Distillation Technology

GEA Wiegand GmbH

Distillation Technology

The separation or extraction of individual substances from liquid mixtures has been practised for centuries, most notably for the production of alcohol. Distillation and rectification technologies are consequently applied as follows:

Distillation is the separation of the constituents of a liquid mixture by partial vaporization and subsequent condensation, taking advantage of differences in volatility.

Rectification is the multiple distillation of liquids in direct contact with steam in counterflow.

Apart from the production of beverage alcohol, distillation technology is frequently encountered in the Chemical, Pharmaceutical, Food and Beverage, and Environmental Technology industries. Another important aspect is for the production of bioethanol as environmentally friendly fuel.

New products such as hollow fibres – required for artificial kidneys, new production processes – e.g. for battery foils, and increased environmental requirements provide ongoing challenges for distillation technology.
The demands of known products may change, necessitating new technologies. Alcohol as a fuel additive, for example, must be virtually free of water.

For this reason, there are no universally applicable solutions for every user. For each system it is consequently of central importance to provide the concept that meets particular individual requirements.

Research and Development

Ongoing research and development combined with the experience of many installed references enables GEA Wiegand to provide wide-ranging technical expertise, offering the best solution for almost any product, capacity, operating condition or application.

GEA Wiegand has its own Research and Development Centre, where numerous laboratory and pilot plants are available for detailed analyses and testing in the fields of distillation and evaporation. At the R & D Centre, important physical characteristics such as boiling point elevation, surface tension, solubility and maximum achievable concentration are determined. Certain pilot plants are available as mobile units and can therefore be installed at a customer's site. Data is captured and plant operating behaviour modelled by means of the latest computer programs.

Tests are performed in different types of evaporators and distillation columns. In addition, a fermentation plant is also available.
Experience has been acquired through more than 3,000 tests to date. The alphabetical list of products ranges from acetone/alcohol mixtures to zinc dichloride.

Contents

Applications for GEA Wiegand Distillation Plants

The following list shows typical applications for GEA Wiegand distillation plants.
New applications are investigated and analysed on an ongoing basis at our Research and Development Centre.

Alternative Fuels

- Production of bioethanol as a fuel additive
- Dehydration of ethanol by means of molecular sieves or entrainer distillation
- Refining of regeneration alcohol/entrainers from the dehydration process
- Refining of glycerine and methanol from biodiesel production

Beverage Alcohol

- Complete plants and plant components for the production of raw alcohol and neutral spirit

Chemical and Pharmaceutical Industries

- Treatment of process water from the production of hollow fibre modules
- Production of perfume extracts
- Concentration of polymer additives
- Refining of extraction solutions
- Separation of reaction by-products, solvents

Food Industry

- Concentration of isopropanol from pectin extraction
- Aroma recovery and concentration
- Fractionation of flavours and aromas
- Treatment of miscella
- Refining of precipitants and solvents

