



[www.nsiequipment.com](http://www.nsiequipment.com)  
[www.nsiequipments.com](http://www.nsiequipments.com)



# Evaporators



## About Us

**NSI Equipments Pvt. Ltd.** is a fast emerging company specializing in the design and manufacture of **EVAPORATORS**. Over the years NSIE has consolidated its experience in its field and has developed its expertise. Our endeavor is to supply well engineered product to the specific need of our customers. Customer satisfaction is our paramount importance, which is the foundation to our business policy. We have excellent reputation for the quality of our product range as always endeavoring to advance technology, appropriate fabrication processes at all stages of manufacture.

This has been possible with the active participation of our management, staff and workers. Everyone has contributed in his own manner and ultimately it is teamwork that has won.

## Vision

**NSI Equipments Pvt. Ltd.** vision is to excel and provide technology that is the most advanced in Asia and at par with the international league. We believe every satisfied customer is an asset and we target to satisfy each and every customer walking in through our door. We envisage achieving these ambitious growth plans as Green Progress meaning attaining the goals in symbiosis with environment and it's an integral part of our corporate vision.

### Our credo is:-

Customer orientation to develop products (machines and auxiliaries) that seek to meet customer aspirations. An organization reputation that instills confidence in the customer to seek pre-purchase counseling, validation through trials and service needs that may arise.

## Mission

**NSI Equipments Pvt. Ltd.** mission is to consolidate at the forefront of our Product Lines in Asia. We believe everything is possible with right efforts and dedication. We are confident that we will achieve our goal by:

**NSI Equipments Pvt. Ltd.** mission is to consolidate at the forefront of our Product Lines in Asia. We believe everything is possible with right efforts and dedication. We are confident that we will achieve our goal by:

## Quality Policy

“To be passive and proactive in providing quality product and solutions to clients by continuously striving to exceed their expectations”

Our commitment to quality is unflinching. Our desire for growth is deep rooted and our capacity for details is amazing. We adhere to national and international standards across all operations: from sourcing the raw materials & till it transfers to the finished machinery and finally successful commissioning. All our suppliers operate quality management standards as dictated by specific markets. This measure undoubtedly reflects our royalty to quality assurance and our determination to provided the products and service our customers demand.

What set us apart is the depth of our commitment and the high level of our concern to deliver quality products, efficient services and total solutions.

And this is where our quality improvement comes from.

At NSIE, **quality is a way of life.**

## Customer Satisfaction

Customer satisfaction is the foremost concern in our work culture. That is why a few of our products are very popular among users. We have met stringent delivery schedules and accepted challenges of precision manufacturing. We have extended our services to small scale and large-scale customers equally, and bagged repeat orders.

# Evaporators

Evaporators are thermal concentrators for concentrating dilute liquid for increasing the solids content and for reducing volume of evaporating liquid, widely used for the concentration of liquids in the form of solutions, suspensions and emulsions.

Three principle elements are of concern in evaporator design.

1. Heat transfer
2. Vapour liquid separation
3. Efficient energy conservation

An evaporator is a shell and tube heat exchanger where the steam is normally in the shell and the product is in the tube and in motion. Depending upon the type of product and the desire results, more than one stage or effect of evaporation may be required. The triple effect is the most common, although as many as five to six are also used in some applications. Evaporators are based on steam economy i.e. kg of solvent evaporated per kg of steam used. Reusing evaporated solvent as heating medium, higher steam economies are achieved. This method of increasing utilization of steam is used in multi-effect evaporator.

**Types Of Evaporators:**

1. Forced Circulation Evaporators
2. Falling Film Evaporators
3. Rising Film Evaporators



# Evaporators

## Forced Circulation Evaporators

These types of evaporators are recommended for the concentration of high viscosities solutions/slurries which have a tendency to crystallize or produce scales.

The circulating product is heated when it flows through the heat exchanger and then partially evaporated when the pressure is reduced in separator. The liquid product is typically heated only a few degrees for each pass through the heat exchanger.

This type of evaporator is also used in crystallization applications because no evaporation and therefore no concentration increase, takes place in the heat transfer surface. Evaporation occurs as the liquid is flashed evaporated in flash vessel/separator.

### Advantage:

- Ideal for high crystallizing and high viscosity solutions & Slurries.
- Single or multiple effect evaporation
- High operational flexibilities, heat transfer co-efficient, vapours liquid separation.
- Low temperature rise operation.
- Minimized fouling due to high velocities & static head.
- High turn down ration.

