Evaporation Technology

Evaporation, Crystallization and Rectification
GIG Karasek is a leading European supplier of system design and turnkey plant construction in the field of process evaporation, thermal separation technology and equipment and machinery for the chemical, pharmaceutical, food ingredients, pulp & paper, petrochemical, and related allied industries.

The advantage for our customers is our ability to be your Single Source Partner for all critical project stages - from basic engineering through manufacturing of key components and final assembly and erection of the entire plant - thus assuring successful implementation and economic execution within a tight project schedule.

What this means is that improvements and alterations in scope of supply are accomplished in the shortest time span and with minimal cost impact. The close working relationship of our engineers and production experts with clients means that further refinements remain consistently a matter of course.

GIG Karasek draws on its extensive experience and expertise over decades in the design and production of Falling-film, Force circulation, Thin-film and Short-path Evaporators.

As a client you will tap into the resources of a dynamic and lean organizational structure comprised of highly skilled technical experts who remain a pleasure to work with and can guarantee efficient realization of your projects. The wealth of experience and in-depth competence of our people in process engineering and successful plant construction are the foundation of a company which never loses sight of the future.

We get the best out for you...
Evaporation Technology
Range of Activities

**Evaporation**
- MVR
- Multi-Effect

**Crystallization**
- Evaporative Crystallizers
- Cooling Crystallizers

**Rectification**
- MVR
- Multi-Effect
- Conventional Single Effect
Some samples of GIG Karasek Mechanical Vapor Recompression (MVR) Plants

**Typical MVR Evaporators with Fan Type Recompressor**
Features: Evaporator with large surface (up to even 6000 m²), Δt (heating to process side) 4-5 K, tube length up to 26 ms, high efficiency in heat recovery between inlet and outlet liquors, evaporator with multiple liquid passes for optimized heat transfer rates

**MVR Evaporator for Potato Tube Liquor**  Capacity: 250 t/h
- 4 off 4600 m² Pre-Evaporators with one mechanical recompressor each. Drives: 4*1,2 MW
- Finisher: Quadruple-Effect Evaporator modified and revamped by GIG Karasek
- Project Schedule: Completed within 7 months after order. On stream with 100 % capacity within 1/2 month after start-up.

**MVR Evaporator for OPE Liquor**  Capacity: 150 t/h
- Pre-Evaporator with single recompressor. Finisher with two additional recompressors in series with the main recompressor.

**MVR Evaporator with Finisher**
If elevation of boiling point gets significant, multiple pass evaporators and finishers provided with an additional recompressor (working in series to the main recompressor) are employed.
Outstanding Economy by MVR Technology

Full recycle of the latent heat by mechanical recompression is the most economic way of heating evaporators. Ingenious know-how allows GIG Karasek to offer MVR technology as one of the only few bidders in Europe in this field. The vapors from the process side are being recompressed and used for heating the evaporator. Depending on application (elevation of boiling point, heat transfer) Power Fans (one, two or three in series) or Turbo Blowers are employed as heat pumps.
Evaporation

Typical Energy Consumption for MVR Systems (per t of evaporated water)

- **Milk and Whey**: 10-12 kWh/t
- **Pectin**: 10-11 kWh/t
- **Flavor Recovery**: 10-14 kWh/t
- **Potato Tube Liquor**: 11-12 kWh/t
- **Dump Drainage**: 10-15 kWh/t
- **Stillage**: 11-25 kWh/t
- **Corn Steep Liquor (with finisher)**: 20-30 kWh/t
- **Corn Steep Liquor (pre-evaporator)**: 11-15 kWh/t
- **Citric Acid**: 25-36 kWh/t
Multi-Effect Evaporators

6-Effect Evaporator with integral stripper for process condensate
Application: Black Liquor

7-Effect Evaporator with feed stripper and air-cooled condenser
Application: Magnesium Bisulphite Liquor

Example:
Multi-effect for distilling highly pure water for pharmaceutical application
Capacity: 6000 l/h
Evaporation

**Film Plate Evaporators**

**Proprietary GIG Karasek**

**Film Plate Evaporators (PFF)**

A liquid film flowing down the outside of a pillow plate, which is heated from the inside, forms the principle of the GIG Karasek PFF Evaporator. The outstanding features of the GIG Karasek turn out where hard incrustations are formed at the outside surface of the plate. When heating the plates at start-ups, such incrustations will prickle off due to the thermal expansion of the plates. Low pressure drop on process side has become another important advantage of the GIG Karasek Film Plate System especially for vacuum applications.

