VOGELBUSCH
Biocommodities

Evaporation

Unit Operations

VOGELBUSCH EVAPORATION PLANTS
Engineered for excellence

Right from the very start in 1921, novel evaporators played a key role in the company's track record of outstanding technical solutions. Since this time, Vogelbusch has been designing and supplying evaporation plants for a wide variety of applications in the chemical and foodstuff industries.

Evaporation systems have been improved in line with the development of proprietary bioprocess technologies, to optimize the concentration of mono- and polysaccharides, polyols, citric acid, yeast cream, and fruit juice as well as the treatment of corn steep water, distillation stillage, slops and other effluents. The spectrum of evaporation capacity in completed projects ranges from 0.4 to 75 tons of evaporated water per hour.

Today, Vogelbusch has a broad selection of proprietary evaporator designs and energy-saving concepts available that meet the diverse requirements of modern bioprocessing.

DECISIVE FACTORS FOR YOUR SUCCESS

As a non-manufacturing engineering company, we can **independently** select the best evaporator type and the best source in our global supplier network.

We are open to **all types of evaporators** and materials and engineer according to client's specifications and common standards such as EN / DIN, ASME, GOST, Japanese or Chinese standard.

Where practical and appropriate, systems are **prefabricated** in easy-to-install skid-mounted modules.

Our expertise in planning **integrated evaporation systems** is premised on our deep insights from proprietary process applications.

Highly specialized solutions stem from an intensive exchange of information with the client. We customize our proprietary evaporation systems to your process specification, with a special focus on **cost effective and reliable** operation.

We can **adapt existing plants** and embed evaporation units perfectly into existing processes.

VOGELBUSCH
Biocommodities

OUR SERVICES FOR EVAPORATION PLANTS

Vogelbusch provides engineering, consultancy and contracting services, and technology licensing. Our service packages for installing evaporation plants include:

- Process know-how and basic engineering
- Detail engineering or review of client's detail engineering
- Supplying equipment and/or provding procurement assistance
- Supplying automation including field instruments, and the hardware and software for control systems
- Supervising plant installation and commissioning

Alternatively, the entire unit may be provided as an EPC solution.

Our highly qualified experts are also available to upgrade or expand existing facilities.

VOGELBUSCH
Biocommodities

PROCESS SOLUTIONS

Evaporation is a proven solution in the bioprocess industry. In addition to being used in the concentration of intermediate and end products, it is also essential when it comes to separating thin slops or low-concentrated wastewater streams into a concentrated fraction and a condensate stream, which is frequently reused in the process.

CUSTOM-DESIGNED TO APPLICATION

Depending on the application, our design concepts differ and take into account the respective product characteristics, cleaning concepts, the required capacity, availability and pressure of steam and cooling water, as well as local energy costs. Every design is precisely adapted to the individual case by process simulation using a sophisticated thermodynamic property database that has evolved out of countless engineering projects.

Since concentration levels and thus the properties of the medium vary considerably during the process, selectively combining different evaporation modes in one unit ensures maximum efficiency.

Recirculated falling film evaporator (RFFE)

This system is suitable for low and medium solid content and viscosity. It is able to handle small temperature differences well, therefore making it predestined for temperature-sensitive products. Ample recirculation rates provide high turbulence in the falling film, resulting in a reduced tendency to fouling. In addition to low power consumption, a small footprint, and reduced steel structure, the system features a small liquid hold-up and residence time inside the evaporator, reducing the amount of cleaning agents needed and lowering the thermal load on the concentrated product.

Forced circulation evaporator (FCE)

Typically used for feedstocks with medium to high solid content and viscosity. Its multipass design for high velocity in the tubes results in high turbulence, minimizing fouling tendencies, and increasing heat transfer. As a result, it has extended operating periods between cleaning cycles.

Plate evaporator

Rising film evaporation in plate evaporators is an option for low-fouling media, being widely used for the concentration of temperature-sensitive products because of the minimized hold-up. Other advantages are the compact design and the low investment costs.