## Falling Film Evaporators

The falling film evaporator consists of shell and tube heat exchanger called as calandria that is mounted in vertical position.

The liquid product enters the evaporator at the head and is evenly distributed to the heating tubes. A thin film enters the heating tube and flows downwards at boiling temperature through the steam in the jacket and is partially evaporated.

The vapour is separated from the liquid in vapour separator and the concentrated liquid is collected at the bottom or transferred to the next stage.

The falling film evaporators can be single effect or multiple effects depending on the capacity.

Falling film evaporators can be operated with small temperature differences between the heating media and the boiling liquid and they also have short product contact time. These characteristics make the falling film evaporator particularly suitable for heat sensitive products and it is the most frequently used evaporator.



### Advantage:

- Ideal for clear, heat sensitive foaming and corrosive solutions.
- Continuous, single pass operation with minimized retention time.
- Single or multiple units with high heat economy.
- High heat transfer co-efficient.
- Low power requirement.
- Simple construction.
- Low floor space requirement.

### Applications:

- Food
- Herbal extracts
- Pharmaceuticals
- Dairy
- Dyestuff
- Black liquor in paper & pulp.
- Ammonium Nitrate.
- Sugar Syrups.

## Rising Film Evaporators

Rising film evaporators operate on a “thermo-siphon” principle. Feed enters at the bottom of the heating tube and as it heats, steam begins to form. The ascending force of this steam produces during the boiling causes liquid and vapours to flow upwards in parallel flow. At the same time the production of vapour increases and the product is pressed as thin film on the walls of the tubes and rises upwards. This concurrent upward movement against gravity has the beneficial effect creating a high degree of turbulence in the liquid which is advantageous during evaporation of highly viscous products and for the products that have tendency to foul during heating surfaces.

These types of evaporators are often used with product recirculation, where some of the formed concentrate is reintroduced back to the feed inlet in order to produce sufficient liquid loading inside the heating tubes.

### Advantage:

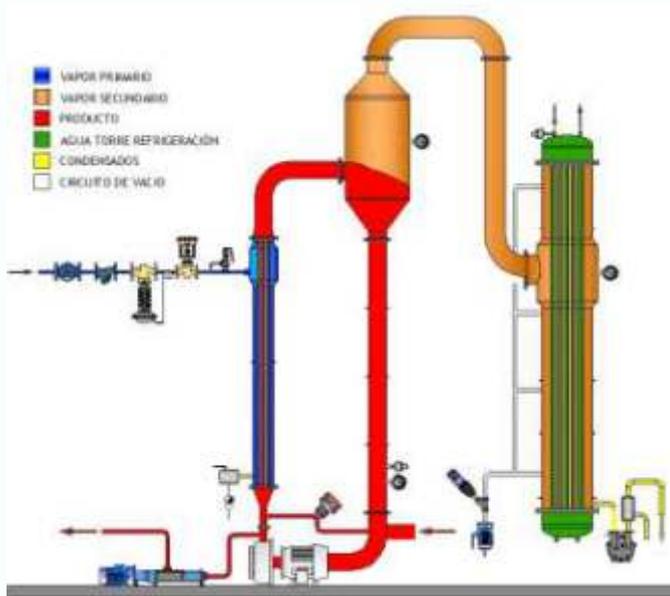
- Ideal for clear, heat sensitive foaming and corrosive solutions.
- Continuous, single pass operation with minimized retention time.
- Single or multiple units with high heat economy.
- High heat transfer co-efficient.
- Low power requirement.
- Simple construction.
- Low floor space requirement.

### Applications:

- Food
- Herbal extracts
- Pharmaceuticals
- Dairy
- Dyestuff
- Black liquor in paper & pulp.
- Ammonium Nitrate.
- Sugar Syrups.



## Single Effect Evaporators



In single effect evaporator while the product is being forced through the tubes of the evaporator, heat is added to remove a specific amount of moisture. After this is completed, both the product vapour and the concentrated product are forced into the separating chamber where the vapour is drawn off and may be used elsewhere. The concentrate is then pumped off to another part of the process.