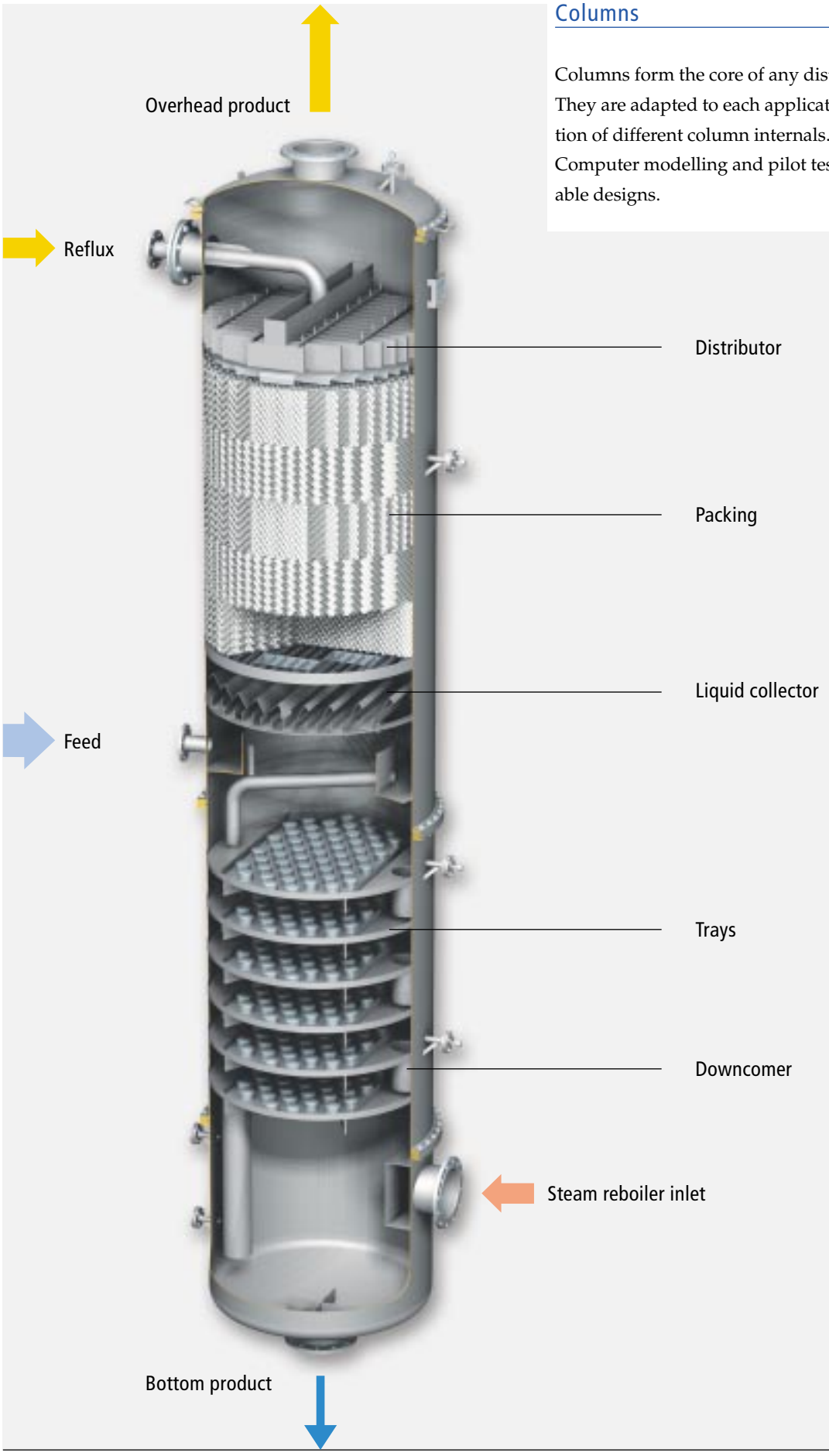
Environmental Technology

- Solvent recovery e.g. printed circuit production
- Removal of organic compounds and solvents from waste streams

Plant Components

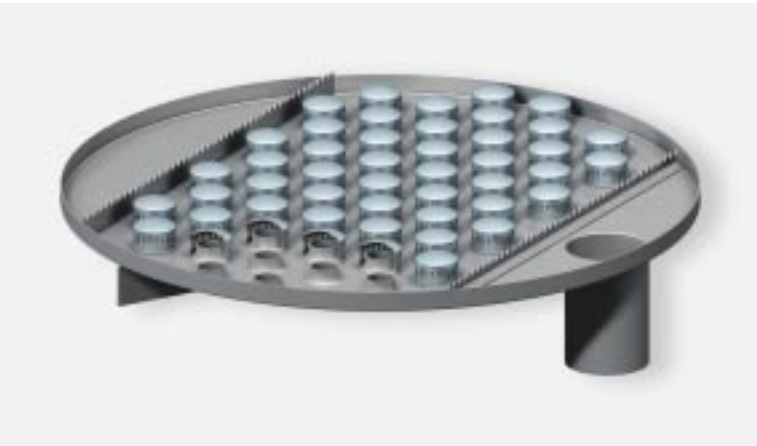
Columns

Columns form the core of any distillation plant.
They are adapted to each application by the design and selection of different column internals.
Computer modelling and pilot testing forms the basis of reliable designs.

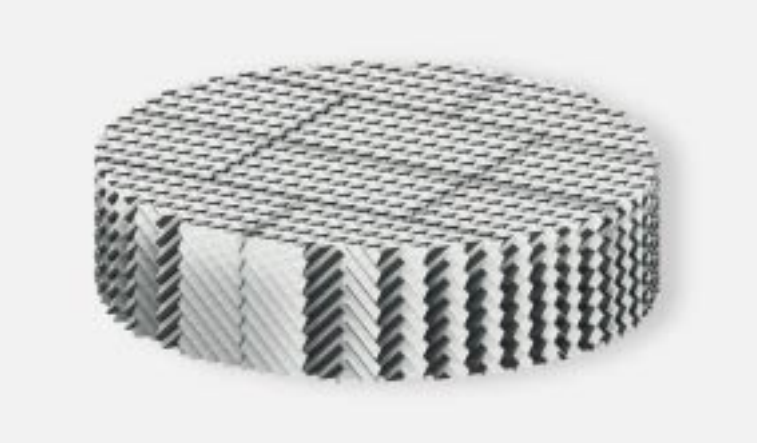


Internals

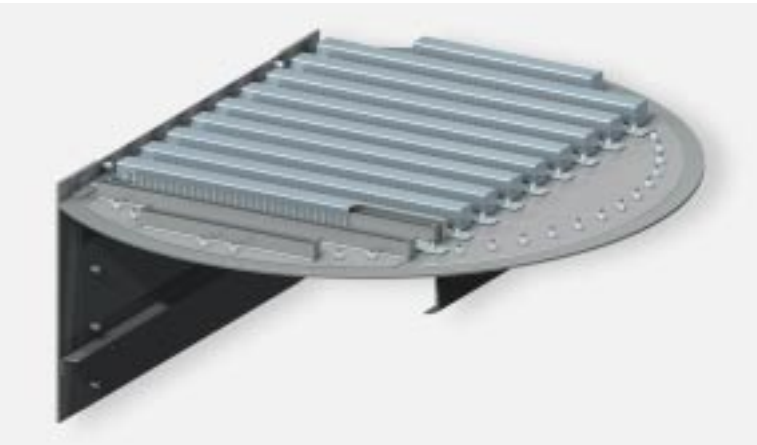
	Cleaning	Load Range	Suitable for Solids	Price
Sieve tray	+	–	+	+



