Aluminium Plate-Fin Heat Exchangers
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Introduction.

The fabrication facility of Linde AG, Engineering Division/Germany is well known as a highly qualified and competent supplier for aluminium plate-fin heat exchangers, a quite sophisticated type of cryogenic equipment.

These aluminium plate-fin heat exchangers are manufactured by vacuum brazing technology.

Over 700 professional employees and skilled workers are engaged at Linde’s fabrication facility Schalchen which is located about 100 km in the east of Munich, Germany. At this location vacuum brazed aluminium plate-fin heat exchangers in various designs and for different applications have been fabricated since 1981. Since that time more than 10,000 heat exchanger cores have been produced. This paper describes the specific technical features of this heat exchanger type.
Aluminium plate-fin heat exchangers.

Characteristics
Vacuum brazed plate-fin heat exchangers are key components in many process plants. They can be advantageously used instead of other heat exchanger types, like tubular heat exchangers.

Especially with regard to compactness the plate-fin heat exchangers are one of the most favourable possibilities to save installation space and costs.

Plate-fin heat exchangers can treat many process streams in only one unit thus avoiding expensive interconnecting piping of different units.

The aluminium alloys used for fabrication of brazed plate-fin heat exchangers provide best possible heat transfer, allow the application in low temperature service and reduce drastically the equipment weight to be supported.

Single-phase liquid and gaseous streams can be treated as well as vaporising and condensing fluids.

Beside the usual counter-flow design also cross-flow arrangement can be realized.

Each aluminium plate-fin heat exchanger is especially designed for the required thermal and hydraulic performance thus providing an exactly fitting and very economical process equipment.

Additional customer requirements can easily be considered, e.g. with regard to already existing pipe connections or support structures to be met.

Applications
Plate-fin heat exchangers can be used for a wide range of applications, especially for low temperature services and treatment of clean fluids.

Beside others the main applications are:
- Petrochemical plants
- Gas treatment plants
- Natural gas liquefaction plants
- Air separation plants
- Helium liquefaction plants

Installation of plate-fin heat exchangers in an air separation plant.

1 Main exchanger
2 Sub cooler
3 Reboiler/condenser
Plate-fin heat exchanger for a LPG plant

**Benefits**

Due to the characteristics and the wide range of applications aluminium plate-fin heat exchangers designed and manufactured by Linde have a lot of benefits for the user.

**Low investment costs due to:**
- Very compact design taking less space than conventional heat exchanger types.
- Reduced number of items, as many streams can be treated within only one compact heat exchanger unit.
- Low weight aluminium design thus reducing costs for support structures.

**Low energy costs due to:**
- Small possible temperature differences between the streams.
- Low pressure drops.

**Optimal performance due to:**
- Tailor-made design for each plate-fin heat exchanger with regard to thermal, hydraulic and mechanical design.
- Highly efficient heat transfer using a big selection of different aluminium fins.
Design standards
The process and mechanical design basis for plate-fin heat exchangers results from the know-how of Linde as a leading engineering company for turnkey plants. Linde is a founding member of the Brazed Aluminium Plate-Fin Heat Exchanger Manufacturers’ Association (ALPEMA) and is also member of other international organizations, such as HTRI and HTFS.

Equipment design and manufacturing, based on client’s specifications and Linde’s own standards, are carried out in accordance with national and international standards, such as:
- PED European Pressure Equipment Directive
- AD-Merkblatt
- ASME Code
- Australian Standard
- British Standard
- Chinese Standard
- Codap
- IGC-code
- Japanese Industrial Standards
- Raccolta/VSR
- Stoomwezen Grondslagen
- Swedish Pressure Code
- Russian Gost

Structure

1 Stub pipe/nozzle
2 Header tank
3 Distributor fin
4 Heat transfer fin
5 Partition plate
6 Side bar
7 Cover plate
Technical data

Dimensions per core max. (W x H x L)  1.5 x 3.0 x 8.2 m

Surface/volume max. approx. 1600 m²/m³

Fin type plain perforated serrated

Fin height 4.0 to 9.5 mm

Fin thickness 0.2 to 0.6 mm

Standard design temperature -269 to +65°C (150°F)

Design pressures up to approx. 110 bar (1595 psig)

Materials block: ASTM 3003/EN AW 3003
headers, nozzles, flanges:
ASTM 5083/EN AW 5083
ASTM 5454/EN AW 5454

Quality management and inspection

Quality management is an essential part of Linde’s company strategy.

