Evaporators

API Schmidt-Bretten
Schmidt technology is know-how; know-how for the design of evaporation plants. It is distinguished by high quality results from the competence and creativity of our engineers. With over one hundred years of experience as manufacturers of heat exchangers and plants for thermal processing, we have had a major influence on the technology of evaporation. In processing liquids with suspended solids, Schmidt has made major contributions to the state of the art.

We have been designing plants with plate evaporators for more than 40 years, and have been guided by the following objectives:
- to design plants which deliver the best possible product quality
- to provide economical systems with low operating cost

Schmidt designs, manufactures and installs complete turnkey plants for many different feed streams, taking into account their inherent product characteristics.

In close cooperation with our customers, we develop the most appropriate process for the product to be treated. When required, we also act as an engineering partner and manage the overall technical design of the plant.

Schmidt technology is the result of extensive research and development. In the early 80's, motivated by a growing need for better, more flexible evaporation systems, we developed the SIGMASTAR® evaporator.

Since its design is fundamentally new, the SIGMASTAR® has been awarded patents in many countries. The unique characteristics of SIGMASTAR® evaporation plants allow Schmidt to supply equipment to many different and diverse industries. The performance of the SIGMASTAR®, on widely different products, far surpassed the most optimistic projections.

Organic Natural Products
We have built plants for processing stick water, hide and bone glue, protein hydrolysates, technical and photographic gelatines, oils, molasses, slops, yeasts, yeast extracts, wort, drug extracts, hops extracts, plant extracts, tanning extracts, corn steep water, glucose, dextrose, fructose, and waste waters from potato and wheat starches.

Areas of Expertise
Schmidt concentration plants are used in the food, chemical, fermentation, and pharmaceutical industries. They are also used for waste treatment. We manufacture plate & frame designs, with energy saving options such as thermal vapour recompression (TVR).

Foods and Beverages
We have delivered systems for fruit juices, fruit purees, pulp concentrates, vegetable juices and purees, tomato juice, vegetable extracts, pectin, edible gelatines, malt extracts, sorghum extract, beer wort, cane and beet sugar, liquid sugar, dealkoholised wine and beer and aroma recovery for many different kinds of products.
The SIGMASTAR® Evaporator Plate

Due to their special construction, SIGMASTAR® evaporators can be used for nearly all evaporation processes. Especially for problem products (e.g., viscous streams, slurries, and liquids with fouling tendencies) which cannot be processed with falling-film evaporators, the SIGMASTAR® evaporator performs smoothly and successfully.

of the plate. Here the corrugation is arranged to permit vapour to flow in the transverse direction, and to the channels. The cross-sectional flow area is the same on both sides of the plate.

- Figure 2 shows a variation of the SIGMASTAR®-90 plate; the partitioned SIGMASTAR®-45 plate. This plate allows two products to be processed simultaneously. On the right is the correspondingly partitioned steam plate. Steam can enter either the left, the right or both sides of the plate, the condensates exit from the bottom of the corresponding side(s) of the plate.

- The SIGMASTAR®-90 and the SIGMASTAR®-45 can be combined in many different ways to increase the flexibility of our plants, especially for small duties.

- As the dimensions of both plates are identical, the same frame supports can be used. Expansions and modifications involving both plate types are possible at any time.

Some advantages of the rising-film SIGMASTAR®-90 and SIGMASTAR®-45 are:

- superior product distribution due to the thermo-siphon principle. As product boils and rises in the tube, fresh product automatically rises to re-fill the tube. This distribution technique operates independently of the feed rate, and allows a high degree of flexibility and the possibility of partial-load processes
- very short residence time; product is in the SIGMASTAR® plate for less than a second. This is due to the short flow distance and the high product film velocity. This feature guarantees a gentle treatment of the product
- low pressure losses across the tubes, a benefit of the short tube length
- high vapour velocity in the rising film, which allows the processor to achieve high concentrations and viscosities
- clearly defined product flow path. There is no chance of local over-concentration
- high heat transfer co-efficients are obtained even when the feed temperature is lower than the boiling temperature
- compared to other evaporator systems less expensive for high grade materials

Product enters the lower part of the evaporator plate and floods the tubes. In this manner, every tube has equal access to the product feed. Steam condenses on one side of the plate, product boils on the other. The vapours generated in the tube channels create a thin, high-velocity film which rises to the top of the plate.

Since Service steam cannot cross corrugation peaks in the transverse direction, we employ a distribution area in the upper part

![Fig. 1: SIGMASTAR®-90 Evaporator Plate](image)

![Fig. 2: SIGMASTAR®-45 Evaporator Plates](image)
The **SIGMASTAR®** Evaporator

Figure 3 shows an assembled SIGMASTAR®-90 evaporator. The evaporator plates are fitted in a frame. Perimeter bolts clamp the fixed and movable covers together. This compresses the gasket seal at the edges of the plate. The function of the flooded lower product chamber is to distribute the product evenly to the tubes.

