>
<td>Net volume (cold tank)</td>
<td>121 200 litres</td>
<td>216 000 litres</td>
</tr>
<tr>
<td>Max working pressure</td>
<td>3 bar(g)</td>
<td>3.5 bar(g)</td>
</tr>
<tr>
<td>Design temperature</td>
<td>-269°C to 100°C</td>
<td></td>
</tr>
<tr>
<td>Design code</td>
<td>ASME or PED</td>
<td></td>
</tr>
<tr>
<td>Inner vessel material</td>
<td>Stainless steel</td>
<td></td>
</tr>
<tr>
<td>Vacuum jacket material</td>
<td>Carbon steel</td>
<td></td>
</tr>
<tr>
<td>Total length</td>
<td>21 650 mm</td>
<td>28 000 mm</td>
</tr>
<tr>
<td>Outer diameter</td>
<td>3 500 mm</td>
<td>4 300 mm</td>
</tr>
<tr>
<td>Empty weight</td>
<td>42 tons</td>
<td>100 tons</td>
</tr>
<tr>
<td>Shield</td>
<td>LIN and Helium (on request)</td>
<td></td>
</tr>
</tbody>
</table>
Worldwide Helium Applications
Installed helium liquefiers

- ExxonMobil 1300 mmscf/y
- US BLM & related fields 6 Plant Locations ~4000 mmscf/y
- Qatar Gas I & II 1900 mmscf/y
- Helison (Skikda) 600 mmscf/y
- Helios (Arzew) 600 mmscf/y
- Gazprom (Orenburg) 100 mmscf/y
- Gazprom (Chayanda)
- Linde (Darwin) 150 mmscf/y
- Riley Ridge 360 mmscf/y
- ExxonMobil 1300 mmscf/y

☆ Existing source
★ Projects to start shortly
★ Potential new project
Linde Helium Plant
The Orenburg Helium Facility

Key Data

Project set-up
— Customer: Gazprom Gazenergoset
— EPC Contractor: Cryogastech LLC
— Equipment Supply: Linde Kryotechnik AG

Project schedule:
— Contract placement in June 2012
— Equipment delivery in August 2013
— Successful Performance Test Run in May 2014

Liquefaction capacity
— Design 500 l/h
— Actual 550 l/h

Special design requirements
— Design according to Russian standards (e.g. GOST) with approval by Rostechnadzor
— Unfavourable climatic winter conditions with low temperatures and snowfall during installation
The Orenburg Helium Facility
Plant Design

- Liquid Helium Storage Tank
- Liquid Nitrogen Tank
- Helium Liquefier
- Helium Recycle Gas Compressors
The Orenburg Helium Facility
Site Impressions

Recycle Gas Compressors

Feed Gas Drier

Coldbox

Oil Removal System
The Orenburg Helium Facility
Site Impressions

Trailer Filling Station with Storage Tank and ISO Transport Container

ISO Transport Container Ready for Filling
Linde Kryotechnik AG has successfully designed, supplied and commissioned a helium liquefaction plant for Gazprom Gazenergoset in Orenburg:

— Design and supply by Linde Kryotechnik AG
— Plant design and installation in close cooperation with Cryogastech LLC
— Design according to Russian codes, standards, and regulations
— Successful commissioning
— Outstanding performance of the plant exceeding guaranteed liquefaction rate by 10%
Thanks for your attention.