

Anhydro Evaporation Process



SPX Flow Technology Danmark A/S is an international engineering company with a consistent goal to provide our customers with the optimal processing technology and the highest plant performance standards. We have specialised in supplying the optimal design and engineering with respect to production performance, flexibility, energy efficiency and environmental protection.

SPX FLOW offers a wide range of Anhydro evaporation technologies for handling numerous applications that give high-quality end-products in the most efficient, and economical way.

SPX FLOW, Inc. (NYSE:FLOW) is a leading manufacturer of innovative flow technologies, many of which help define the industry standard in the market segments they serve. From its headquarters in Charlotte, North Carolina, it operates a sales and support network, centers of manufacturing excellence, and advanced engineering facilities, throughout the world. Its cutting-edge flow components and process equipment portfolio includes a wide range of pumps, valves, heat exchangers, mixers, homogenisers, separators, filters, UHT, and drying technology that meet many application needs. Its expert engineering capability also makes it a premium supplier of customized solutions and complete, turn-key packages to meet the most exacting of installation demands.

Incorporating many leading brands, SPX FLOW has a long history of serving the food and beverage, power and energy, and industrial market sectors. Its designs and engineered solutions help customers drive efficiency and productivity, increase quality and reliability, and meet the latest regulatory demands. In-depth understanding of applications and processes, state-of-the-art Innovation Centers, and advanced pilot/testing technology further assist in optimizing processes and reducing timescales to reliably meet production targets.

To learn more about SPX FLOW capabilities, its latest technology innovations and complete service offerings, please visit www.spxflow.com.

Anhydro Evaporation Technologies

Industrial evaporation is normally used in the dairy, food, pharmaceutical, and chemical industries to obtain a significant reduction in liquid content prior to a liquid-to-powder drying process. This results in a more efficient drying process with lower energy costs and a reduced environmental footprint.

Modern evaporation technology from SPX FLOW is designed to preserve flavour, aroma, colour, and nutritional properties, which can be adversely affected by exposure of solutions to high temperatures. This is achieved by evaporation under a vacuum in order to ensure a low boiling point.

The optimum choice of evaporation technology depends on factors such as the viscosity and thermal characteristics of the product, the required output rate, and the available energy supply. Evaporation techniques include single-pass or circulation, single or multiple effect, and thermal or mechanical vapour recompression.

PRIMARY PROCESSES – FALLING FILM EVAPORATION

Falling film evaporation is widely applied for evaporation of low-viscosity products such as dairy products, fruit juices, plant extracts, blood plasma, a wide variety of pharmaceutical products, effluents, and many other organic and inorganic products.

Falling film evaporation enables:

- Minimum flavour impact on sensitive ingredients due to short residence time
- High efficiency heat transfer

and can employ two vapour recompression techniques, depending on the available energy source:

- Mechanical Vapour Recompression (MVR), which requires very little or no steam
- Thermal Vapour Recompression (TVR), using live steam to recompress vapour from one effect to be used as heating medium for the first effect.

FINISHING PROCESS – RISING FILM EVAPORATION

Rising film evaporation is designed for medium-viscosity products with moderate heat sensitivity such as caustic soda, nitrates, sweet water glycerine, and electrolytic thinning liquids.

Based on a simple operation principle, rising film evaporation requires no pumping energy as vapour is used as the transport medium. Rising film evaporation is often used as a finishing process following a multi-effect TVR evaporator or an MVR evaporator.

FINISHING PROCESS – FORCED CIRCULATION EVAPORATION

Forced circulation evaporation is suitable for high-viscosity products. Hydrostatic pressure is applied in the heat exchanger in order to prevent crystallization and scaling as a result of boiling. Boiling takes place, when the liquid flashes out at the separator inlet.

Forced circulation evaporation is often used as the last evaporation stage.



Bottom part of MVR evaporator

Typical Product Applications

With the Anhydro evaporation equipment, you can produce a wide range of powders for various industries.

Dairy Industry



Food & Beverage Industry



Pharmaceutical Industry



Chemical Industry



Anhydro Evaporation Process

FALLING FILM EVAPORATION USING MECHANICAL VAPOUR RECOMPRESSION (MVR)

Mechanical vapour recompression delivers substantial operational cost savings in areas with an ample supply of electrical energy.

Once an MVR evaporator is running, little or no additional steam is required. In MVR, a high-pressure fan is used to recompress the vapour to a higher pressure, resulting in a rise in temperature. This means that the recompressed vapour can be used as the evaporator heating medium, while the condensate is ideal for preheating of the feed product.

The high-pressure fan can be powered by an electric motor, or gas or steam turbine.