**Tube and Shell Type Falling Film**

A liquid film flows down the tubes. The heat is transferred through this thin, in most cases turbulent film. Evaporation takes place at the surface of the film. The evaporator can be fitted with multiple liquid passes. In case of important evaporation rates the liquor is being recirculated for sufficient liquid load at the heating surface. The GIG Karasek falling film philosophy is based on:

- **High Liquid Loads**
  - improved heat transfer, less fouling

- **Large Tube Diameters**
  - low pressure drop excellent for multi-effect and MVR plants

- **Multi-Liquid Pass with Dynamic Liquor Separation**
  - high efficiency of the heating surface, low residence time, proper drain

The details above make the falling film evaporator an ideal equipment for concentrating pure liquors and even liquors containing sludge and liquors with low and medium viscosity. With medium viscosity it even beats the forced circulation evaporator, if sufficient recirculation rates are applied!
Forced Circulation Evaporator

The process liquor is being superheated at the heating surface. The liquid level above the heating surface prevents bubbling at the heating surface. Thus flashing only takes place in the separator and fouling of the heating surface by incrustation under the bubbles is sufficiently avoided. A high-flow pump provides sufficient recirculation rates for the job. Fields of employment:

- Evaporative Crystallization
- Liquors with low and medium viscosity
- Liquors with tendency to fouling
- Reboiler for columns

Fields of Application:

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<th>Starch Industries</th>
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<td>Corn steep liquor</td>
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<td>Wheat waste liquor</td>
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<th>Industries for Saccharides and Polyols</th>
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<td>Invert sugar solutions</td>
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<td>Isomaltulose</td>
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<td>Maltose</td>
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<th>Cellulose and Fiber Industries</th>
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<td>Magnesium bisulphite liquor</td>
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<td>Bleaching plant effluent</td>
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<td>Fiber solution</td>
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<td>Spinning bath solution</td>
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<th>Industries for Organic Acids and Salts</th>
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<td>Citric acid</td>
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<tr>
<td>Sodium citrate</td>
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<td>Lactic acid</td>
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<td>Amino acids</td>
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<td>Citrus and apple pectin solutions</td>
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<td>Fruit juices</td>
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<th>Industries producing Vitamines</th>
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<td>Yeast solutions</td>
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<td>Vitamin B formulations</td>
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<th>Bio-Alcohol Industries</th>
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<td>Stillage from cereals or corn</td>
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<td>Vinasse</td>
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<th>Pharmaceutical Industries</th>
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<tr>
<td>Fermentation waste liquor</td>
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<td>Active substances</td>
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<th>Miscellaneous Applications</th>
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<td>Glycerin Solutions</td>
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<td>Oil Emulsions</td>
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<td>Copper sulfate solutions</td>
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Crystallization

Magma Crystallizers

GIG Karasek offers magma crystallizers. This type of crystallizers are employed where low difference in density between the crystals and the mother liquor does not allow reasonable classifying, or such crystal classification is not required. Low temperature difference in the recirculation and high recirculation rates are the tools to obtain reasonable crystal sizes.

Application:
Many organic acids and salts, e.g. citric acid, citrates, amino acids.

Evaporative Crystallizer

Saturation of solids in the solution is exceeded by evaporation of the solvent and thus crystallization is effected. High recirculation of the crystal magma offers sufficient crystal surface in the zone of supersaturation for crystal growth. As crystallization mainly takes place at the crystal surfaces offered by the recirculated crystal magma, formation of fines is being kept at a sufficiently low level.

Energy: In case of low or moderate boiling point elevation of the mother liquor, it is possible to employ either double or triple-effect systems, or mechanical vapor recompression

Example: MVR heated crystallizer with three mechanical recompressors in series for energy-economic crystallization of an organic salt.
**Cooling Crystallizer**

**Cooling through Exchanger Surface:**
Heat of crystallization and surplus heat supplied with the feed is being removed by a coolant through a tube and shell cooler situated in the recirculation line. High recirculation rates ensure the presence of sufficient quantity of crystals in the zone of supersaturation, in order to take care for good crystal growth and thus formation of fines is being reduced.

**Vacuum Flash Cooling:**
The superheated solution is fed to the recirculation line of the crystallizer. Flashing takes place under the vacuum conditions, but after mixing of the feed with the crystal magma. Thus crystal growth rules over the formation of fines, which is being sufficiently reduced.
Rectification

Some samples of GIG Karasek MVR Plants

**MVR Rectification System for Alcohol**
- Capacity: 100 t/h Feed / 50 % alcohol
- Column: 40 ms high, Packing: High Performance Rings
- Recompressors: 2 Power-Fans in series
- MVR Drives: 2*1800 kW / 6 kV Motors

**MVR Rectification with Separate Stripping Column**
- Application: Low content of solvent causes already decrease of the boiling temperature to less than (+10) K above that of the top product and the steam consumption for stripping the residual solvent is low.
- Thus: There is only a single recompressor required for the main reboiler, but steam is additionally necessary for the stripping column.

