CHEM

EVAPORATORS AND CRYSTALLIZERS

Vacuum | Evaporation | Crystallization | Drying | Desalination | Heat Transfer | Air Pollution Control

EVAPORATORS WITH TVR/MVR, CRYSTALLIZERS AND MULTI-EFFECT TURNKEY PLANTS

CHEM Process Systems is a leader in Evaporation and Crystallization technology with more than 1,000 installations.

Chem Process is committed to supplying evaporation, crystallization, drying, desalination, vacuum and heat transfer process technology and systems. We design, fabricate, and test systems for the chemical, pharmaceutical, bulk drugs, agrochemicals, fertilizers, biotech, food, dairy, beverage industries, and for environmental applications.

Chem Process provides the complete scope of services, from start to finish, including:

- Pilot plant testing
- Process design
- Plant configuration
- Equipment engineering
- Equipment fabrication
- Automation / Controls
- Pre-fabricated & modular systems
- Training
- Turn-key installations
- Documentation
- Start-up and commissioning
- Complete Solutions Range
- Service and spare parts

Chem Process provides the full range of equipment to cater to all application and industries:

Energy Efficiency

Energy Efficiency of Chem Process Evaporators and Crystallizers is a crucial consideration during design of each customer's specific application. Energy efficient systems utilize waste heat, multiple effects, mechanical vapour recompression (MVR) and / or thermal vapour recompression (TVR).

Multiple Effect Operation

The evaporation duty is separated into stages operating at different temperatures. External heat drives the first effect of the evaporator, with subsequent effects being driven by vapor generated from the previous higher temperature effect. Product may be passed through the evaporator in forward, back or mixed flow configurations. Additional efficiency is achieved with the use of regenerative heaters, condensate heaters, and vapour heaters.

Types of Evaporators & Crystallizers

Evaporators

- Forced circulation
- Falling film
- Natural circulation
- Rising film
- Plate
- Horizontal wetted
- Combination types
- Multi-stage flash
- Multi-effect distillation

Crystallizers

- Adiabetic vacuum
- Evaporative forced
- Draft Tube Baffle (DTB) type
- Spray evaporator crystallizer
- Oslo Type

Thermal Vapour Recompression, TVR

Multiple effect evaporation plants save steam by repeatedly using the same quantity of heat from effect to effect. The vapours from the first effect is compressed to a higher pressure by the thermocompressor, and these compressed vapours are the heating medium for the subsequent effect. Vapours from the final effect are condensed, heat is recovered and supplemented by the cooling water if required.

Mechanical Vapour Recompression, MVR

MVR technology yields the greatest energy efficiency for an evaporator, andrequires low cooling water. An MVR evaporator may be coupled with TVR and multiple effects.

Evaporation plants with mechanical vapour recompressors normally require very low live steam and shifts the necessary energy to electric energy.

MVR can be either high pressure fans or centrifugal compressor types depending on the application.Single-effect centrifugal compressors are frequently used. For high pressure increases, multi-stage compressors are provided. To supply the power to the compressor, either electric power, or combustion engines are used where heat is available from the cooling water and exhaust gases. If high pressure steam is available, a steam turbine may be installed for high total energy efficiency.

EVAPORATORS

Falling Film

The falling film evaporators can be operated with a low temperature difference and since the product residence time is very less, they are best suited for liquids which are temperature sensitive, have a high rate of specific heat transfer, particularly for non-crystalline solutions. Having low liquid holding volumes, the falling film evaporators are very easy to operate, clean, switch to another product and are extremely sturdy, thus the most frequently used types.

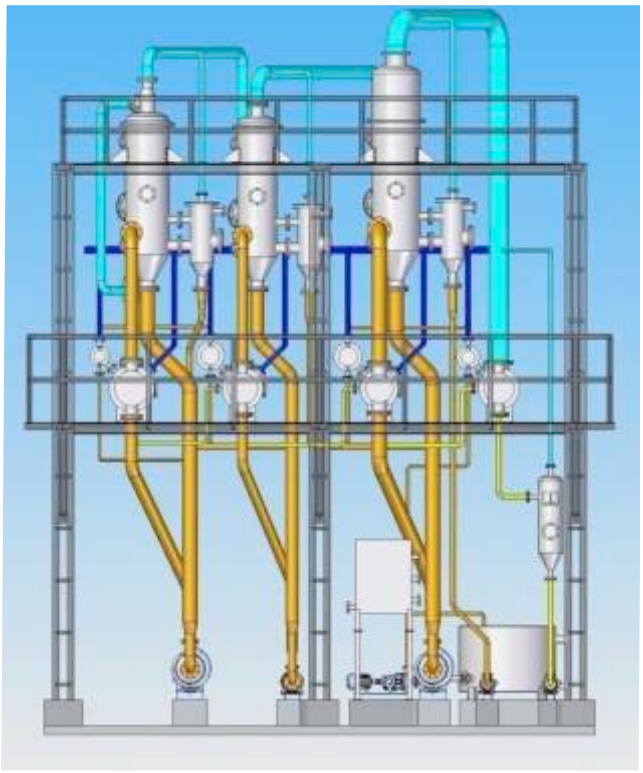
Caution must be used to ensure a continuous film wetting rate and to prevent nucleate boiling; otherwise, the rate of heat transfer will fall off dramatically, and the rate of fouling on the heat transfer surface will increase.

