RAJ
GROUP

E vaporators

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Evaporators

Evaporators

Evaporators are used for concentration of liquids. In most of the cases evaporators are used to increase the solid contents of the liquid product prior to drying. This is a cost effective method of removal of moisture. Depending on the number of effects used in an evaporator the quantity of water evaporated per kilogram of steam increases. In case of multiple effect evaporators, steam jet ejectors or thermo-compressors are used to increase the thermal efficiency.

An evaporator consists of either plate type or shell and tube type heat exchanger. The liquid feed is passed through the heat exchanger and indirectly heated with the help of steam. This operation is either done at atmospheric pressure or under vacuum. Evaporation under vacuum is most energy efficient and also ensures that the product does not get over heated. The different types of evaporators are:

Agitated Thin Film Evaporator

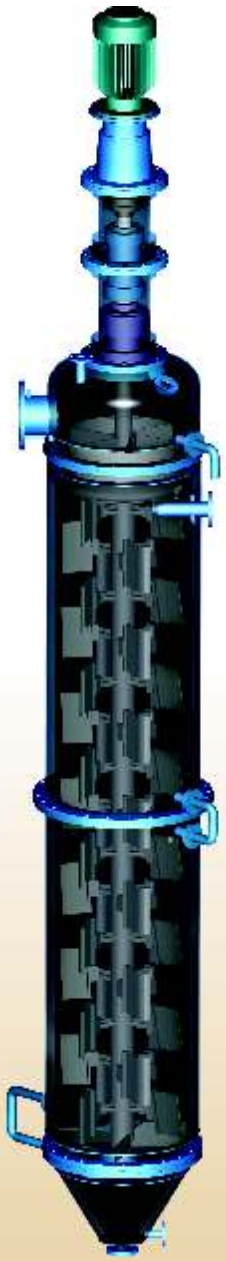
Thin film and wiped film evaporators are used to separate a mixture of liquids having different boiling points. It is also used to increase the concentration of liquids.

Principle of Operation

The liquid feed is distributed on the heated wall of the evaporator to form a uniform thin film with the help of suitable configuration of blades. The volatile component or the component with lower boiling point gets evaporated and is vacuumed out of the evaporator, while the component with higher boiling point flows down the wall and is collected at the bottom. The vapours are passed through a condenser and collected separately.

Operating Features

The heat transfer in thin film evaporator is very quick and efficient, thus demanding lower surface area and heat input as compared to other types of evaporator. Due to high vacuum distillation and very short residence time the thin film evaporator are suitable for handling wide range of heat sensitive, high boiling and viscous feeds. Due to low rotor speeds in the range of 100 to 150rpm, the horse power requirements are very low. To reduce the pressure drop between the evaporator and condenser, the internal condensers can be provided to achieve short path distillation. The thin film evaporators are designed to handle various products with operating pressures up to O.1torr. Liquids with viscosities above 2,00,000cps can be handeled in these evaporators.

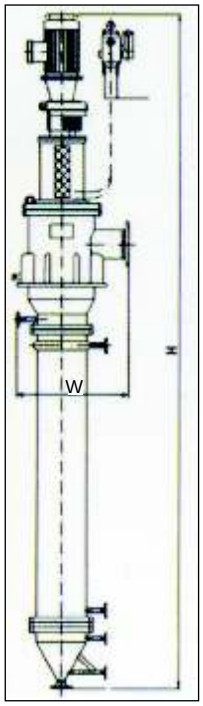


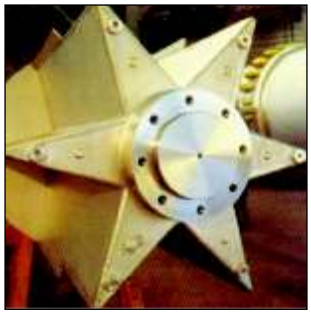
Construction of ATFE

The Agitated Thin Film Evaporator consists of a jacketed shell having a machined surface on the inner side. The rotor assembly consisting of different configuration of blades depending upon the nature of product is mounted in the shell. Feed inlet is provided at the top side. Specially designed feed distributor is integral with the rotor at the top side. The rotor is also fitted with an entrainment separator. Generally the vapour outlet is provided on the top side of the shell. The different types of blade configurations available are:

- Fixed blade rotor
- Spring loaded rotor
- Cylindrical wiper rotor
- Centrifugal blade rotor

The construction of the evaporator is such that different types of rotors can be mounted in the same equipment for different products. The evaporators having surface area up to 50sq.m. can be supplied.





RAJ Agitated Thin Film Evaporator Models

Model	Surface area (m^2)	Dimension (mm.) (W)	Total height (mm) (H)	Motor Hp
RE-5	0.5	350	2250	2
RE-10	1	450	2650	3
RE-30	3	550	3500	5
RE-50	5	800	4750	7.5
RE-75	7.5	900	5750	10
RE-100	10	1100	6500	15
RE-150	15	1300	7500	20
RE-200	20	1500	8000	25
RE-250	25	1800	8500	30
RE-350	35	2050	9500	40
RE-500	50	2500	11000	60

Falling Film Evaporators

A falling film evaporator is a industrial device to concentrate solutions, especially with heat sensitive components.