## Multiple-effect Evaporators

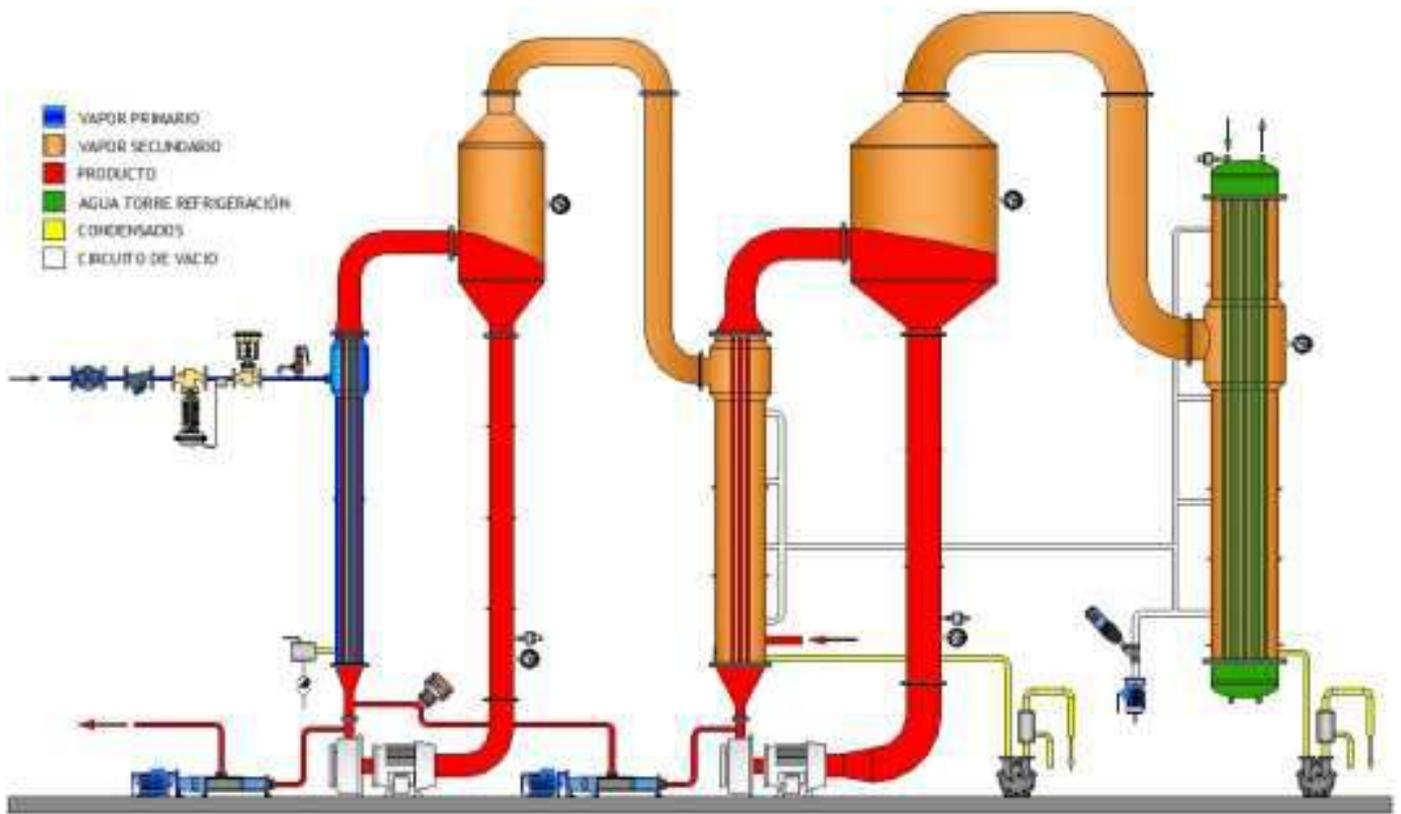


If we consider the heat balance of a single-effect evaporator we find that the heat content (enthalpy) of the evaporated vapour is approximately equal to the heat input on the heating side.

In the common case of water evaporation, about 1 kg/hr of vapour will be produced by 1 kg/hr of live steam, as the specific evaporation heat values on the heating and product sides are about the same. If the amount of vapour produced by primary energy is used as heating steam in a second effect, the energy consumption of the overall system is reduced by about 50%. This principle can be continued over further effects to save even more energy.

