TMCI Padovan
Evaporators
Our range includes 4 types of evaporators:

**Forced Circulation**  
**Falling Film**
Evaporators

**Plates**

**Thin Film**
Evaporator choosing criteria:

- product type (e.g. heat sensitivity, colour stability, etc.)
- product rheological properties (i.e. product with high or low percentage of solids in suspension)

<table>
<thead>
<tr>
<th></th>
<th>FALLING FILM EVAPORATOR</th>
<th>PLATES EVAPORATOR</th>
<th>FORCED CIRCULATION EVAPORATOR</th>
<th>THIN FILM EVAPORATOR</th>
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</thead>
<tbody>
<tr>
<td><strong>Product viscosity</strong></td>
<td>Very Low</td>
<td>Low</td>
<td>Medium-high</td>
<td>Very high</td>
</tr>
<tr>
<td><strong>Residence time</strong></td>
<td>&lt; 1 min</td>
<td>~ 2 min</td>
<td>~ 25 min</td>
<td>&lt;&lt; 1 min</td>
</tr>
<tr>
<td><strong>Heat transfer efficiency</strong></td>
<td>high</td>
<td>high</td>
<td>medium</td>
<td>high</td>
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Forced circulation evaporator
Forced circulation evaporator

Suitable for products with high levels of suspended solids or highly viscous products.

Fitted with high-capacity circulation pumps: extend the production time thus reducing downtimes for plant cleaning operations.

It is indicated for the concentration of:

- Tomato
- Puree
- Meat broth
- Industry waste processing
- Waste water
Concentration obtained by means of continuous circulation between a tube bundle heat exchanger and a flash vessel (separator).

Product flows through the heat exchanger from the bottom to the top (rising circulation).

Product releases vapour in the separator (flashing).

Rising forced circulation permits a higher heat transfer coefficient “flow boiling” phenomena: vapour and liquid together
Steam effects and product stages in counter flow

Plant under vacuum (barometric condenser or surface condenser with tower water)

Thanks to condensation vapour (hot medium) coming from the evaporation of the product in the 1° stage heat the product in the next stage and so on until the condenser

Product temperature increases stage by stage

Higher product temperature on the last stage (1° effect)

Product at maximum concentration is kept fluid (no pipes block up in tube bundle heat exchanger).

Product extraction on the last stage checked by a refractometer (standard precision: ± 1 °Brix)

Condensate recovery for washing
Double effect forced circulation evaporator

Barometric condenser

Vacuum pump

Condensate pump

Product circulation pump

Extraction pump
Energy efficiency: multiple effect evaporators

**ONE EFFECT**: 1 Unit of steam generates 1 Units of water

**FOUR EFFECTS**: 1 Unit of steam generates 4 Units of water
Energy efficiency: TVR technology

DOUBLE EFFECTS WITH TVR: 1 Unit of steam generates 4 Units of water
Main features

- Tube nest heat exchangers, designed in a vertical position, made of AISI 304.
- Cylindrical chambers, for separating the vapours from the liquid-vapour mixture coming from the heat exchanger, completely made of AISI 304.
- All the parts in contact with the product are mirror polished.
- Each chamber is equipped with an internal spay balls.
- Anti-implosion external rings welded on the chamber cylindrical wall
- "Patented" system for tangential symmetrical circulation of the product.
- Centrifugal pumps for the forced product circulation (parts in contact with the product in AISI 304).
a) Superior product quality as a result of:
   – reduced holding time especially for higher concentrations where maximum thermo damage occurs.
   – automatic control and regulation instruments for the principal process parameters to keep constant the operating conditions.

b) Very low water consumption:
   – pump seals cooling
   – make-up water for cooling tower circuit

c) Complete condensate recovery.

d) Guaranteed absolute precision in measuring the paste Brix degree.

e) Volumetric and transfer pumps driven automatically.
Forced circulation evaporator
Falling film evaporator
Suitable for thermal sensitive and not scaling products.

Product in evaporation drops down inside heated pipes by gravity force, sticking on them like a film.

A special unit can be associated to the evaporation plant in order to collect separately the aromatic fraction.

The product must have a percentage of solids in suspension less than 5%.

It is indicated for the concentration of:

- Clear juice
- Clear syrup
- Milk
- Pharmaceuticals
Several tubes are built together side by side.

Each tube end is fixed to tube plates.

Tube bundle is enclosed by a jacket (together they form the “calandria”)

Steam is introduced through the jacket. The space between the tubes is the heating section.

Inner side of the tubes is called boiling section.

Concentrated liquid and vapour leave the calandria at the bottom.
The liquid is evenly distributed on the inner surface of a tube.