Bubble cap tray	–	+	o	–



Structured packing	–	+	–	+

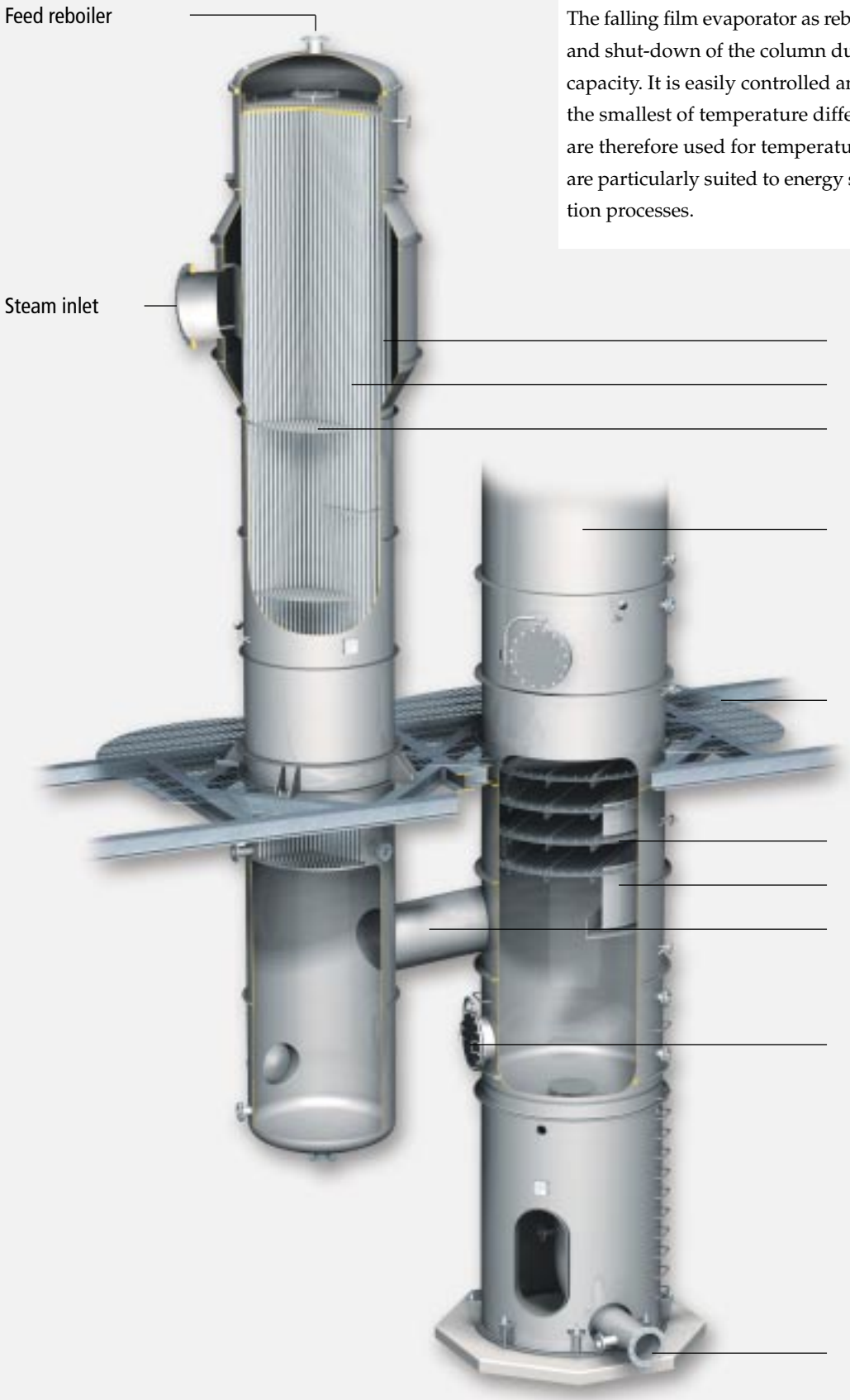


Tunnel cap tray	–	+	o	–

Plant Components

Falling film reboiler

The falling film evaporator as reboiler supports rapid start-up and shut-down of the column due to its limited liquid holding capacity. It is easily controlled and suited to operation with the smallest of temperature differences. Falling film reboilers are therefore used for temperature-sensitive products and are particularly suited to energy saving, multiple-effect distillation processes.