The maximum allowable heating temperature of the first effect and the lowest boiling temperature of the final effect form an overall temperature difference which can be divided among the individual effects. Consequently, the temperature difference per effect decreases with an increasing number of effects. For this reason, the heating surfaces of the individual effects must be dimensioned accordingly larger to achieve the required evaporation rate, but with a lower temperature difference. A first approximation shows that the total heating surface of all effects increases proportionally to the number of effects. Consequently, the investment costs rise considerably whereas the amount of energy saved becomes increasingly lower.

## Double Effect Evaporators:



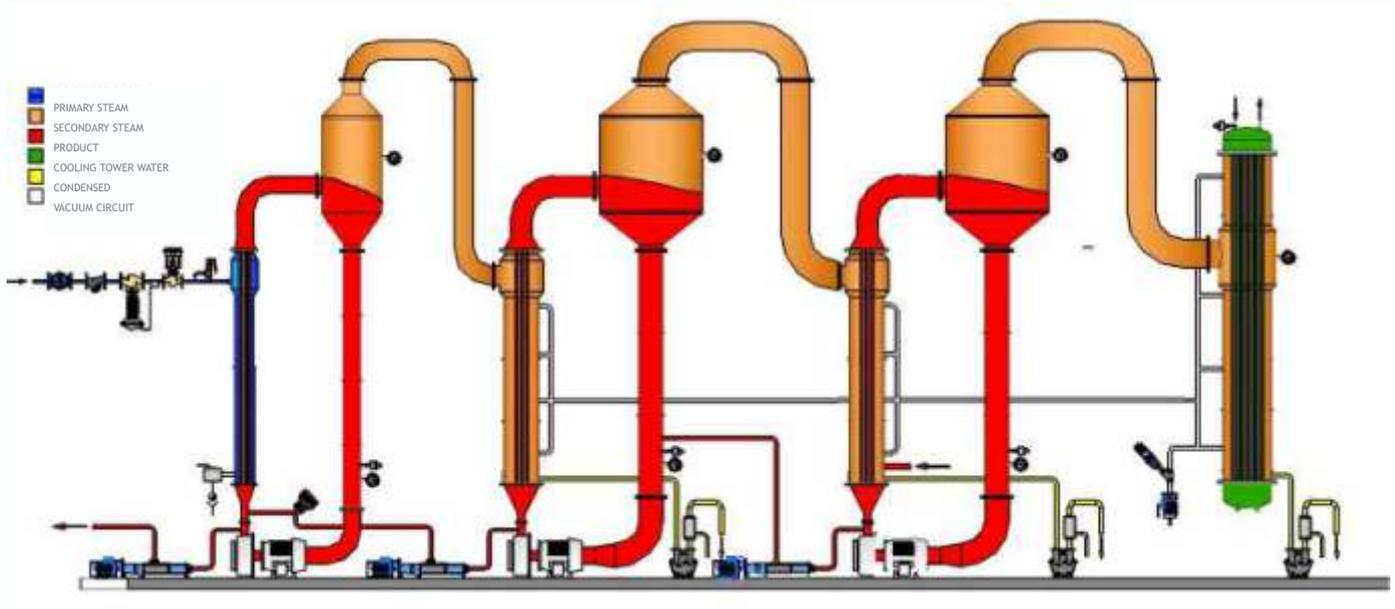
There are two base units of circulation flow. With the term “first effect” we refer to the stage fed by living vapour coming from the boiler.

Both effect work with concentrated is introduced into the evaporator by the second effect, where it undergoes an initial concentration, although the final (desired) concentration will be obtained in the first effect after the transport between effects with a lobe pump.

This system is completed with a final condenser, whose function is to condense the vapours coming from the second effect.



## Double Effect Evaporators:



This type of evaporators is designed for transformation industries where high capacity is sought, joining maximum possible energy saving to minimum necessary manpower.

The working principle is the same: the product to concentrate enters through the third effect at a lower temperature, from there goes into the second effect where the concentration is reached in the first effect.

	Live steam	Vapour	Specif. steam consumption
1-Effect-Plant	1 kg/h	1 kg/h	100%
3-Effect-Plant	1 kg/h	3 kg/h	33%

## Steam Consumption Chart

EFT.	1	2	3	4	5	6	7
A	1.10	0.56	0.40	0.30	0.24	0.16	0.12
B	0.40	0.33	0.25	0.20	0.16	0.14	0.12
C			0.20	0.17	0.14	0.13	0.11
D					0.13	0.11	0.10
E						0.10	0.09

- A. Specific Steam Consumption without TVR.
- B. Specific Steam Consumption with TVR over 1st effect.
- C. Specific Steam Consumption with TVR over 2nd effect.
- D. Specific Steam Consumption with TVR over 3rd effect.
- E. Specific Steam Consumption with TVR over 4th effect.



