Small-scale LNG plant capabilities:
Simple design, low unit cost and a fast schedule

Unmatched experience

For more than 50 years Air Products has engineered, and designed nitrogen recycle refrigeration technology and systems as the primary liquefaction process in air separation facilities. Air Products also owns and operates more than 100 nitrogen recycle (or air recycle) liquefiers and over 300 cryogenic plants. Year in and year out, our system-wide plant availability exceeds 99 percent, while achieving the industry's lowest levels of operating and maintenance costs. This world class capability and proven experience carries over to the design and engineering practices as well as the manufacturing of equipment utilized in plants Air Products builds for the natural gas liquefaction. As a result, Air Products’ small LNG offerings provide cost effective and reliable solutions for owners and project developers.

Air Products small-scale LNG offerings include:

- **LNG 200™ system - Standard/modular 200 TPD AP-N™ process**
- **LNG 400™ system - Standard/modular 400 TPD AP-N process**
- **AP-CT™ and AP-N customized and low-cost design for other small-scale capacity**
- **AP-SMR™ or multiple trains of AP-N process for higher capacity**

The standard design also allows for flexibility in selection of cooling medium (air, water, or closed-loop glycol), type of drivers (motor or gas turbine), heavy hydrocarbon removal and nitrogen rejection technologies.
Proven design

Air Products’ efficient and reliable process designs have proven to be robust and reliable in natural gas liquefaction service. Small-scale liquefaction plants built by Air Products decades ago remain in service today, with many producing well over their original design capacity. Utilizing our experience from the sale of over 2,000 cryogenic facilities, Air Products can help with your small-scale LNG needs.

Various process configurations available to suit your requirements

**AP-N™ Nitrogen recycle**

This process is available in two options: single-expander or dual-expander.

- **Single-expander AP-N process** offers standard designs, low capital cost and proven technology.
- **Dual-expander AP-N process** offers standard designs, multiple expanders allow for higher efficiency at higher capacity.

Features and benefits of nitrogen expander cycles

- Lower capital cost than competing mixed refrigerant technologies
- Simple operation and superior turndown efficiency
- Nonflammable and environmentally benign nitrogen refrigerant
- Low cost and ready availability of nitrogen
- Modularized design of the nitrogen recycle liquefier minimizes field construction cost

3D drawing of peakshaving LNG plant using the AP-N™ process.
**AP-SMR™ single mixed-refrigerant process**

The AP-SMR process incorporates Air Products’ unique coil-wound heat exchanger (CWHE), offering an attractive and straightforward solution that minimizes process equipment and provides enhanced performance and reliability. To minimize fieldwork or depending upon plant site logistical challenges, the CWHE can be fully modularized. Air Products’ mixed refrigerant process cycles with coil-wound heat exchangers benefit from years of experience and “know-how” gained in the LNG industry.

**AP-C1™ methane expansion process**

The AP-C1 process uses the feed gas as the refrigerant therefore eliminating the need for external refrigerant components (e.g. N₂) and reducing the costs associated with refrigerant import and storage. The technology is proven and can convert natural gas feed directly to LNG by taking advantage of the pressure differential between two pipelines, thereby eliminating incremental power input as well as a refrigeration compressor. An optional methane recycle compressor would provide increased process flexibility and availability. This process has been considered for peakshaving plants, BOG reliquefaction, and for LNG production at natural gas letdown stations.

**Comparison of small-scale LNG liquefaction process options**

<table>
<thead>
<tr>
<th></th>
<th>Single-expander AP-N</th>
<th>Dual-expander AP-N</th>
<th>AP-C1</th>
<th>AP-SMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed gas rate</td>
<td>5 to 20 MMSCFD</td>
<td>10 to 30 MMSCFD</td>
<td>3 to 30 MMSCFD</td>
<td>&gt;30 MMSCFD</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Good</td>
<td>Good</td>
<td>High</td>
<td>Higher</td>
</tr>
<tr>
<td>Capital cost</td>
<td>Lower</td>
<td>Low</td>
<td>Lower</td>
<td>Medium</td>
</tr>
<tr>
<td>Refrigerant components</td>
<td>N₂</td>
<td>N₂</td>
<td>C1</td>
<td>N₂, C1, C2, C3, C4 or C5</td>
</tr>
</tbody>
</table>
Air Products Rotoflow® Turbomachinery for N₂ and C1 expanders/companders

Building turbomachinery with reliability, high efficiency, improved safety and lower operating costs is second nature at Air Products. Why? Because for more than seventy years we have been building turbomachinery equipment to exacting standards for our own use. As one of the only OEMs both manufacturing and operating turbomachinery, we intimately know the equipment and the processes.

Small-scale LNG plant experience

<table>
<thead>
<tr>
<th>Country</th>
<th>Customer</th>
<th>Start-Up</th>
<th>LNG Capacity MMSCFD (TPD)</th>
<th>Air Products Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>England</td>
<td>British Gas Council</td>
<td>1981</td>
<td>11 (227 TPD)</td>
<td>AP-SMR</td>
</tr>
<tr>
<td>Japan</td>
<td>Japex</td>
<td>2004</td>
<td>7 (144 TPD)</td>
<td>AP-N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2007</td>
<td>10 (206 TPD)</td>
<td>AP-N</td>
</tr>
<tr>
<td>United States</td>
<td>Alabama Gas Co.</td>
<td>1965</td>
<td>5 (103 TPD)</td>
<td>Cascade</td>
</tr>
<tr>
<td>United States</td>
<td>Massachusetts</td>
<td>1973</td>
<td>8 (165 TPD)</td>
<td>AP-SMR</td>
</tr>
<tr>
<td>United States</td>
<td>Hopkinton LNG Corp</td>
<td>1977</td>
<td>19 (392 TPD)</td>
<td>Cascade</td>
</tr>
<tr>
<td>United States</td>
<td>Cove Point LNG</td>
<td>1994</td>
<td>15 (310 TPD)</td>
<td>AP-SMR</td>
</tr>
<tr>
<td>United States</td>
<td>Keyspan LNG</td>
<td>2001</td>
<td>6 (124 TPD)</td>
<td>AP-N</td>
</tr>
<tr>
<td>United States</td>
<td>Philadelphia Gas Works</td>
<td>2002</td>
<td>16 (330 TPD)</td>
<td>AP-C1</td>
</tr>
<tr>
<td>United States</td>
<td>National Grid</td>
<td>2019</td>
<td>20 (412 TPD)</td>
<td>AP-N</td>
</tr>
</tbody>
</table>

This experience enables us to deliver to you turbomachinery with exceptional performance, reliability, safety and value.

With nearly 1,000 units operating worldwide, we have unique access to operating data, giving us insight into every nuance of both equipment and processes. We continuously incorporate this operational feedback and knowledge into our machinery designs.

About Air Products

Air Products is a world leading industrial gases company celebrating 75 years of operation. The company’s core industrial gases business provides atmospheric and process gases and related equipment to manufacturing markets, including refining and petrochemical, metals, electronics, and food and beverage. Air Products is also the world’s leading supplier of liquefied natural gas process technology and equipment.

Air Products’ cryogenic expander used in the production of a small LNG plant.

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