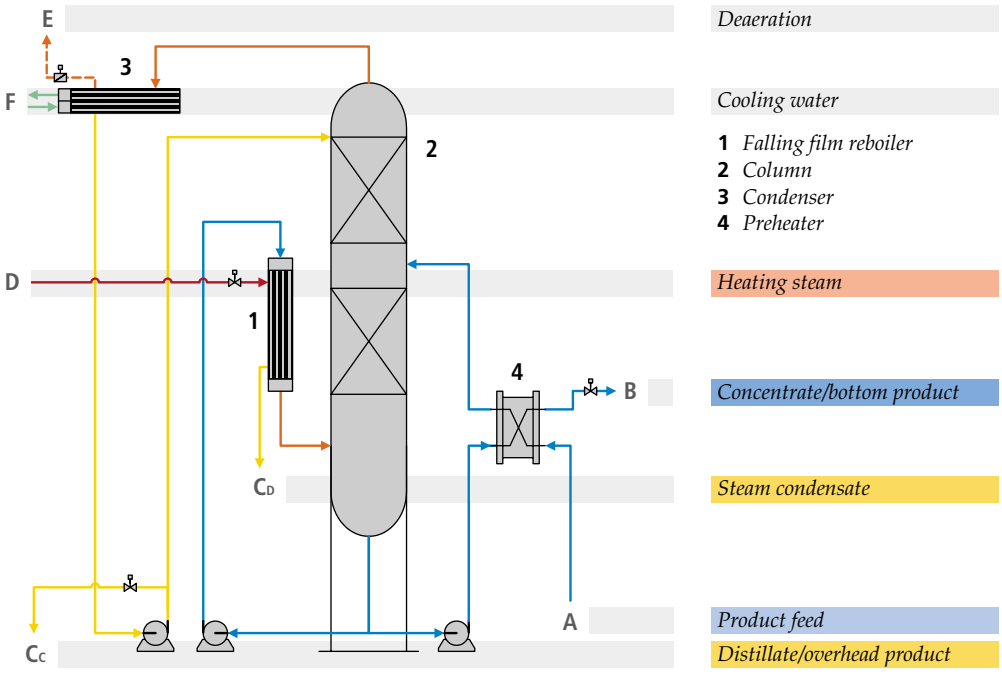


Multiple-effect distillation permits the repeated use of the energy supplied to a system. Energy consumption is effectively reduced by a factor about equal to the number of effects. Since a temperature difference is required for heat transfer within the reboiler, there are practical limitations to the number of effects that can be used. Maximum and minimum temperatures are, as a rule, determined by the product, or the heating steam pressure and the cooling water temperature.

The smaller the temperature difference per effect, the greater the number of effects that can be used. Falling film evaporators are suited to these applications since smaller temperature differences are possible than in conventional thermal siphon circulation or forced circulation reboilers.

Right: *A 4-effect, continuous rectification plant with falling film reboilers, downstream finisher and residue concentration system, designed for process water from the production of hollow fibre modules*

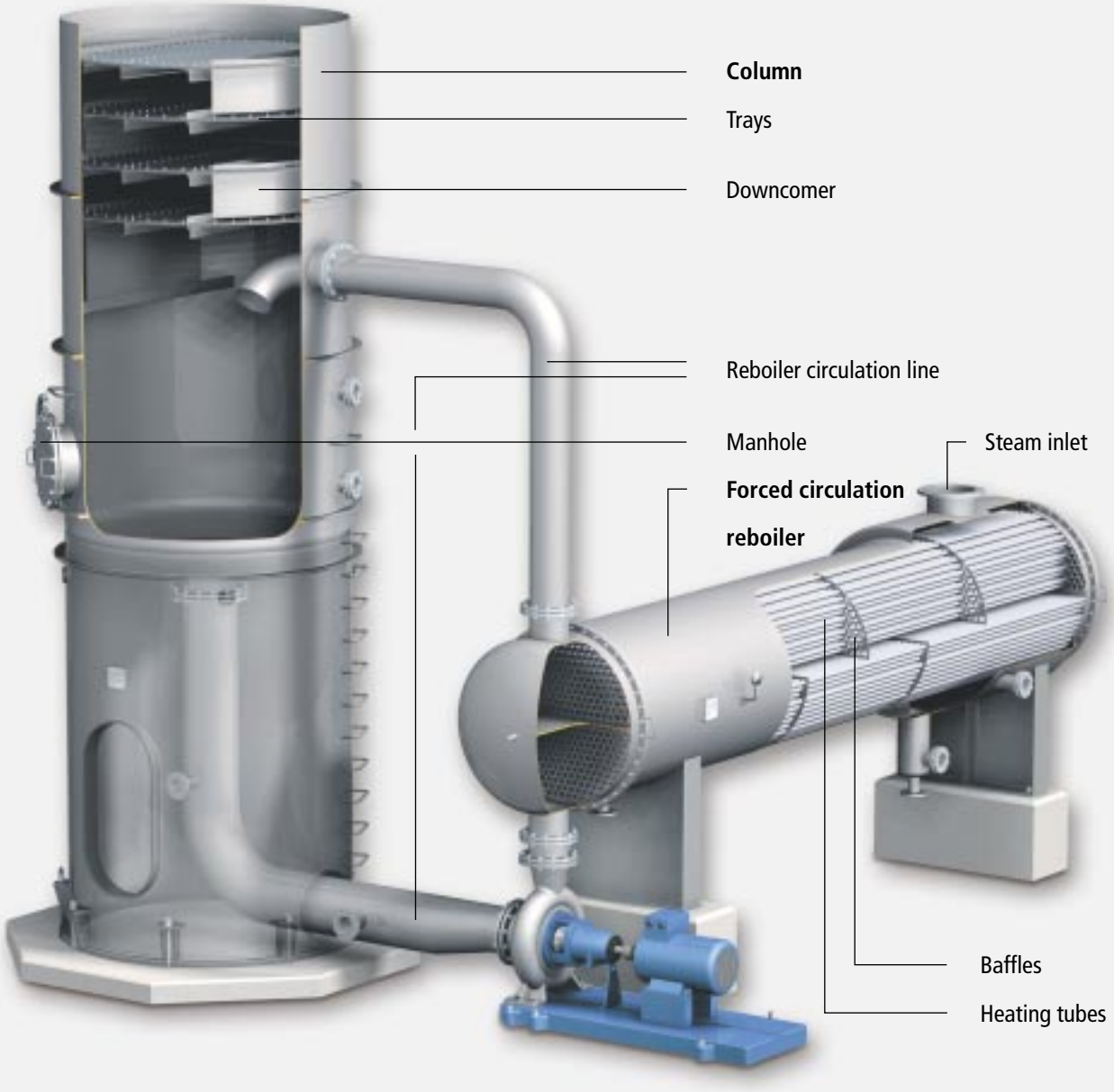
Below: *Flow diagram of a single-effect distillation plant heated by a falling film reboiler*