Vapour Induced Film

- Falling Film-tubular & plate
- Rising Film-tubular & plate
- Mechanically Induced Film
- Mechanically Agitated Thin Film

Natural Circulation Evaporatos

Natural circulation evaporators are very simple and are normally used where the effluent has a high viscosity, higher levels of hardening agents, un-dissolved solids, for products which are affected by their own high temperatures and longer residual times. The operation could be continuous, batch or semi-batch and do not require pumps for recirculation or intermediate product transfer-



Forced Circulation Evaporators

Normally used for liquids which are prone to fouling, scaling, crystallizing or for those which are inversely soluble or while concentrating thermally de-gradable materials. Here high re-circulation rates allows high liquor velocities through the tubes which help to minimize the build up of deposits or crystals along the heating surface.

Plate Type Evaporators

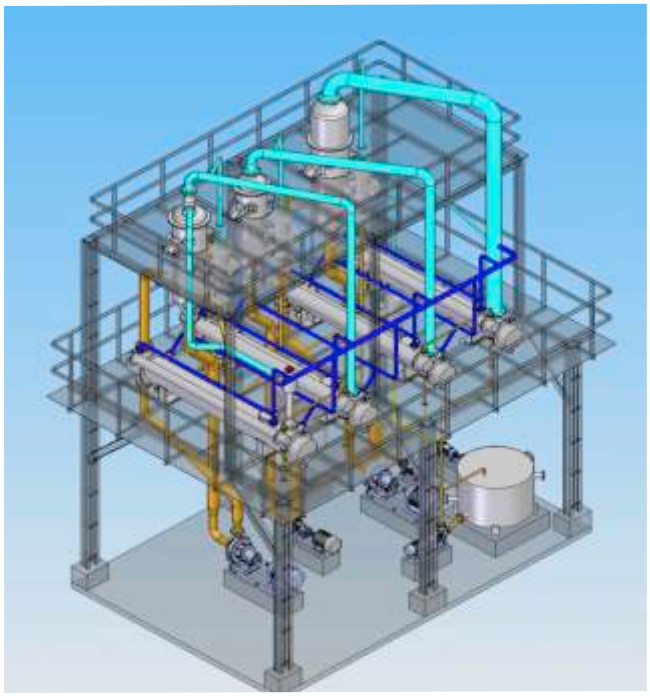
Plate type evaporators are of a compact design and are designed for single pass climbing film operations, which result in even and gentle evaporation of the product. Useful to handle asymmetrical flows- when a limited pressure drop is acceptable for one of the media but pressure drop is not a limiting factor for the other.

Horizontal Wetted Tube Type Evaporators

In the horizontal wetted tube evaporators, the heating fluid or vapour flows inside the tubes, while the liquid to be evaporated flows outside the tubes within the evaporator shell. There are many advantages offered by these types; the space within the tube bundle allows the evaporated vapours to flow at a low velocity and hence evaporation can be carried out a very low temperatures. Other benefits relate to easy mechanical cleaning, possibilities of tube bundle removal, low risk of liquid priming, low height requirements and ease of retrofitting.

Multi-Stage Flash

In multi-stage flash evaporators, the product flows with a positive pressure through the tubes of all the stages i.e. from the last stage to the first stage, where the liquid is heated gradually by the vapour condensed in all the stages. From the last stage the liquid is discharged by the concentrate pump. The distillate is collected from all the



condensers to the last stage condenser and from here it is discharged by the distillate pump. The non-condensable gases released in all the stages are discharged by the ejectors.

Chem Process designs and manufactures multi-stage flash evaporation plants, which may be used for producing fresh water from sea water, well water or industrial water. A special advantage of the multi-stage flash technology is that the thermal efficiency can be tailored to the individual client requirements. Chem Process multi-stage flash evaporation plants are also used for reduction of the volumes of industrial waste waters generated by industries.

Multi Effect Distillation

In multi-effect distillation evaporators , the upper end of the rising film evaporation tubes protrude from the upper tube plate of the calandria, so that the liquid after evaporation does not flow back into the tube and the vapour produced inside the tubes can leave the tubes without passing the liquid level on the upper tube plate. This avoids the excessive entrainment of the liquid and higher vapour and distillate salinity.

