Natural Gas Processing Plants.
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Introduction.

Natural gas is valuable both as a clean source of energy and as a chemical feedstock. Before reaching the customer, it has to pass several processing steps. These steps are partly necessary to be able to transport the gas over long distances and partly necessary for the recovery of valuable components contained in the gas.

Linde AG’s Engineering Division has world-class experience in the entire natural gas processing chain. Linde offers engineering as well as technical and commercial services, including feasibility studies, pre-FEED, FEED, detail engineering and turnkey plant construction. Plant design and scope of supply typically includes specialized and tailor made cryogenic equipment manufactured in Linde workshops such as plate-fin and coil-wound heat exchangers.

Linde’s competence in project development, planning, execution and construction of turn-key plants is clearly demonstrated by the fact that it has built more than 4,000 plants world-wide.
Components of natural gas
Natural gas is a mixture of gases containing primarily hydrocarbon gases. It is colorless and odorless in its pure form. It is the cleanest fossil fuel with the lowest carbon dioxide emissions. Natural gas is an important fuel source as well as a major feedstock for fertilizers and petrochemicals.

Pretreatment of natural gas
Natural gas pretreatment typically consists of mercury removal, gas sweetening and drying. Natural gas is dried in molecular sieve adsorbers. Depending on the downstream processing steps and the concentration of the sour gas components, it may be necessary to remove H₂S and CO₂ from the natural gas. Scrubbing processes such as MDEA, Benfield or SULFINOL are offered for this service. Should only minor amounts of sour gas be present, they can be removed by adsorption along with the removal of water. Mercury guard beds are recommended to protect people and equipment.
Cryogenic processes are the most economical method for separating natural gas components. Nitrogen is removed from natural gas to reduce transportation volumes and increase heating value. Nitrogen removal is combined with the recovery of helium, when present. High purity helium is produced by the combination of cryogenic and pressure swing adsorption process steps.

Processes for the pretreatment and separation of natural gas as well as the extraction of NGL, LPG, nitrogen and helium are offered by the Engineering Division. Combined with Linde’s project execution know-how, these processes can be implemented on a turn-key basis for all kinds of projects.

NGL, LPG and condensate as well as the pure components methane, ethane, propane and butane often have higher sales values compared to the pipeline gas itself. Therefore, they are often extracted and fractionated in tailor made processing plants according to the specific requirements of the regional market and the customers.

Natural gas plants.
Extraction of hydrocarbons

Due to their added value, heavier hydrocarbons are often extracted from natural gas and fractionated by using several tailor made processing steps.

LPG plants

LPG (Liquefied Petroleum Gas) is widely used as alternative fuel for cars, but is also suitable as a chemical feedstock. It consists of propane and butane (C₃/C₄).

For the recovery of LPG/C₃⁺ the Engineering Division offer an absorber process, which guarantees recovery rates as high as 99.9 %, while at the same time featuring low specific energy consumption. Furthermore the tolerable CO₂ content of the feed gas is higher than for conventional expander processes.

To achieve high C₃ recovery rates, Linde implements an absorber column upstream of the deethanizer. Here the feed gas is scrubbed by using a light hydrocarbon reflux coming from the top of the deethanizer. LPG is separated from the heavier hydrocarbons downstream of the deethanizer using a distillation column.
References for LPG/C₃⁺ recovery plants.

C₃⁺ recovery plant in Constanta, Romania
FEED gas capacity: 160,000 Nm³/h
Customer: Petrom S.A. (member of OMV Group)
Start of production: 2009

C₃⁺ recovery plant in Kollsnes, Norway
FEED gas capacity: 1,100,000 Nm³/h
Customer: Troll Group (Statoil)
Start of production: 2003

C₃⁺ recovery and fractionation plant in Rayong, Thailand
FEED gas capacity: 258,000 Nm³/h
Customer: Petroleum Authority of Thailand
Start of production: 1995
NGL consists of ethane and heavier hydrocarbons (C\(_{2+}\)) and constitutes an ideal feedstock for steam crackers producing olefins. It has a higher sales value compared to the pipeline gas itself, which justifies an extraction.

For the recovery of NGL/C\(_{2+}\), the Engineering Division offers a well proven expander process enabling recovery rates up to 98 %. The cryogenic process utilizes an expander to provide the refrigeration duty, which is necessary for the partial liquefaction of the natural gas upstream of the distillation process.

The process is characterized by the use of internal refrigeration to the maximum extent in order to minimize or even eliminate the necessity of external refrigeration. This ensures the lowest possible life cycle costs and investment costs for the customer.

References for NGL/C\(_{2+}\) recovery plants.