Plant Components

Forced circulation reboiler

Forced circulation reboilers are used for reboiler duties where viscous and/or heavily contaminated media are to be expected in the bottom product.
High liquid velocities in the tubes and the resulting shearing forces ensure that this type of heat exchanger is operated within its optimum performance range, while keeping fouling to a minimum. Pump selection influences performance and efficiency. Forced circulation reboilers can be designed for either horizontal or vertical installation.



A single-effect ethanol distillation plant, shown during construction

The arrangement shown above, is of a forced circulation reboiler, mounted below the heads condenser and preheater. This plant produces ethanol following the fermentation of the process wastewater from a starch process. GEA Wiegand also provided the complete continuous fermentation plant.

Specification of Distillation Plants

The key criteria to investment decision making includes the plant purchase price, performance, reliability and operating costs, versus the specification, value and yield of the products to be processed.

The core of the distillation range of products is the multiple-effect pressure/vacuum rectification system. The design is largely determined by the characteristic properties of the feed and the specific requirements of the final product. GEA Wiegand is recognised for the high thermodynamic efficiencies and high distillate purities achieved.

Apart from petrochemical products, raw materials from fermentation processes are an important feedstock for distillation units. GEA Wiegand thus offers fermentation lines, complementing the core distillation process. The complete range of innovative processes relating to distillation technology is therefore available from a single, reliable source.

We have internationally recognized expertise in the processing of by-products that contain solids, which often result from distillation processes. Depending on the customer's requirements and the actual product, value is added to by-products through dewatering, decanting, concentration or extraction in evaporation plants and processing into marketable products by subsequent drying.