It will flow downwards forming a thin film, from which the evaporation will take place because of the heat applied by the steam.

The steam will condense and flow downwards on the outer surface of the tube.

Very short residence time (pipe length up to 30 m).
Falling film evaporator

- Very high thermal exchange coefficient: evaporation with little differences temperature between the heating steam and the product
- This evaporator can work in many stages and effects
- In this case number of effect and number of stage are the same because the steam flows in co-current with the product.
Falling film evaporator: thermo-compressor

- Its function is to reduce the steam consumption.
- The steam coming from the boiler has got high pressure (8-10 bar) and intercept the vapour coming from the evaporation of a stage.
- In this way it “sucks” by Venturi system the vapour reintroducing it in the line to the 1° effect.
- Part of the vapour of that effect is sent back and the remaining goes ahead to heat the product in the following stage.
Aroma recovery

- Suitable to recover aromas that would be lost during concentration.
- It condenses the vapour coming from the condensate obtained from the evaporation of the product.
- This concentrate aroma is cooled and it is stored into a drum or an apposite tank, available to be added during juice preparation process.
4 Effect falling film evaporator
This kind of concentrator is particularly suitable for the concentration with low to medium evaporation rates, for liquids containing only small amount of un-dissolved solids and with no tendency to fouling.

Also for temperature-sensitive products, for highly viscous products or extreme evaporation conditions, a product circulation design is chosen.

Is required a product with maximum 5% of suspended solids.

It is indicated for the concentration of:

- Clear fruit juices
- Milk
- Filtrate sugar syrups
Plate evaporators have a relatively large surface area.

The plates are usually corrugated and are supported by frame. During evaporation, steam flows through the channels formed by the free spaces between the plates.

The steam alternately climbs and falls parallel to the concentrated liquid. The steam follows a co-current, counter-current path in relation to the liquid. The concentrate and the vapour are both fed into the separation stage where the vapour is sent to a condenser.

Plate evaporators are frequently applied in the dairy and fermentation industries.

This type of evaporator is limited in its ability to treat viscous or solid-containing products.
Plate evaporator

- Vapour separator
- Steam
- Condensate
- Heating Plates
Plate evaporator
Particular features:

Use of different heating media: due to plate geometries, the system can be heated with both water as well as steam.

High product quality: due to especially gentle and uniform evaporation during single-pass operation.

Little space required: due to compact design, short connecting lines and small overall height of max 3-4 meters.

Easy installation requiring little time: due to pre-assembled, transportable construction units.

Flexible evaporation rates: by adding or removing plates.

Ease of maintenance and cleaning: as plate packages can be easily opened.
Thin Film Evaporator
Scrapped Surface/Thin Film Evaporators are designed for evaporation of highly viscous and sticky products, which cannot be otherwise evaporated.

This type of evaporators have been specially designed to provide high degree of agitation, effecting heat transfer as well as scrapping the walls of the evaporator to prevent deposition.

It is indicated for the concentration of any kind of product, especially for highly viscous product.

Thin Film Evaporation refers here to the thermal separation of products in a mechanically generated, thin and highly turbulent liquid film.
The product is continuously fed into the vertical Thin Film Evaporator above the heating jacket and is spread on to the periphery by the distribution ring. The product is then picked up by the rotor blades and immediately formed into a thin turbulent film (0.5 - 3.5 mm) on the heat transfer surface. In front of each rotor blade, the fluid creates a bow wave.

The fluid in the gap between the heat transfer surface and the rotor blade tip is highly turbulent and this leads to intensive heat and mass transfer rates. This turbulence produces high heat transfer coefficients even with highly viscous products.

Due to the intensive mixing action within the bow wave, temperature sensitive products are prevented from over heating and fouling on the heat transfer surface can be reduced or eliminated.
Thin Film Evaporator

- Product inlet
- Concentrate outlet
- Steam
- Vapour outlet
Thin Film Evaporator

- a) Inner shell
- b) Rotor blade
- c) Gap between rotor and inner shell
- I) Film zone
- II) Bow wave
- III) Gap zone
The volatile components of the feed stock are therefore very quickly evaporated and flow counter-currently with reference to the feed, up towards the top of the evaporator to the rotating separator. Here, entrained droplets or foam are knocked out of the vapour steam and return to the evaporation zone.

The evaporated components (low boilers) then flow out of the evaporator in to the condensation stage, column or to another downstream process step.

For special applications co-current vapour/product flow can be used in which case a separation vessel is fitted at the bottom of the evaporator below the rotor in place of the normal rotor mounted separator and the upper vapour outlet nozzle.