- **C\(_{2+}\) recovery and fractionation plant in Middle East**
  - FEED gas capacity: 3,000,000 Nm\(^3\)/h
  - Customer: National oil and gas company
  - Start of production: 2005

- **C\(_{2+}\) recovery plant in Middle East**
  - FEED gas capacity: 1,000,000 Nm\(^3\)/h
  - Customer: National petrochemical company
  - Start of production: 2005
Expander process for C2+ recovery

C2+ recovery and fractionation plant
in Rayong, Thailand
FEED gas capacity : 390,000 Nm³/h
Customer : Petroleum Authority of Thailand
Start of production : 1997

C2+ recovery and fractionation plant
in Kårstø, Norway
FEED gas capacity : 670,000 Nm³/h
Customer : Statoil for Statpipe Group
Start of production : 1986
Natural gas is a mixture of gases containing primarily hydrocarbon gases. It is colorless and odorless in its pure form. It is the cleanest fossil fuel with the lowest carbon dioxide emissions. Natural gas is an important fuel source as well as a major feedstock for fertilizers and petrochemicals.

**Nitrogen rejection units (NRU)**
Nitrogen is removed from natural gas to reduce transportation volumes and increase heating value. In some cases nitrogen rejection units are integrated within LNG plants to limit the nitrogen content in the fuel gas or to recover methane from tank return or end flash gas.

The Engineering Division is typically using a double column process for the removal of nitrogen. This maximizes the heat integration of the process. Depending on the nitrogen content of the feed gas, an additional enrichment column may be foreseen upstream of the actual removal process.

**Helium recovery and liquefaction plants**
Helium is a rare gas, which is recovered from natural gas when present in sufficient concentrations. Linde Engineering offers a well-proven cryogenic process for the recovery of high purity helium (> 99.999 %). High purity helium is used for special applications such as space technology or the realization of superconductivity.

To attain high purity the raw helium is first recovered from natural gas in a cryogenic separation process. Downstream of this process step it is purified in a pressure swing adsorption (PSA) unit and then liquefied for storage at temperatures of about -270°C. The Engineering Division has own technologies for each process step and is in a position to offer complete plants on a turn-key lumpsum basis.
## References for NRUs and helium plants.

**NRU integrated in Pluto LNG plant in Karratha, Australia**
- FEED gas capacity: 78,000 Nm³/h
- Customer: Woodside Burren Pty. Ltd.
- Start of production: 2010

**Helium recovery and liquefaction plant in Darwin, Australia**
- Production rate: 2.6 t/d liquid helium
- Customer: BOC Australia
- Start of production: 2009

**NRU integrated in Snøhvit LNG plant in Hammerfest, Norway**
- FEED gas capacity: 71,400 Nm³/h
- Customer: Snøhvit Group
- Start of production: 2007

**Helium recovery and liquefaction plant in Skikda, Algeria**
- Production rate: 10 t/d liquid helium
- Customer: Helison S.p.A.
- Start of production: 2005

**NRU integrated in a helium plant in Skikda, Algeria**
- FEED gas capacity: 47,000 Nm³/h
- Customer: Helison S.p.A.
- Start of production: 2005

**NRU in Onslow, Australia**
- FEED gas capacity: 47,000 Nm³/h
- Customer: BHP Petroleum
- Start of production: 1994
Collaborate. Innovate. Deliver.

Linde’s Engineering Division is a leading player in the international plant engineering business. Across the globe, we have delivered more than 4,000 plants and cover every step in the design, project management and construction of turnkey industrial facilities. Our proven process and technology know-how plays an indispensable role in the success of our customers across multiple industries – from crude oil, natural gas extraction and refining to chemical and metal processing.

At Linde, we value trusted, lasting business relationships with our customers. We listen carefully and collaborate closely with you to meet your needs. This connection inspires us to develop innovative process technologies and equipment at our high-tech R&D centers, labs and pilot plants – designed in close collaboration with our strategic partners and delivered with passion by our employees working in more than 100 countries worldwide.

From the desert to the Arctic, from small- to world-scale, from standardized to customized builds, our specialists develop plant solutions that operate reliably and cost-effectively under all conditions.

You can always rely on us to deliver the solutions and services that best fit your needs – anywhere in the world.

Discover how we can contribute to your success at www.linde-engineering.com

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Core competencies at a glance

Plant engineering
→ Air separation plants
→ LNG and natural gas processing plants
→ Petrochemical plants
→ Hydrogen and synthesis gas plants
→ Adsorption plants
→ Cryogenic plants
→ Carbon capture and utilisation plants
→ Furnaces, fired heaters, incinerators

Component manufacturing
→ Coldboxes and modules
→ Coil-wound heat exchangers
→ Plate-fin heat exchangers
→ Cryogenic columns
→ Cryogenic storage tanks
→ Liquefied helium tanks and containers
→ Air-heated vaporisers
→ Water bath vaporisers
→ Spiral-welded aluminium pipes

Services
→ Revamps and plant modifications
→ Plant relocations
→ Spare parts
→ Operational support, troubleshooting and immediate repairs
→ Long-term service contracts
→ Expert reviews for plants, operations and spare part inventory
→ Operator training