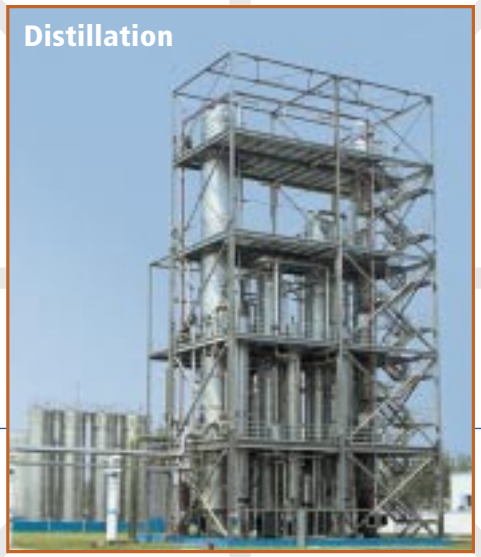
Technologies and Concepts

Cleaning-in-place

Fermentation

Drying

Distillation



Molecular Adsorption

Centrifugal Separation

Membrane Filtration

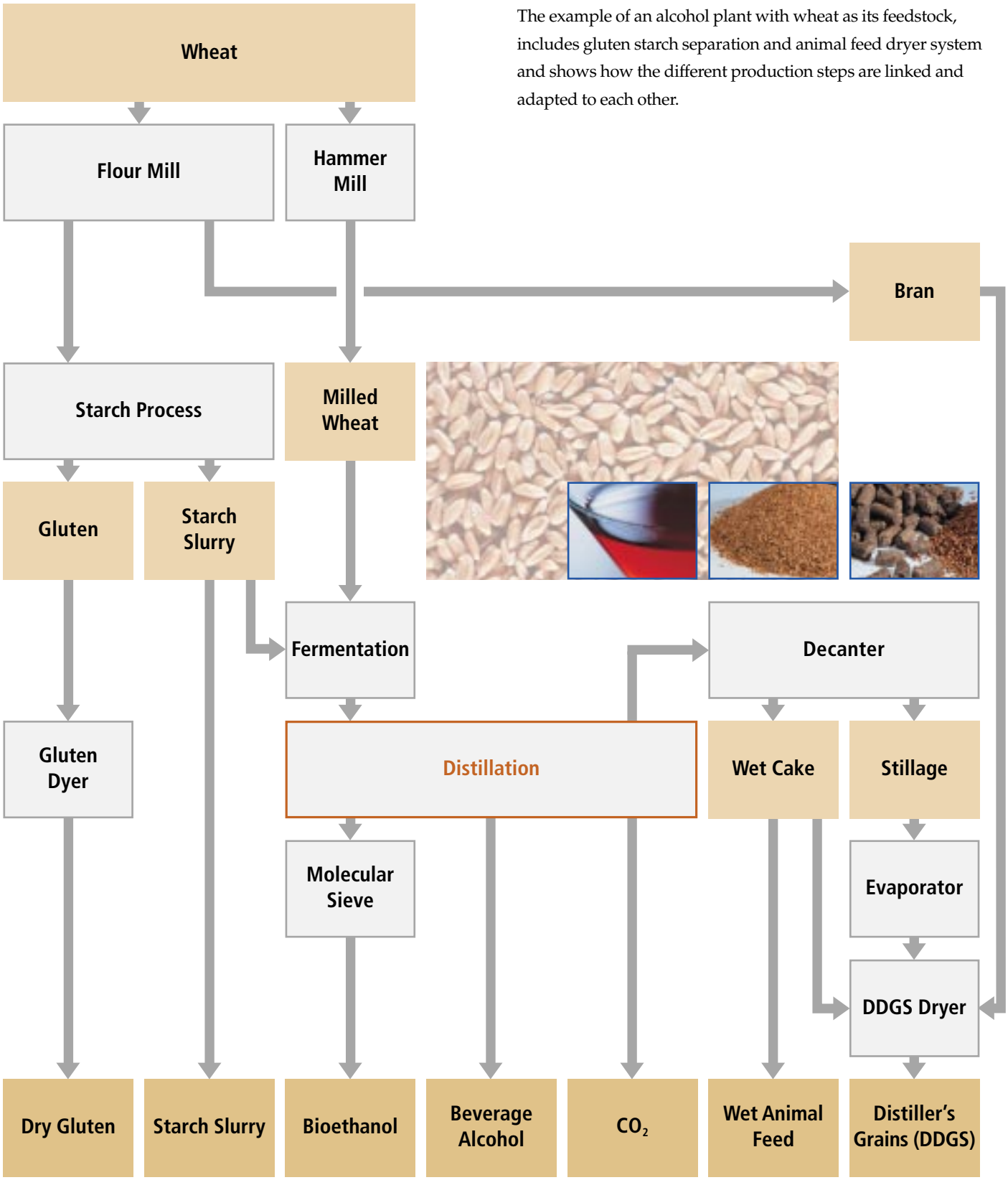
Evaporation

Crystallization

Tailor-made systems providing a wide range of upstream and downstream unit operations are available to complete the distillation system. Extensive know-how and long-standing experience within the GEA group provides our customers with the best, most efficient and reliably engineered solution in each case.

Unit Operations for Starch and Fermentation Products

The example of an alcohol plant with wheat as its feedstock, includes gluten starch separation and animal feed dryer system and shows how the different production steps are linked and adapted to each other.