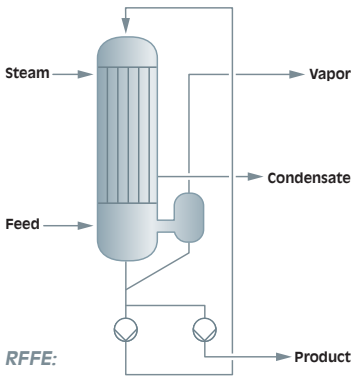
Thermo-syphon evaporator (TSE)

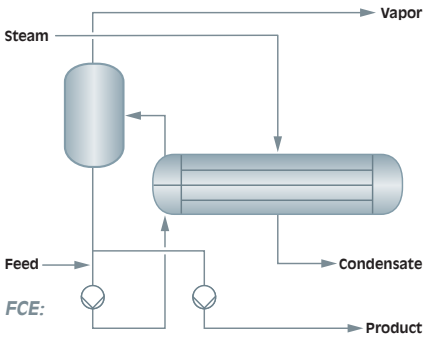
Thermo-syphon systems ensure a smooth transfer of heat without the need for a pump. They are the first choice when it comes to evaporating clear substrates at high temperature differences (dT>15 K), for example as reboilers for rectification columns.

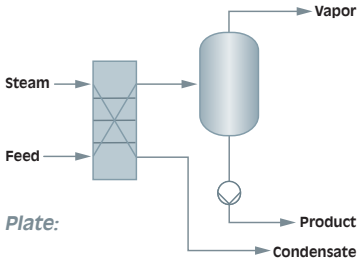
DESIGN OPTION

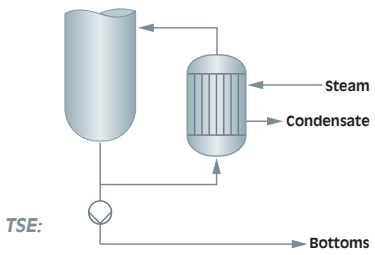
Prevention of fouling

We select the design details and temperature levels in our evaporation plants in such a way as to minimize fouling in the most economical manner, even when it comes to the evaporation of difficult substrates such as slops from molasses (vinasses). Vogelbusch evaporation plants may be equipped with a CIP (cleaning in place) system to clean the surfaces periodically with alkali or acid solutions. The entire plant, including the CIP system, may be controlled in a fully automatic way depending on the requirements of the client.









VOGELBUSCH
Biocommodities

TYPICAL APPLICATIONS IN THE FERMENTATION INDUSTRY

Vogelbusch evaporation plants are an integral part of the production process. On the one hand, evaporation serves to concentrate intermediate and end products while, on the other, it is used to process effluents that accumulate in large quantities in the fermentation industry, as well as to obtain valuable by-products from the slops.

Product concentration

Biocommodities such as glucose, citric acid, and sorbitol typically form in low concentration solutions. Removing the water leads to high evaporation loads, which require particularly efficient processes with gentle product treatment. Our evaporation plants are always perfectly embedded in the overall process, in particular by way of the distinct thermal integration and reuse of condensates.

Stillage

As a by-product from grain alcohol production, decanted stillage is concentrated by means of evaporation and mixed with decanter cake to obtain WDGS (wet distillers grains and solubles). To increase its shelf life and make shipment easier, it can be dried and even pelletized to DDGS (dried distillers grains with solubles). Both are commonly sold as a high-protein feed supplement.

Vinasses

Slops from molasses/sugar juice alcohol production (vinasses) are evaporated to certain concentrations before being used in different applications. They can be spread as fertilizer, incinerated in cogeneration systems, or used as additive in animal nutrition (its specific potassium content can make desalination necessary though). Residues from biogas digesters may also be concentrated by evaporation.

DESIGN OPTION

Incineration of vinasses

It is possible to make good economic use of concentrated vinasses by means of incineration with subsequent heat recovery. This type of utilization requires vinasses with a dry matter substance content of about 55 - 60 %. At these concentrations, the energy value is usually sufficient for combustion without an additional supporting fire. The cogeneration of electrical power with superheated steam can cover a considerable portion of the power and heating needs of the factory.

VOGELBUSCH
Biocommodities

ENERGY-SAVING CONCEPTS

Vogelbusch evaporation systems are designed for outstanding performance in terms of energy consumption and overall economics. Our specific choice of equipment is geared to

- prevailing energy costs
- steam versus electric power costs
- availability of the various types of energy
- availability of secondary energy

in relation to the respective investment costs.

