The Role of Brazed Aluminium Heat Exchangers in Mid-Scale LNG Liquefaction

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Product & Market Evolution

What is a Brazed Aluminium Heat Exchanger (BAHX)?

What is Mid-Scale LNG?

Typical Applications of BAHX in Mid-Scale LNG Technology

2Φ Distribution / Transient Analysis

Summary and Questions
Product & Market Evolution

1950
2000
2030
Brazed Aluminium Plate & Fin Heat Exchangers (BAHX)

\[ Q = U \cdot A \cdot \Delta T_{LMTD} \]
BAHX Fabrication
Fin Types

Plain
- Low heat transfer
- Low pressure drop

Perforated
- Medium heat transfer
- Medium pressure drop

Serrated
- High heat transfer
- High pressure drop

Herringbone
- High heat transfer
- High pressure drop

Other fin variables -> height, density, thickness, perforation ...
Braze Joint
Two or three core blocks can be welded together.
Features & Benefits

**Versatile**
- 2 - 20 streams
- -269°C / +204°C design
- 0 - 160 bar

**Surface area-to-volume**
>1000 m²/m³
- Compact
- 1°C approach
- Thermal margin
Range of Application

Industrial Gases

Natural Gas Processing

Petrochemical

Industrial Refrigeration

BAHX
Range of Application

Industrial Gases

LNG

BAHX

Petrochemical

Industrial Refrigeration
Energy Consumption and Fuel Mix

Identified Gas Fields

Source: Zeus
Growth of Unconventional Gas

Worldwide Gas Production Forecast (BCM)

Unconventional Gas Production Forecast (TCF)

Gas Production, billion cubic metres

Gas Production Capacity, billion cubic metres

Conventional | Unconventional

North America | Rest of World
## Definition of Mid-Scale LNG

<table>
<thead>
<tr>
<th>Production Requirement</th>
<th>TPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fueling Station</td>
<td>&lt; 30</td>
</tr>
<tr>
<td>Peak Shaving</td>
<td>50 - 200</td>
</tr>
<tr>
<td>Small-Scale</td>
<td>30 - 500</td>
</tr>
<tr>
<td>Mid-Scale</td>
<td>500 - 2850</td>
</tr>
<tr>
<td>Baseload</td>
<td>&gt; 7,500</td>
</tr>
</tbody>
</table>
Fit of Mid-Scale LNG

Source: Zeus
Shorter Project Execution

TYPICAL 5.0 MTPA LNG PLANT

Multi FEED proposals > Contract Selection & Award

Pre- FEED ➔ FEED & Prep of EPC ITB ➔ EPC Bid Prep ➔ EPC Award ➔ EPC Execution

6 ➔ 5 ➔ 10 ➔ 6 ➔ 3 ➔ 42

72 months including Pre-FEED

TYPICAL MID-SCALE 0.5 MTPA LNG PLANT

Equipment award

Study ➔ EPF Execution ➔ Ship, install, test

5 ➔ 18 ➔ 9

32 months

Source: Adapted model courtesy of Siemens
LNG Technology
Process Selection Criteria

- **Nitrogen Cycle**
  - Lower efficiency & cost
  - Small to Mid-Scale

- **Single Mixed Refrigerant**
  - Medium efficiency & cost
  - Mid-Scale

- **Cascade, C3/MR**
  - Higher efficiency & cost
  - Baseload
BAHX Enabled Features

- Flexible
- Robust
- Optimised
- Module
- Cost Effective
- Efficient

Scale-adapted, standardized, modularized, expandable and efficient
BAHX Enabled Features

- Robust
- Flexible
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LIQUEFIER
Mid-Scale LNG Cold Box
Mid-Scale LNG Cold Box
Natural Gas Liquids (NGL)

✓ To prevent freezing
✓ To meet LNG specification
✓ To produce NGL product
BAHX Layer Types

- Hot or Cold
- Inlet distributor
- Heat transfer fin
- Outlet distributor
Stacking Arrangement

1 : 1 (Hot : Cold)

1 : 2 (Hot : Cold)

The stacking arrangement is crucial to optimising heat transfer. A repeating pitch of layers is usually best.
Visual Representation
PRE-COOLING
Core-in-Kettle™

- Kettle up to 55 bar
- Core up to 160 bar
- Temperatures between -269°C and + 204°C
CIK™ technology enables approach temperatures to be reduced from 7°C to 1°C resulting in a 15% saving on compression energy requirement.

7460kW (10,000 HP) requirement

Save 15% on compressor cost @ $800/kW = $900,000

Save 15% on operating expense @ $0.06kWh⁻¹ = $600,000 / year
CIK Engineering

Kettle up to 55 bar

Core up to 160 bar

Temperature range: -269°C/+204°C
Other Applications

- Carbon Capturing
- Helium recovery
- Boil Off Gas
Boil Off Gas Re-Liquefaction
2Φ Inlet Distribution

Vapour

Liquid

2Φ
Transient Conditions

✧ Stream-to-stream temperature difference should be below 30°C at any given location

✧ Rate-of-change-of-temperature should be kept at 2°C per minute

✧ Outside of these rules we can evaluate in more detail using:

✓ Numerical Analysis (CFD/FEA)
✓ Aspentech LNG Dynamic Analysis
✓ Bulk Analysis
BAHX are Proven, Efficient, Compact, and Cost Effective Mission Critical Heat Exchangers for LNG!

Thank you!

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Come and talk with us at stand D080!