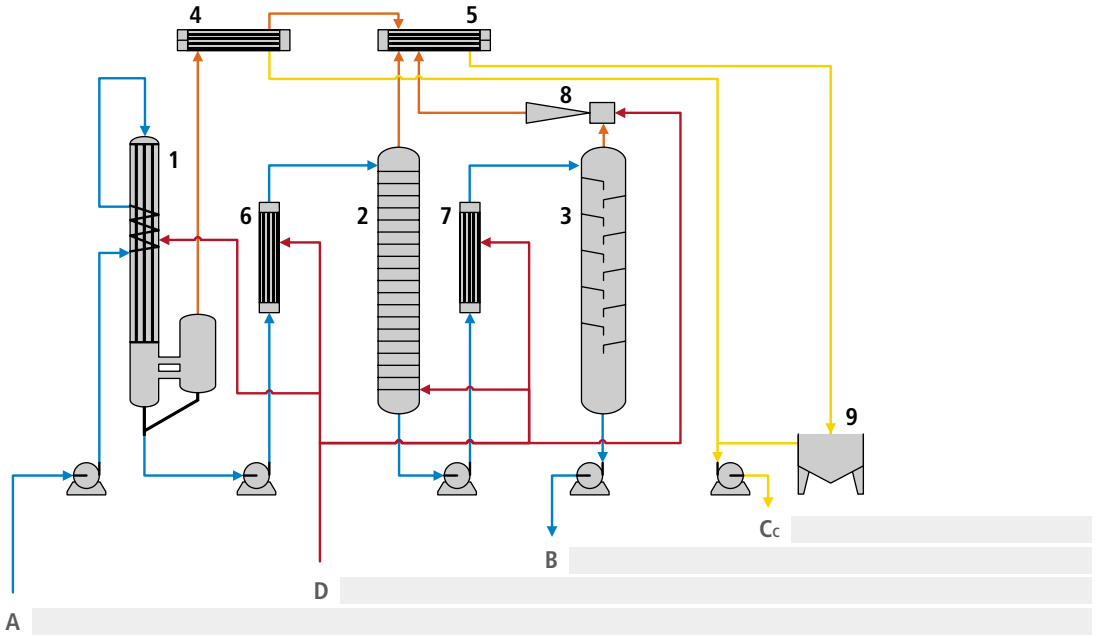


Applications in the Chemical, Pharmaceutical and Food Industries

Solvents and precipitants are frequently recovered from process and wastewaters, separated as high-purity substances or re-cycled. This is often of benefit to the environment and results in reductions to energy, utility, feedstock and waste disposal costs.

Within this range of applications, the number of solvents to be treated can be very high, and the performance range of the plants is particularly extensive.

The recovery of solvents and precipitants for their recycling within a process is most efficiently achieved where the energy requirement is very low, or where the energy can effectively be re-employed in other applications.



1 *Falling film evaporator*
2 *Stripping column*
3 *Dehydration column*
4, 5 *Condensers*
6, 7 *Preheaters*
8 *Thermal vapour recompressor*
9 *Decanting vessel*

Vapour condensate
Concentrate
Heating steam
Product feed

Opposite page:

Above left: *Solvent rectification system for a pectin extraction plant*

Above right: *A stripping and rectification column, indirectly heated, for the recovery of solvents from a pharmaceutical production process*
Feed: 3,000 l/hr

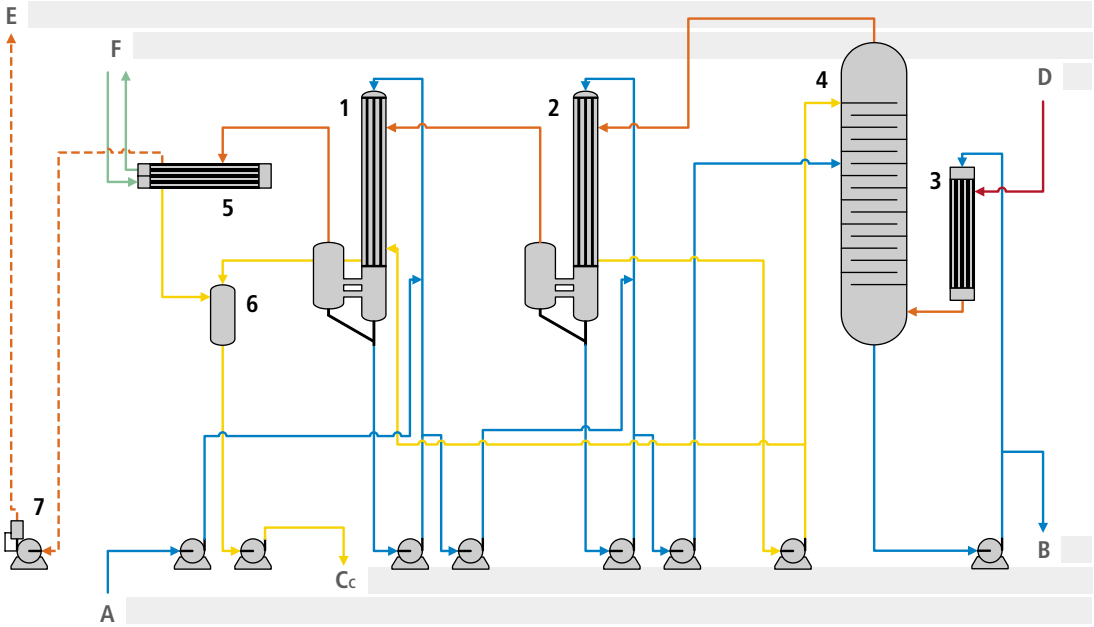
Below: *Flow sheet of an installation for the treatment of miscella*

Right: *Multi-purpose production plant for the recovery of various active ingredients from plant extracts*
Capacity: 490 kg/hr based on the recovery of 92 % ethanol

Below: *Example of a capacity increase for a distillation column by the addition of a 2-effect pre-evaporator*

For example, the energy used for distillation can be reused for the concentration of the bottoms product, which contains solids, by means of an intelligent design configuration. Alternatively, this energy can be utilised for the pre-concentration of the feed. This is especially interesting if existing distillation capacity is to be increased and the columns are already operating at their full capacity.