Chem Process multi-effect distillation evaporators have removable covers for easy accessibility to the demister pads. On the condensation side the heating elements are designed with special internal air cooling zones which ensure optimum concentration of the non-condensable gases which are evacuated by the ejector.

CRYSTALLIZERS

Adiabetic Vacuum

Chem process batch vacuum crystallizers are used for cases requiring very low operating temperatures achieved only by very high vacuum, and for those applications involving relatively small amounts of material, or when the material being processed must be handled on less than a continuous basis, it is often both convenient and economical. Where the material is cooled through a very wide range and/or to a final temperature which requires very high vacuum, a large ejector or booster is utilized to compress the vapor to a pressure high enough for condensation with available cooling water. In such cases, the batch vacuum crystallizer steam economy is achieved by multiple stage continuous equipment of five or more stages.

Evaporative Forced

Forced Circulation Crystallizers are of the Mixed Suspension Mixed Product Removal types and operate either on controlled or natural slurry density, depending upon process requirements and/or unit material balance.

These systems can be either single or multiple effects and width which thermal or mechanical vapor recompression concept is often applied. Usually, they operate from low vacuum to atmosphere pressure.

As a rule, these units are used for high evaporation rates and when crystal size is not of the utmost importance or if crystal grows at a fair rate. Almost any material of construction can be considered for the fabrication of these crystallizers.

Research, Development & Test Centre

Chem Process offers complete testing and pilot plant facilities to check the behavior of the product during evaporation and crystallization process. This is particularly important when considering applications for which the product characteristics are unknown, or not well defined.

Pilot units are available on a rental basis for short term, client-based testing.

Draft Tube Baffle Type

The Draft Tube Baffle type of crystallizer is an elaborated mixed suspension mixed product removal design, which is suited for vacuum

cooling and for processes having a moderate evaporation rate. Since almost heat make-up is required, the arrangement is compact and hence initial investment is minimized.

These units operate with low supersaturation, which at times is a limitation to crystal growth; very large crystals can be produced only by providing extensive and costly dissolving of fines. When destruction of fines is not needed or wanted, baffles are not provided and the internal circulation rate is set to have the minimum nucleating influence on the suspension.When large evaporation rates are required, an external heating has to must be provided.

ADVANCED MECHANICAL VAPOUR CASCADE RECOMPRESSION EVAPORATION PLANTS

Chem Process designs, installs and commissions Mechanical Vapor Recompression (MVR) technology based AVCC Evaporator systems.

Process

The evaporated vapour passes through a compressor or high pressure fan where the pressure of the vapour is increased by a factor of 1.2 to 2.0. The increased pressure of the vapour enables it to provide the energy and temperature difference required for evaporation.

Mechanical Vapor Recompression

Evaporation plants equipped with mechanical-vapor-recompre-ssion-type heat pumps require low energy input during normal operation. Jet compressors can compress only a part of the vapor and the energy of the motive steam is discharged as residual heat via the cooling water. In mechanical vapor recompression systems, however, all vapors are compressed to a higher condensation pressure, as shown in the heat diagram.

The specific energy consumption corresponds to the compressor energy input/evaporation rate ratio. This is determined by the compression ratio, which represents the temperature difference between the heating steam and boiling liquid. Furthermore, it depends on the boiling point elevation and the pressure loss in the system. Under favourable conditions this value can be as low as 4 kwh per 450 kgs. of water.

With an MVR evaporator system efficiencies can run as high as 90 kgs. of water evaporated per kwh (roughly the equivalent of 25 kgs. water evaporated per kg of steam with a TVR evaporator).

Chem MVR Evaporator Systems can be designed for rates from under 5 m/hr to over 70 m/hr.

Applications

MVR evaporators with fans are prevalent within the food industry. The MVR evaporator is often applied as a pre-concentrator followed by a finisher.

MVR's are predominantly used in the food industry for the evaporation of,

- Milk, whey and other milk products
- Sugar solutions
- Salt solutions,
- Sulphite liquors and in the chemical industry for,
- Vapourization crystallization of sodium sulphate
- Concentration of thiocarbomide solution
- Rectification of propylene
- Treatment of aqueous process liquids and waste waters by evaporation

Characteristics

Vacuum-proof housing design, up to 0.1 bar (abs.).
Rotors for extremely high circumferential speeds for increasing the efficiencies.

Chem uses a new type of fan to series production stage, the rapid rotor MXDA, for smaller mass flow rates, primarily in wastewater treatment evaporators.