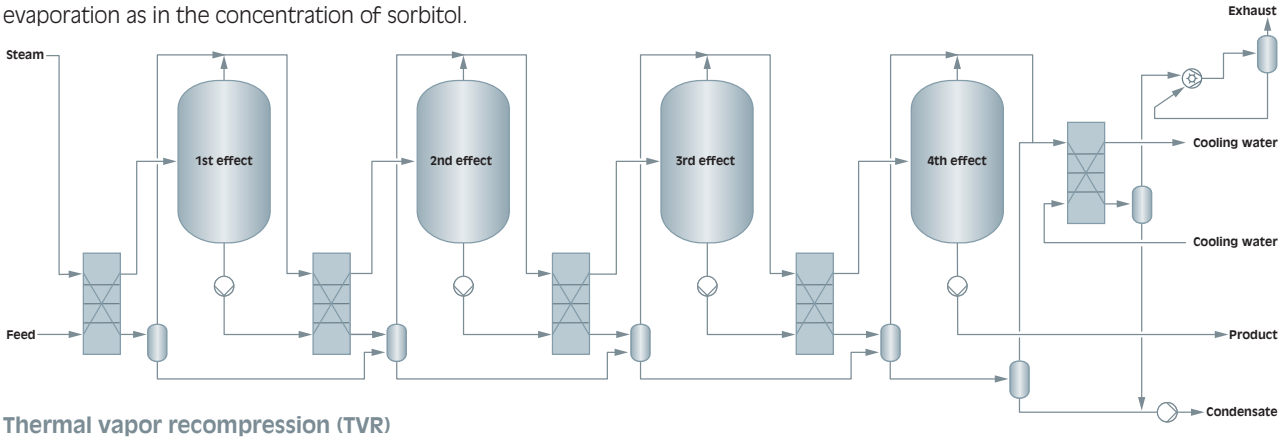
Heat recovery from thermal processes and the reuse of secondary energy significantly reduce the primary energy requirements. This sort of process optimization not only reduces operating costs, but also improves the plant's environmental footprint.

MULTIPLE USE OF PRIMARY HEAT INPUT

When it comes to our custom evaporation systems, we take the available steam pressure and available utilities into account to achieve the best possible heat recovery rate.

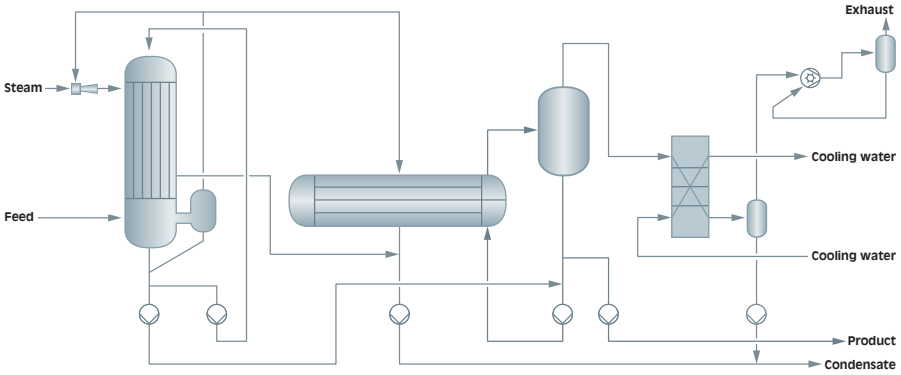
Multi-effect evaporation

To achieve the required degree of concentration, evaporation units can consist of a series of evaporation stages or "effects", being designed in a cascading fashion, with each effect heating the next with its vapors. Depending on the product characteristics and utilities available, the process of heat recycling has been realized in systems with up to nine effects. Multi-effect evaporation systems are also suitable when low-pressure (waste) steam or other heat sources (for instance exhaust vapors from a dryer) are available on site. The following example shows multi-effect evaporation as in the concentration of sorbitol.



Thermal vapor recompression (TVR)

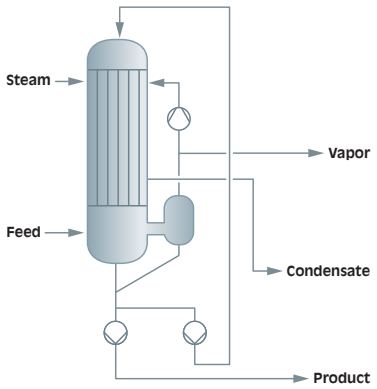
If high-pressure steam is available, a thermal vapor recompression system reduces the steam and cooling water consumption. The illustration below shows a combination of falling film and forced circulation evaporators arranged in a double effect TVR system.