Examples from the Pharmaceutical industry show the wide ranging field of application, size and design – from pre-assembled, multi-purpose plants to multiple-effect pressure/vacuum plants.



Deaeration
Cooling water
Heating steam

1, 2 *Falling film pre-evaporators*
3 *Falling film reboiler*
4 *Distillation column*
5 *Condenser*
6 *Condensate collecting tank*
7 *Vacuum pump*

Concentrate/bottom product
Vapour cond./top product
Product feed

Engineering, Design and Automation

Our reputation is built on our engineering capabilities. Whether basic engineering, or a detailed engineering package, in each case you will receive the technology and expertise for the entire plant from one company.

Mass and energy balance calculations are prepared using the latest computer simulation programs, providing detailed analyses for different plant alternatives and thermally linked configurations.

The practical experience of our engineers, combined with a wealth of retained knowledge covering many specific products, is important for the correct design of a plant. In addition, upstream and downstream process steps such as fermentation and drying are also taken into account. On a day-to-day basis, our designers and manufacturing team are prepared to meet the requirements of implementing the engineering and planning activities at superior levels of quality, while at the same time, maintaining low costs.

Up to date design programs make it possible to depict the future plant in three-dimensional views while programs for the calculation of the load strengths of individual components are used for optimised designs.

Distillation aims primarily at achieving products of high purity and quality. For this reason, the steam pressure, product supply, vacuum and other parameters, which influence the distillation process and change mass and heat transfer rates, are controlled. Depending on the technical and customer specific requirements, GEA Wiegand plants are equipped with measuring and control systems – from simple conventional controls to complete integrated process control systems.

Above: *Control room with highly advanced automation*

Left: *3D depiction of a solvent rectification system for a pectin extraction plant*

Manufacture, Transport, Erection, Commissioning and After-sales Service

Manufacture

The GEA Wiegand manufacturing works is situated in Beckum, Westphalia. Covering an area of more than 6,500 m², large plant components are manufactured and prepared for transport. Additional manufacturing facilities are available, for example, in South America and China.

Transport

Smaller plants may be completely assembled in our manufacturing works and dispatched as compact or skid mounted units, ready for site connection. Most plants however, are assembled on site due to their large size.

Erection and Commissioning

Depending on the arrangement, distillation plants can be extremely complex, and therefore initial commissioning requires certain experience. Experienced specialists are therefore assigned this task, and would also be available to train the customer's personnel.

After-sales service

Each plant permanently achieves its optimal performance if it is expertly maintained. This service requires specialists who, if required, immediately trace and eliminate faults so that production losses caused by periods of standstill can be minimised. Our trained service personnel are therefore available. Thanks to their up-to-date training, they are in a position to carry out maintenance and repairs quickly and thoroughly. Users benefit from our spare parts service: based on our plant reference numbers and a description of the item, spares can be ordered online or quotations requested for the required item.

Top down:

Specialist welding of a stainless steel distillation column

Road transport of an abnormal load column, part of an alcohol plant

Erection of ethanol columns for the production of biofuel

Overview on our Range of Products

Evaporation plants
to concentrate any type of fluid food, process water, organic and inorganic solutions and industrial waste water; with additional equipment for heating, cooling, degassing, crystallization and rectification.

Membrane filtration – GEA Filtration
to concentrate and process fluid food, process water and industrial waste water, to separate contaminations in order to improve quality and recover valuable substances.

Distillation / rectification plants
to separate multi-component mixtures, to recover organic solvents; to clean, recover and dehydrate bio-alcohol of different qualities.

Alcohol production lines
for potable alcohol and dehydrated alcohol of absolute purity; integrated stillage processing systems.

Condensation plants
with surface or mixing condensers, to condense vapour and steam/gas mixtures under vacuum.

Vacuum/steam jet cooling plants
to produce cold water, cool liquids, even of aggressive and abrasive nature.

Jet pumps
to convey and mix gases, liquids, and granular solids; for direct heating of liquids; as heat pumps; and in special design for the most diverse fields of application.

Steam jet vacuum pumps
also product vapour driven; also in combination with mechanical vacuum pumps (hybrid systems); extensive application in the chemical, pharmaceutical and food industries, in oil refineries and for steel degassing.

Heat recovery plants
to utilize residual heat from exhaust gases, steam/air mixtures, condensate and product.

Vacuum degassing plants
to remove dissolved gases from water and other liquids.

Heating and cooling plants
mobile and stationary plants for the operation of hot water heated reactors, contact driers.

Gas scubbers
to clean and dedust exhaust air, separate aerosols, cool and condition gases, condensate vapours and absorb gaseous pollutants.

Project studies, engineering for our plants.

Process Engineering
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