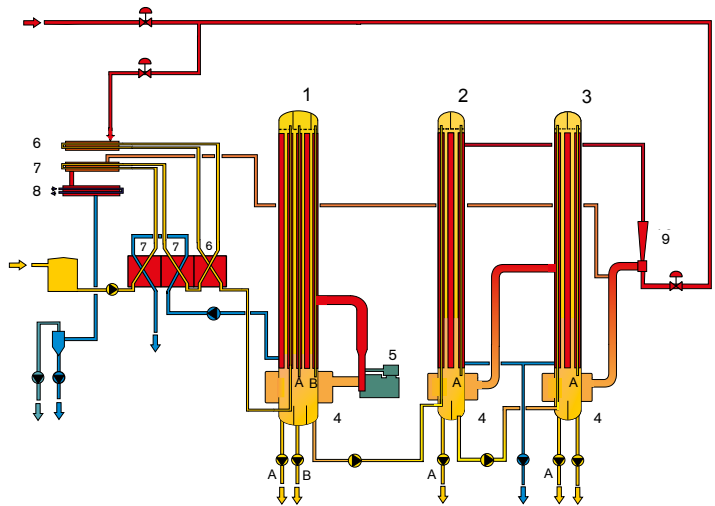
The MVR evaporation process is often followed by further concentration in a TVR or forced circulation evaporator.

FEATURES

- Low energy consumption
- High-heat transfer coefficients
- Optimum thermal efficiency
- Short residence time
- Single-pass evaporation
- Easy building conversion and adaptation to existing facilities

MVR FLOW

- 1-3 Calandrias
- 4 Vapour separator
- 5 High-pressure fan
- 6 Pasteurizing unit
- 7 Pre-heater
- 8 Condenser
- 9 Thermo-compressor



Vapor duct of MVR evaporator



MVR fan

FALLING FILM EVAPORATION USING THERMAL VAPOUR RECOMPRESSION (TVR)

Steam-heated falling film evaporators require an ample supply of live steam to drive the evaporation process through multiple effects.

Multi-effect evaporation uses vapour from one effect as the heating medium in a subsequent effect, operating at a lower pressure and temperature. This procedure can be repeated a number of times, depending on the available overall temperature difference of the system and the return on investment of additional effects. Evaporation temperature is determined largely by the heat sensitivity and viscosity of the product.

Thermal vapour recompression across one or more effects enhances process cost-effectiveness by using a steam jet compressor to compress part of the vapour discharged from one effect for use as the heating medium for the first effect.

Multi-effect evaporation thus enables the regeneration of low-grade heat from the evaporator itself for gentle and effective preheating across calandrias with a low temperature difference.

FEATURES

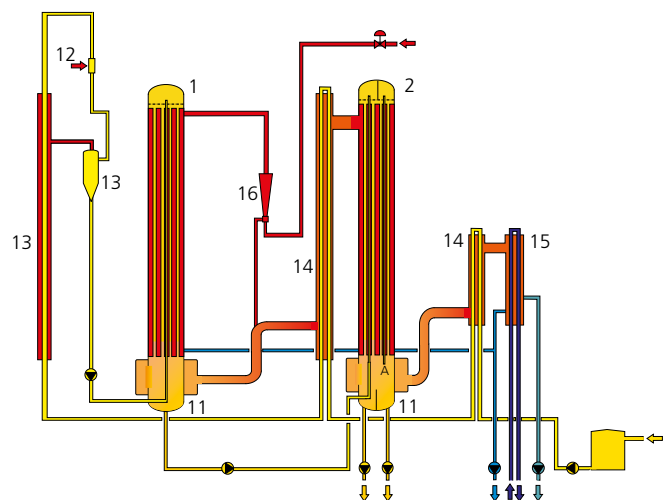
- Optimum energy utilization
- High-heat transfer coefficients
- Short residence time
- Single-pass evaporation
- Easy building conversion and adaptation to existing facilities

TVR FLOW

- 1-2 Calandrias
- 11 Vapour separator
- 12 DSI unit
- 13 Pasteurizing unit
- 14 Pre-heater
- 15 Condenser
- 16 Thermo-compressor



Multi-effect TVR evaporator



Design Characteristics and Special Features

Special design characteristics and features maximize uptime and output by preventing fouling and reducing cleaning time, and minimize operational costs through optimum energy utilization.

LIQUID DISTRIBUTION SYSTEM

The wetting rate of every individual tube is critical in preventing product fouling. Liquid distribution is based on the static principle with distribution plates built into the top cover of the calandria. This ensures constant and even distribution of a thin film over the total inside surface of each tube.