In falling film evaporators the liquid product usually enters the evaporator at the head of the evaporator. The product is evenly distributed into the heating tubes. A thin film enters the heating tube and it flows downwards at boiling temperature and is partially evaporated. In most cases steam is used for heating the evaporator. The product and the vapor both flow downwards in a parallel flow. This gravity-induced downward movement is increasingly augmented by the co-current vapor flow. The separation of the concentrated product from its vapor is undergoing in the lower part of the heat exchanger and the separator.

Falling film evaporators can be operated with very low temperature differences between the heating media and the boiling liquid, and they also have very short product contact times, typically just a few seconds per pass. These characteristics make the falling film evaporator particularly suitable for heat-sensitive products, and it is today the most frequently used type of evaporator.

However, falling film evaporators must be designed very carefully for each operating condition; sufficient wetting (product film thickness) of the heating surface by liquid is extremely important for trouble-free operation of the plant. If the heating surfaces are not wetted sufficiently, dry patches and incrustations will occur; at worst, the heating tubes will be completely clogged. In critical cases the wetting rate can be increased by extending or dividing the evaporator effects, keeping the advantages of single pass (no recirculation of product) operation.

The proper design of the product distribution system in the head of the evaporator is critical to achieve full and even product wetting of the tubes.

Because of the low liquid holding volume in this type of unit, the falling film evaporator can be started up quickly and changed to cleaning mode or another product easily.

Evaporators

Falling film evaporators are highly responsive to alterations of parameters such as energy supply, vacuum, feed rate, concentrations, etc. When equipped with a well designed automatic control system they can produce a very consistent concentrated product.

The fact that falling film evaporators can be operated with small temperature differences makes it possible to use them in multiple effect configurations or with mechanical vapor compression systems in modern plants with very low energy consumption.

Features of RAJ F. F. E.

- They result in vapor with very little entrained liquid
- They provide high rates of heat transfer
- They require lower liquid circulation rates (smaller pumps)
- They are suitable for operation at low temperature differences.

Working Principle:

The process fluid to be vaporized is feed to the evaporator at the top of the tube sheet. A suitable distribution unit is necessary in order to achieve an even liquid distribution. It is paramount that for this process minimal wetting rate is achieved.

Applications :

Falling film evaporators are used extensively in chemical process industry, food and paper industry. Due to the absence of static head effect caused by liquid column as in other types of evaporators, evaporation can take place at very small effective mean temperature differences. The temperature difference are typically between 3 - 8^{o}C. This is significantly less than in other devices used for evaporation, e.g. forced reboilers or kettle evaporators, here the effective mean temperature difference is between 15 and 30^{0}C. The film heat transfer coefficients are in general high, and characterised by surface boiling.

The absence of hydrostatic head allows this type of evaporator to operate at very low absolute pressures.

Product residence time can be very short, especially in one through operation. These characteristic of short retention time low operation pressure and small required effective mean temperature differences makes this type of evaporator particularly suitable for concentration of heat sensitive liquids. The absence of nucleate boiling under normal operation conditions, and low temperature differences also reduces possible fouling tendencies.

Forced Circulation Evaporators

Design Features:

Forced circulation evaporators are most suited for the liquids which tend to crystallize upon concentration and which have tendency to scale.
Evaporators in which circulation is maintained, regardless of evaporation rate or heat duty, by pumping the liquid through the heating element with relatively low evaporation per pass are suitable for a wide variety of applications.

The forced circulation system is the easiest to analyze and permits the functions of heat transfer, vapor-liquid separation, and crystallization to be separated. Forced circulation systems are generally more expensive than natural circulation systems and are therefore used only when necessary.

A choice of forced circulation can be made only after balancing the pumping energy cost, which is usually high, with the increase in heat transfer rates or decrease in maintenance costs. Tube velocity is limited only by pumping costs and by erosion at high velocities. Tube velocities are usually in the range of 5 to 15 feet per second.

Factors which must be considered when establishing the pumping rates include:

- Maximum fluid temperature permitted
- Vapor pressure of the fluid
- Equipment layout
- Tube geometry
- Velocity in the tubes
- Temperature difference between the pumped fluid and the utility fluid, and
- Characteristics of pumps available for the service.

Features of RAJ Forced Circulation Evaporators:

RAJ Forced circulation evaporator offer following advantages :

- High rate of heat transfer.
- Positive circulation.
- Relative freedom from salting, scaling, and fouling.
- Ease of cleaning and a wide range of application.

Applications

- Chemicals
- Food processing
- Effluent treatments
- Dyes

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