Advantages of Mechanical Vapour Recompression Evaporator with TurboFans

- Most energy efficient.
- Various system concepts, one or two stages
- Atmospheric or vacuum operation
- Low retention time, optimum quality
- CIP system according to client need
- Flexible arrangement of body and fans
- None or minimum cooling water required
- Computer based operation and control
- Ideal for heat recovery from condensate

Features

- Eternal straight tube preheaters give short residence time, bater deaeration of the calandrias, and easy inspection and cleaning.
- Chem's freestanding design reduces floor space requirements and building costs, and is flexible in arrangement for installation in existing buildings.
- Cleaning costs are minimized by CIP producers, which may be fully automated.
- Instrumentation is per customer requirements, inlcluding PLC controllers that can optimize product and quality.

EVAPORATION & CRYSTALLIZATION SYSTEM FEATURES & APPLICATION

- Design compliance to ASME, TEMA and Local Codes
- Once through product flow scheme i.e.no recirculation for heat sensitive products
- Multi-pass provided to permit once through operation, yielding higher efficiency and requiring less heat transfer surface
- Low product retention time
- Simplified maintenance
- Facilities for CIP
- Feed preheating
- Product heat treatment systems
- Feed balance tanks and automation
- Product recovery from initial start-up and shutdown
- Product flash cooling
- Crystal growth and centrifuging
- Product flash cooling
- Crystal growth and centrifuging

Evaporator Applications

- Food
- Natural Juices & Beverages
- Dairy
- Sugar
- Starch
- Natural Extracts & Products
- Chemicals
- Pharmaceuticals
- Salts
- Specialty Chemicals
- Desalination
- Power
- Water Treatment
- Agrochemicals & Pesticides
- Textiles, Dyes & Dye Intermediates
- Petrochemicals & Refineries
- Organic & Inorganic Wastewaters

Crystallizer Applications

- Aluminum Chloride
- Ammonium Chloride
- Ammonium Sulphate
- Calcium Sulphate
- Manganese Sulphate
- Monoethylene Glycol
- Potassium Chloride
- Sodium Acetate
- Sodium Chloride
- Sodium Nitrate
- Sodium Silicate
- Sodium Thiosulphate
- Sulphuric Acid
- Ammonia
- Ammonium Nitrate
- Calcium Chloride
- Ferrous Sulphate
- Mercerizing Caustic
- Phosphoric Acid
- Potassium Sulphate
- Sodium Carbonate
- Sodium Hydroxide
- Sodium Phosphate
- Sodium Sulphate
- Sulphur Dioxide

Criteria for Selection

- Evaporation capacity, operational data, including quantities, concentrations, temperatures, annual operating hours, change of product, controls, automation, etc.
- Product characteristics, including heat sensitivity, viscosity and flow properties, foaming tendency, fouling and precipitation, boiling behavior, etc.
- Required operating media, such as steam, cooling water, electric power, cleaning agents, spare parts, etc.
- Capital, financial and operational costs
- Choice of materials of construction and surface finishes
- Site conditions, such as available space, climate (for outdoor sites), connections for energy and product, service platforms, etc.
- Legal regulations covering safety, accident prevention, sound emissions, environmental requirements, and others, depending upon the specific project.

PRODUCT RANGE

EJECTORS AND VACUUM SYSTEMS
- Steam Jet Ejectors
- Liquid Jet Ejectors
- Thermocompressors
- Liquid Ring Vacuum Pumps
- Ring Jets
- Eductors
- Jet Heaters
- Jet Mixers
- Silencers
- Hybrid Systems

EVAPORATORS WITH TVR/MVR
- Single and Multi Stage Flash
- Forced Circulation
- Natural Circulation
- Falling Film
- Rising Film
- Combination Type
- Multi-Effect Distillation
- Scraped Surface Type
- Horizontal Wetted

CRYSTALLIZERS AND DRYERS
- Adiabatic Vacuum
- Evaporative Forced
- Draft Tube Baffle Type
- Spray Evaporator
- Oslo Type
- Agitated Thin Film Dryers : ATFD
- Flash Dryers
- Fluid Bed Dryers

PROCESS PLANTS/ TURNKEY PROJECTS
- Zero Liquid Effluent Discharge Plants
- Ethylene Glycol Vacuum Systems
- Caustic Concentration Systems
- Salt Recovery Plants
- Desalination Plants
- Venturi Scrubbers
- Milk Condensing & Khoa Cooling Equipment
- Distillery Spent Wash Treatment
- Food & Beverage
- Distillation
- Gas Scrubbing System

POWER PLANT EQUIPMENT
- Steam Surface Condensers
- Air Extraction Systems
- Gland Steam Condensers
- Condensing Packages
- Feed Water Heaters - LP & HP

SPECIALIZED EQUIPMENT FABRICATION
- Heat Exchangers
- Oil Coolers
- Reactors & Columns
- Pressure Vessels
- Media Filters
- Re-Boilers
- Skids & Packaged Plants

CHEM

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