Linde is certified according to:
– EN ISO 9001 / EN 29001
– German Pressure Vessel Rules (AD-HP0)
– ASME (U, U2, R-Stamp) and others.
– Manufacture license of special equipment (China)
– Certificate of manufacture registration of cylinder (Korea)

Acceptance inspection is carried out by Linde’s own specialists and further by experts from various international inspection organisations, such as:
– TÜV (German Technical Supervisory Society)
– Lloyd’s Register
– Stoomwezen
– ISPESL
– Bureau Veritas
– Det Norske Veritas
In 1981 Linde started fabrication of aluminium plate-fin heat exchangers, applying the vacuum brazing technology. This procedure does not require any flux and no post-braze cleaning steps are necessary.

Since that time, Linde has fabricated more than 10,000 heat exchanger blocks for a wide range of applications.

Before and during production all raw materials and prefabricated parts are stringently controlled to ensure proper choice of material as well as surface quality and dimensional accuracy.

After forming, cutting and cleaning of the single parts the block is stacked and prepared for high vacuum brazing at about 600°C.

For welding of headers and nozzles to the core proven welding procedures, such as GTAW and GMAW, are used.

Extensive test procedures are carried out on the completely assembled heat exchangers. These include radiographic and dye penetrant testing of weld seams, pressure test and helium leak tests and if requested, flow tests.
Design versatility.

**Cold boxes**
An economical alternative, which saves time during site work, is the installation of different exchangers in a steel containment (cold box). Interconnecting piping, vessels, valves and instrumentation are included in this packaged unit to form, after filling with insulation material (perlite), a ready-to-operate unit.

**Block-in-shell**
One or more heat exchanger blocks installed in a shell instead of a tube bundle. This is a highly efficient and economical alternative to standard shell-and-tube heat exchangers.

Benefits:
- Tighter approach temperatures
- Smaller in size and weight
- Lower capital costs (CAPEX)
- Lower operating costs (OPEX)
Installation and after sales service.

Plant components and assemblies up to 7 m in height and width, 56 m in length and more than 200 tons weight can be handled. Bigger units can be assembled on shore or at site.

Linde AG provides complete services on:

Field installation
Qualified and experienced Linde erection engineers, fitters and welders are available to carry out and/or to supervise the installation of the heat transfer systems on site.

Operation
The Linde Engineering team with numerous thermodynamic, hydraulic, process and mechanical engineering specialists is pleased to support the customer with sound problem analysis and operational improvements.

Cleaning
If problems occur due to fouling or plugging of exchanger passages, immediate problem analysis can be carried out and suggestions for possible cleaning procedures will be made. Supervision of the cleaning process can be provided.

Repairs
A specialized service crew is available for immediate and professional repair services.

Linde is a founding member of ALPEMA (Aluminium Plate-Fin Heat Exchanger Manufacturers’ Association)
Designing processes – constructing plants.

Linde’s Engineering Division continuously develops extensive process engineering know-how in the planning, project management and construction of turnkey industrial plants.

The range of products comprises:
- Petrochemical plants
- LNG and natural gas processing plants
- Synthesis gas plants
- Hydrogen plants
- Gas processing plants
- Adsorption plants
- Air separation plants
- Cryogenic plants
- Biotechnology plants
- Furnaces for petrochemical plants and refineries

More than 4,000 plants worldwide document the leading position of the Engineering Division in international plant construction.

Production facilities.

At Linde Engineering Schalchen Plant over 700 skilled engineers and workers design and manufacture components and complete modules for numerous applications in process plants such as ethylene plants, hydrogen and synthesis gas plants, LNG plants and air separation plants. Production capacity totals approx. 1.3 million hours per year.

In addition, the plant offers services for field installation and advice on operation. A specialised service crew is available for immediate and professional repair services.

Product range.

- Aluminium plate-fin heat exchangers as single units or as manifolded assemblies
- Cold boxes with aluminium plate-fin heat exchangers, columns and vessels
- Coil-wound heat exchangers and isothermal reactors for chemical and petrochemical plants
- Columns and pressure vessels in aluminium for cryogenic plants
- Spiral-welded pipes in aluminium
- Storage tanks for liquefied gases
- Steam-heated waterbath vapourisers as well as air-heated vapourisers for liquefied gases

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