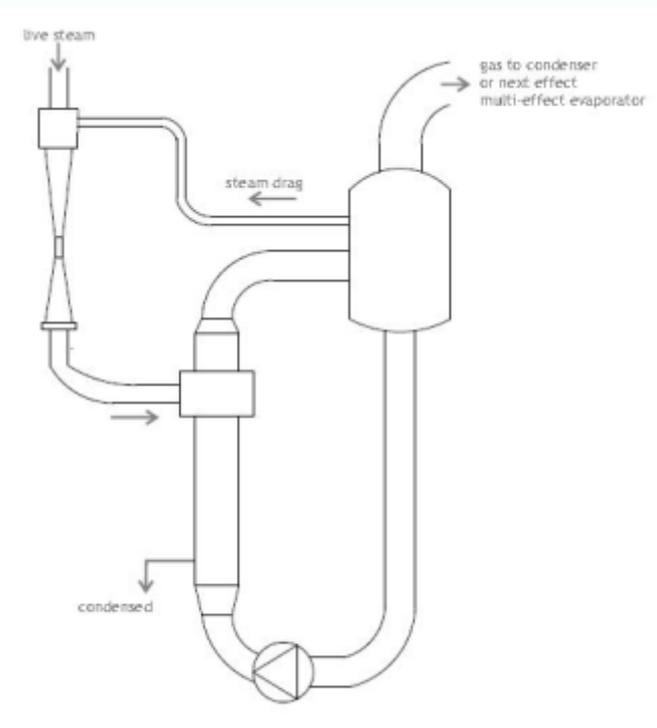
Thermo compressor is used as energy saving to reduce the energy requirements of evaporation.

The thermo-compressor will increase the temperature/pressure level of the vapour by compressing the vapour from a lower pressure to a higher pressure using steam of a higher pressure than that of vapour. In multiple effect evaporators with TVR, the heating medium in the first calandria is the product vapour from one of the associated effects, compressed to higher temperature level by means of steam ejector (TVR). The heating medium in any subsequent effect is the vapour generated in the previous calandria. Vapour from the final effect is condensed with the incoming product.

The use of TVR gives the same steam/energy saving as an additional evaporation effect.

A certain steam quantity, so called the motive steam, is required for operation of TVR. The motive steam portion is transferred as excess vapour to the next effect or the condenser.

## TVR



## Mechanical Vapour

### Recompression (mvr)

In evaporators with MVR, the heating medium in same effect, compressed for a higher temperature by means of a higher temperature by means of a high pressure fan (MVR).

## Evaporation Plant

### Components

The core of any evaporation plant is the calandria and for the operation of the plant several addition components are required.

## Separators:

Separators is a part of evaporator system to separator the product and the vapour. The majority of the concentrate is discharged from the bottom of the calandria below the tube bundle. Due to high vapour velocity some of the concentrate will be carried along with the vapour as small droplets and the separation is done in a separator with tangential vapour inlet.

## Preheaters And Heaters:

In most case the product to be evaporated must be preheated to boiling temperature before it enters the calandria. As a rule straight tube preheaters are used for this duty.

## Condensers:

Where possible, the heat content of the vapours produced during evaporation is used for heating downstream effects and preheaters, or the vapours are recompressed and reutilized as the heating medium. The residual vapours from the last effect of an evaporation plant which cannot be used in this way must be condensed. Evaporation plants can be equipped with surface, contact or air-cooled condensers.

## Deaeration/vacuum System:

Vacuum pumps are required for maintaining the vacuum in the evaporation plant. They discharge leakage air and non-condensing gases from the process, including dissolved gases which are introduced in the liquid feed. For this application, liquid ring pumps can be used depending on the size and the operating mode of the evaporation plant.

## Pumps:

Pumps must be chosen in view of a wide range of design conditions and applications. The main criteria for the selection of pumps are product properties, suction head conditions, flow rates and the pressure ratios in the evaporation plant. For low-viscosity products, centrifugal pumps are mostly used. Highly-viscous products require the use of positive displacement pumps. For liquids containing solids or crystallized products, other pumps types such as propeller pumps are used. The type, size, speed, mechanical seal and the material are determined by the particular case of application and the relevant conditions of use.