- The rising-film evaporation creates a two-phase flow: the generated vapours induce a product film on the tubes. The resulting mixture of liquid and vapours flows to the channel at the top of the plate. From there it flows forward to the fixed cover of the frame and into a downstream vapour/liquid separator.

- The steam enters through two channels at the top of each side of the plate. Heating steam is distributed across and along the plate, condensate is discharged at each side of the bottom.

- Since all connections and steam inlets are on the fixed frame, it is no problem to open the unit or to rearrange the evaporation surface.

- Furthermore, it is possible to direct steam to all four steam inlet areas. When all four steam inlets are used, a portion of the steam passes to the rear of the plate pack allowing the SIGMASTAR® to be used for larger evaporation capacities and at higher vacuum.

Besides the possibility of a large number of operating variations, the SIGMASTAR®-45 plate presents the advantage that different effects or stages can be incorporated into a single frame. An extremely compact system can be built at reasonable cost.

Figure 4 shows an example - a 2-stage unit with a downstream condenser. In the first evaporation stage, the raw product is pre-concentrated by means of a mixture of vapours and motive steam. In the second stage, concentration is continued by means of vapours coming from the first stage. The vapours boiled off of the product in the second stage are condensed by means of cooling water in the condenser.

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**Fig. 3: SIGMASTAR®-90 Evaporator**

**Fig. 4: SIGMASTAR®-45 Multisection Evaporator**
Single and Multiple Effect Evaporation

The evaporation of liquids is, independent of evaporator type, always associated with high energy costs. Thus the energy cost is the major in the overall operating cost.

By using multieffect plants and by judicious use of thermal and mechanical recompression the energy consumption can be reduced. (Specific steam consumption under 3%).

In a similar way this vapour can be used to heat a further effect; thus two, three or multiple effect evaporators can be constructed.

With such evaporators the water evaporated per unit mass of steam approaches the theoretical optimum of 2:1 with double effect plants, 3:1 with triple effect plants and so on. Thus with an increasing number of effects the specific steam consumption decreases. The necessary temperature difference per effect is achieved by progressively lowering the operating pressure (i.e. increasing vacuum).

However, lower operating costs entail a higher initial investment. The most profitable balance depends on the individual application criteria (concentration, performance, annual production times, length of production, product data, cost and availability of energy, etc.).

Multiple Effect Evaporation

In multiple effect evaporators the same heat energy is used several times. This is effected by progressively lowering the temperature from stage to stage. Fresh steam is used to heat the first effect. The vapour product, at a lower temperature, is used as heating medium for the second effect which operates at an even lower temperature.

Evaporation with Vapour Recompression

The reuse of heat, effected in the multiple effect evaporator, can also be achieved by means of thermal or mechanical recompression.

The use of thermal vapour recompression (thermocompression) can, for example, be used to give a triple effect evaporator the same energy economy as a quadruple effect plant with a corresponding reduction in investment.
The use of mechanical vapour recompression allows almost complete energy recovery and a theoretical zero steam consumption. The operating costs are low but the technically complex plant is expensive.

Vapour Recompression
These are effectively heat pump systems wherein low pressure/temperature vapours are recompressed to the pressure/temperature of the heating steam permitting their reuse. At this point we must distinguish between thermal and mechanical vapour recompression.

Thermal Vapour Recompression (TVR)
This type of plant has steam ejectors as compressors. These, having no moving parts, are simple and inexpensive.

Thermocompressors recompressing only a portion of the vapour, do not represent the ultimate in energy conservation. Under certain conditions (e.g. high load, long operating times, low electricity costs) mechanical vapour recompression becomes the preferred energy saving alternative.

The steam ejector consists essentially of a steam nozzle which discharges a high-velocity jet across a suction chamber that is connected to the vapour-liquid separator. The vapour is entrained by the steam and carried into a venturi-shaped diffuser which converts the velocity energy of the steam into pressure energy. This resultant vapour is then used as the heating medium for this effect.

Fine Chemicals and Pharmaceuticals

Fields of application
We have provided systems for acids (citric acid, etc.), bases (sodium hydroxide, etc.), salt solutions (ammonium nitrate and ammonium sulfate), aluminium sulfate, magnesium chloride, amine solutions (urea, etc.), alcohols (glycol, methanol, glycerin, etc.), aromatic compounds (toluol, xylene, etc.), raw and intermediate products for synthetic materials and fibers (caprolactam water), synthetic glue, pharmaceutical products (sorbitol, sorbose, enzyme solutions, antibiotics, monosodium glutamate, as well as many types of waste water.