VOGELBUSCH
Biocommodities

Mechanical vapor recompression (MVR)

MVR systems are based on the principle of a heat pump and use electricity and a fan or turbo-compressor to run the evaporation process. With negligible levels of steam and cooling water consumption, MVR systems are an economical alternative, especially for solutions with low concentration and low boiling point elevation. As such, MVR systems are often used as pre-evaporators in a complex evaporation unit, while the final concentration is achieved in a multi-effect evaporator.



COMPARISON OF TYPICAL CONSUMPTION FIGURES

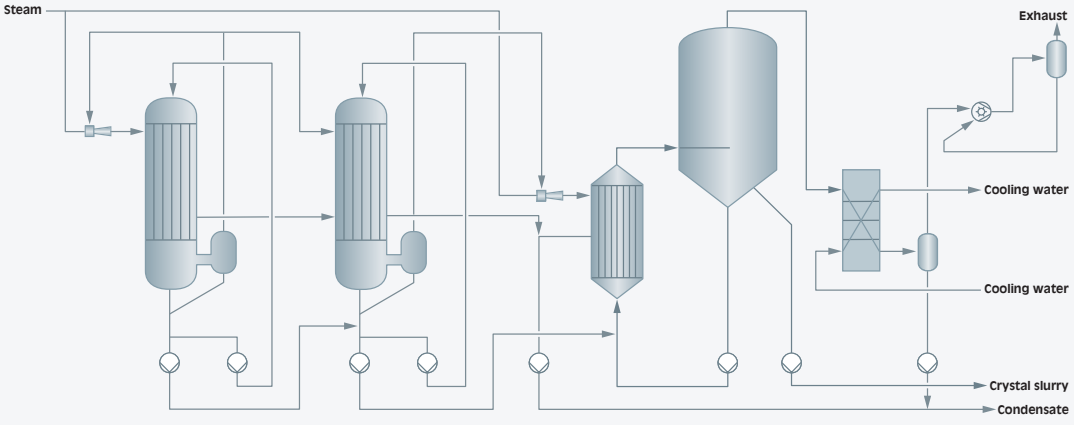
The following table shows typical consumption figures of different evaporation concepts on the example of glucose evaporation. The values apply to 1,000 kg of evaporated water.

SYSTEM	STEAM PRESSURE (barg)	STEAM (kg)	ELECTRICITY (kWh)	COOLING WATER dT=10 K (m^3)	Criteria CAPEX / OPEX
3 Effects	1	370	2	22	minimum investment if cheap low-pressure steam is available
3 Effects + TVR	9	250	2	14	efficient system with moderate investment costs
4 Effects + TVR	9	210	2.5	12	highly efficient system with medium investment costs
MVR	1	25	25	1.5	higher investment costs pay off due to minimized operating costs

THERMAL INTEGRATION

In order to save primary energy, our designs also consider the options of integrating the heat of the evaporator with other process groups:

- Flash vapors, as always available in sweetener or alcohol production plants, are a valuable source for heating product or effluent evaporators.
- A standard solution in Vogelbusch grain alcohol plants is reusing drier vapors to heat the multi-effect stillage evaporator. This design reduces the live steam demand for the evaporator to zero.
- Alternatively, coupling distillation/rectification and dehydration with the evaporator also results in a significant reduction in steam demand.
- The latent heat of the vapors from the last effect - usually condensed by cooling water - can be utilized in other process units. For instance, the crystallizer in citric acid production can be heated in this way (example below).



VOGELBUSCH
Biocommodities

VOGELBUSCH
Biocommodities

VOGELBUSCH Biocommodities GmbH | Blechturmgasse 11 | 1051 Vienna | Austria
T +43 (0) 1 54661 | vienna@vogelbusch.com | www.vogelbusch-biocommodities.com

VOGELBUSCH USA Inc. | houston@vogelbusch.com
VOGELBUSCH Hong Kong Ltd. | hongkong@vogelbusch.com

2020 | Evaporation

We make biotechnology work