SPLIT CALANDRIA

A split calandria enables a correct wetting rate without product recirculation, for example by enabling two or more separate passes on the product side interconnected in series using pumps. Alternatively two or more calandrias can be used within the same effect.

FINISHERS

Final evaporation to the required degree of concentration can be achieved by a high-concentrator, for example using a rising or falling film calandria. In case of high-viscosity products with an increasing risk of fouling, a finisher with forced circulation is recommended.

VAPOUR SEPARATOR

Separators integrated into the process ensure efficient separation of liquid and vapour. Low entrainment rates result in a condensate that can usually be used as boiler feed water and for Cleaning-In-Place (CIP).



Liquid distributor of MVR evaporator

THERMO-COMPRESSOR

Steam jet compressors – also known as thermo-compressors – are used in a wide range of processes to save energy. The motive steam expands through a nozzle, which converts pressure energy to velocity energy, and the steam is mixed directly after the nozzle with the vapour to be compressed. Part of the kinetic energy is transferred to the stream of vapour to be compressed. In the diffuser directly after the mixing stage, the kinetic energy of the mixed flow is reconverted into pressure energy.

COMPRESSOR/HIGH-PRESSURE FAN

High-pressure fans are normally used in single-effect evaporators. They can handle an extremely large amount of vapour at low temperature differences. The correct choice of fan depends on the required capacity, product properties, energy costs, etc. Two high-pressure fans can be coupled in series to achieve higher temperature differences, where required.

CLEANING EQUIPMENT

All evaporators are equipped with Cleaning-In-Place (CIP) systems, enabling faster cleaning and shorter downtime without the need to dismantle equipment components.

SPX FLOW has the equipment, experience, and expertise to provide you with processing solutions, which are tailored to your specific needs.



Top of TVR evaporator

Process Line Expertise and Service

PRE-HEATERS AND PASTEURIZERS

SPX FLOW can provide pre-heaters and pasteurizing units for all evaporation applications:

- Direct or indirect steam heating
- Tubular and plate designs
- With or without heat regeneration

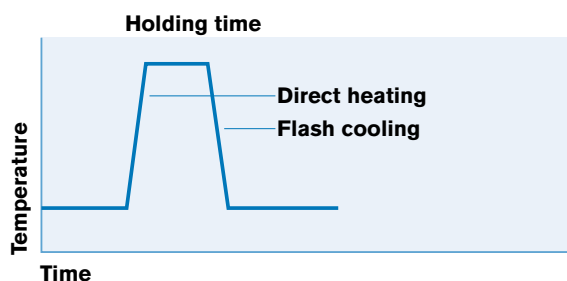
Very gentle pre-heating can be achieved in systems with very small temperature differences such as multi-effect systems with thermal or mechanical vapour recompression.

Straight tube heat exchangers are available, when visual inspection is required, while SPX FLOW can supply direct heating systems with heat regeneration for applications with high pasteurizing temperatures.

HEAT TREATMENT

The shorter the time it takes to heat the product up to the desired pasteurization temperature and cool it down again prior to evaporation, the less the likelihood of thermophilic bacteria growth is during the evaporation process.

SPX FLOW has developed a pre-evaporation pasteurizing process with direct heating and flash cooling to achieve spontaneous heating up to and cooling down from the required temperature. This means that the effect of a given holding time at a given temperature can be determined precisely.



COOLERS

After concentration, the product can be cooled in tubular, plate, or flash design cooling units. The flash design can be combined with a crystallization process.

CONDENSERS

Surplus vapour from the final evaporation stage must be condensed. For this purpose SPX FLOW offers various types of indirectly cooled condensers, which ensure optimum environmental protection.

AROMA RECOVERY

Volatile aromas, for example from fruit juices, can be recovered using vapourisation and condensation prior to the evaporation process. After condensation, the aromas can be added back into the concentrated product or used as flavourings in other products.

AUTOMATION

Automation is a natural feature of all industrial evaporator systems, enabling constantly optimised operation.

Start/stop, timing, sequencing, and monitoring of motors, valves, pumps, CIP equipment and other functions are handled by microprocessors, and all modes and operations are visualized on a central control system. In case of an emergency, the entire plant can be shut down from the control system. Process data registration enables full end-to-end traceability with detailed and aggregated report features available via a PC interface. The automation system also enables remote diagnostics, while equipment status monitoring allows cost-effective scheduling of preventive maintenance.

SERVICE

SPX FLOW Innovation Centre in Soeborg, Denmark offers a wide range of evaporators for test purposes. New products can be tested to analyse product properties in order to identify the best evaporation process and parameters. We coordinate everything from initial product testing, plant design, and manufacture to shipping, installation, and commissioning. Our service engineers are also available with prompt support in any part of the world.



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