An example of a typical installation
Concentration plant with SIGMASTAR® evaporators for the concentration of vegetable oil with the simultaneous recovery of extraction solvent.
Evaporator capacity: 1,500 kg/h of solvent
Final product: solvent-free vegetable oil

A comprehensive cooling and condensation system guarantees minimum solvent concentrations in the exhaust gases. The special construction of the gaskets ensures a maximum service life.

Due to the azeotropic nature of the mixture, concentration must be done in two effects at different process pressures in order to achieve a complete separation.
Organic Natural Products

Fields of application
Schmidt evaporators are used for processing stick water, hide and bone glues, hydrolyzed proteins, technical and photographic grade gelatines, oils, molasses, slops, yeasts, yeast extracts, wort, drug extracts, hops extracts, plant extracts, tanning extracts, corn steep water, glucose, dextrose, fructose and potato waste water.

A typical installation
Concentration plant with SIGMASTAR® evaporators for glucose.
Evaporation capacity: 10,000 kg/h
Concentration: 33 to 85% total solids
Specific steam economy: approx. 27%

- For this product, the extremely high viscosity required a special plant arrangement. The product flows through the effects in the sequence 4-3-2-1 counter current to the heating steam. Low evaporation temperatures and a final flash cooler prevented thermal damage to the product. Condensate streams from the various effects are used for inter-effect heating thereby reducing steam consumption.
Another typical installation
Concentration plant with SIGMASTAR® evaporators for hydrolyzed proteins

Evaporation capacity: 4,000 kg/h
Concentration: from 8-12 to 50-58% t.s.
Steam Economy: approx. 22%

For this product, consideration of many product specific characteristics led us to choose a 3-1-2 arrangement. Discharging the product at the slightly higher temperature of the second effect enabled a trouble-free achievement of the final concentration. A thermocompressor ensured optimum economy. Continuous operation coupled with extremely short residence times maintain the highest product quality. This plant has as an additional feature full automatic control for start-up, operation, shut-down and cleaning-in-place.
SIGMASTAR®
Evaporation plants

Schmidt-Bretten has been developing evaporation technology continuously for decades. The revolutionary concept of the SIGMASTAR® evaporator was derived from the first industrial Schmidt plate-type evaporator.

The novel corrugation of the SIGMASTAR® evaporator plate results in parallel tubes that take in the product at the bottom and discharge the concentrate and vapour mixture at the top. This pioneering technique is accomplished in the SIGMASTAR® rising-film plate evaporator.

Its outstanding attributes are:

- **Supreme performance:** Clear juices, juices with a high solid or fibre content, purées and highly viscous products can be evaporated to very high concentrations. Three examples: normal clear or coloured juice concentrates up to above 85% dry substance, mango and guava purées 32% dry substance, and untreated apple purée (hot break) 24% dry substance.

- **Fast and gentle evaporation:** The low temperature load ensures benevolent evaporation during very brief dwell times.

- **High concentrate quality:** The pure characteristic taste provides broad scope for further processing to obtain products that are full of natural goodness.

- **Optimum product distribution:** Thanks to the rising-film principle of the evaporator, the channels act like "communicating tubes", filling uniformly and autonomously across the entire evaporator width and depth.

- **Performance range:** Up to 40 m³ input per hour, evaporation rates up to 25 tons per hour.

- **Capacity adjustment:** In the performance range between 50 and 100% of the stated nominal output, SIGMASTAR® evaporators guarantee faultless operation. The evaporation output continuously adjusts to match the current operating capacity utilization.

- **Flexibility:** Two different plate variants and numerous circuit options ensure flexible performance adaptation.

- **High efficiency:** The five steam consumption is between 0.4 and 0.2 kg per kg evaporated water.

- **Low overall height:** Maximum evaporator and separator height 4.50 m.

- **Capacity expansion:** The evaporator output can easily be expanded to maximum capacity by inserting additional plates.
SIGMASTAR®
Aroma recovery plants

When concentrating juices, important flavours enter the vapour phase. These have to be processed separately to ensure their availability for the drink production process.

SIGMASTAR® aroma recovery systems employ a rectifying column to recover the flavour. This achieves the following:

- **Complete aroma recovery:**
  The SIGMASTAR® method recovers the aroma from all vapours and vapour condensates so that the full complement of flavours contained in the juice is regained.

- **Genuine flavour concentrate:**
  The use of a rectifying column with stripping and concentrating stages reliably obtains a genuine flavour concentrate of very high quality.

- **Benevolent recovery:**
  Temperature control in the rectifying column is matched to the product, thus ensuring the most favourable aroma recovery conditions.

- **High efficiency:**
  The aroma recovered from a juice is sufficient for a larger quantity of concentrate when subsequently manufacturing the drinks.

The combination of SIGMASTAR® evaporation and aroma recovery plants currently ensures the most protective and efficient concentrate production and the highest aroma yield from all kinds of juices.