**MVR Rectification with Two Recompressors:**
- Application: The boiling temperature increases considerably with reducing solvent content. The vapor quantity required for stripping is important enough to integrate the stripping into the MVR system.
- Thus: 2 recompressors in series, the MVR also heats the stripping section, which is an integral part of the column.
Double-Effect Distillation Systems

**Basics:** The top vapors of the column working at higher pressure heats the reboiler of the column working at lower pressure.

**Energy:** needs only 50 to 65% of the steam required by a conventional system.

**Flexibility:** Similar to a conventional system

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Energetic Single Effect

Example:
Methanol / Water / Isopropanol. Methanol is the top product. A mixture with high isopropanol content is being removed as a sidestream.

Heat economy: Bottom product is used for pre-heating the feed.

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Design Details

GIG Karasek offers self-contained rectification systems based on the following components:

**Columns:**
- Structured Packings (Sheet or Fabric Type)
- High Performance Rings
- Distillation Trays

**Reboilers:**
- Falling Film (Tube or Plate* Type)
- Thin Film
- Forced Recirculation

*) for working pressures below 10 mbars absolute it is recommended to employ film plate reboilers, due to their low pressure drop on process side.

**Condensers:**
- Tube and Shell Type
- Coil Type for vacuum systems
- Plate Type for vacuum systems
Multi-Effect Rectification
The top vapors of the column working under the higher pressure heat the reboiler of the column working under the lower pressure.

MVR
The top vapors of the column are being recompressed by a mechanical recompressor and are employed for heating the reboiler.

TVR
Top vapors with higher pressure than the working pressure of the column serve as motive vapors for an ejector. The ejector recompresses the top vapors of the column. The recompressed top vapors are used for heating the reboiler.

The differences in boiling point between the top and the bottom of a column, and the thermodynamic properties of the top product are the criteria for the decision, whether one of the packages can be applied in your case or not.

Typical processes, the feed to GIG Karasek Rectification Systems may come from:

- **Extraction** of substances from biomasses or from plants
- **Precipitation** of high-molecular biological substances e.g. with isopropanol
- **Solvent Crystallization** (e.g. an organic solvent is being used to reduce the solubility of a valuable substance dissolved in water)

Typical clients are the pharmaceutical industries, fine chemical industries and producers of additives for food or cosmetics.

GIG Karasek offers a service package comprising engineering and supply of the plant including control system, erection and start-up assistance.
Features for Applications

**Multi-Effect Distillation**
- There is low cost steam available which has to be used (e.g. from a steam turbine)
- The difference head to bottom temperature is too big for mechanical or thermal vapor recompression
- The product characteristics and the steam pressure available allow operation within the range of temperature required for the multi-effect system.
- Note: The system is not applicable for high vacuum distillation

**TVR Distillation (thermal recompression)**
- The top product is water only, or water with negligible content of organic substances.
- Or distillate can be easily evaporated in order to provide motive vapors for the ejector.
- The heating agent (steam or heat oil) is available at the necessary temperature level
- Low or moderate difference between top and bottom temperature

**MVR-Distillation (mechanical recompression)**
- Low or moderate difference between top and bottom temperature
- The outlet temperature of the recompressor should be below the temperature of self-ignition of the top vapors.
- The feed characteristics must allow an efficient heat transfer between the feed and the top and bottom stream.
- Note: Not applicable for high vacuum
- If applicable, excellently low energy consumption!

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**Fluid Mixtures:**

*Some examples of our expertise in thermal separations:*

- Acetone / Water
- Butyl acetate / Water
- Butyl alcohol / Water
- Ethanol / Water
- Ethanol / Cyclohexane / Water
- Formamide / Water
- Glycerin / Water
- Glycerin / Fatty Matters
- 2-propanol / Water
- 2-propanol / Cyclohexane / Water
- 2-propanol / Methanol / Water
- Methanol / Water
- Lactic acid / Water
- Toluene / Water
**Pilot Plant Station - the Research Center of GIG Karasek**

GIG Karasek’s new Pilot Plant in Gloggnitz is the most comprehensive Evaporation and Molecular Distillation Center in the world. The complete set of Unit Operations in the Pilot Plant includes Falling Film Evaporation, Forced Circulation Evaporation, Thin Film Evaporation, Wiped Film Evaporation, Short Path Evaporation and Drying Systems. For each Pilot Test a unique equipment set up and testing protocol is offered for customer review and approval prior to testing.

We can develop your process, generate real process operating data, optimize your design, and formulate your new products under GIG Karasek expert supervision. We can also generate samples for evaluation and testing, and can achieve complete demonstration of equipment. All this can be done before the expenditure of capital.

Over the years, we have found that the experience of hundreds of test runs and the resulting results of these test runs have given our customers the information to make the right decision - the decision to use the technology of GIG Karasek.

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