



Once through and circulation evaporators

Evaporators may be operated either as once through or as circulation units.

In once through operation the feed liquor passes through the tubes only once, releases the vapour, and leaves the unit as thick liquor.

All the evaporation is accomplished in a single pass. The ratio of evaporation to feed is limited in single pass units, thus the evaporators are well adapted to multiple effect operation, where the total amount of concentration can be spread over several effects.

Agitated film evaporators are always operated once through; falling film and climbing film evaporators can also be operated in this way. Once through evaporators are especially useful for heat sensitive materials. By operating under high vacuum, the temperature of the liquid can be kept low.

With a single rapid passage through the tubes the thick liquor is at the evaporation temperature but a short time and can be quickly cooled as soon as it leaves the evaporator.

In circulation evaporators a pool of liquid is held within the equipment. Incoming feed mixes with the liquid from the pool, and the mixture passes through the tubes.

Unevaporated liquid discharged from the tubes returns to the pool, so that only part of the total evaporation occurs in one pass. All forced circulation evaporators are operated in this way.

Climbing film evaporators are usually circulation units. The thick liquor from a circulation evaporator is withdrawn from the pool.

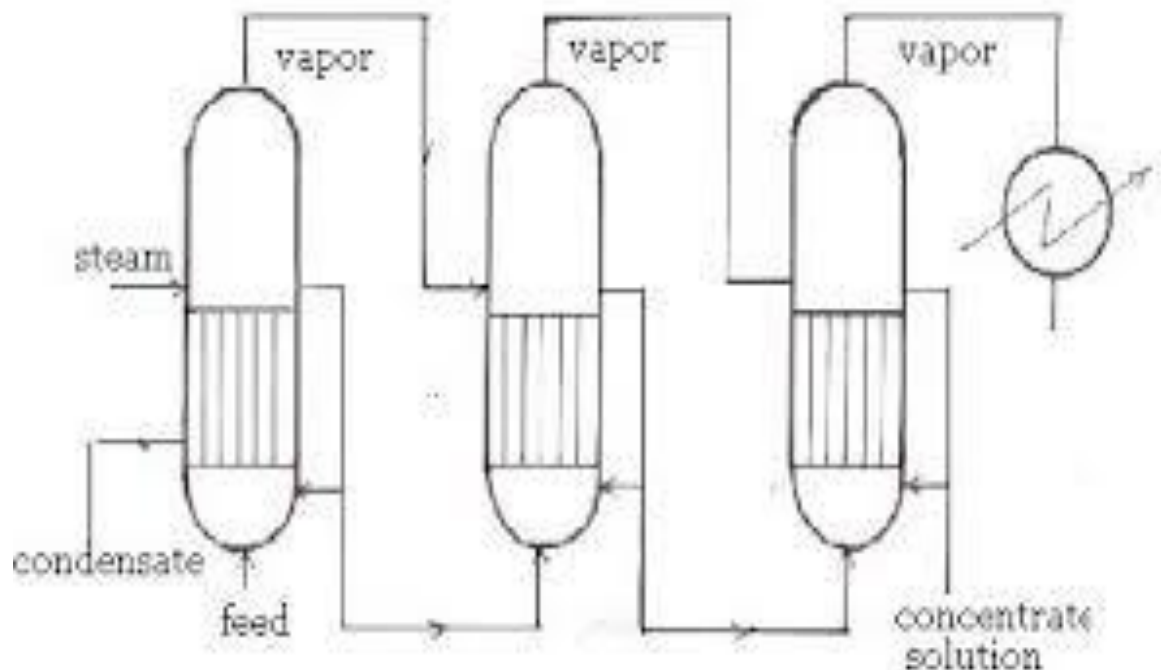
All the liquor in the pool must therefore be at the maximum concentration. Since the liquid entering the tubes may contain several parts of thick liquor for each part of feed, its viscosity is high and the heat transfer coefficient tends to be low.

Circulation evaporators are not well suited to concentrating heat sensitive liquids. With a reasonably good vacuum the temperature of the bulk of the liquid may be nondestructive, but the liquid is repeatedly exposed to



contact with hot tubes. Some of the liquid, therefore, may be heated to an excessively high temperature. Although the average residence time of the liquid in the heating zone may be short, part of the liquid is retained in the evaporator for considerable time. Prolonged heating of even a small part of a heat sensitive material like a food can ruin the entire product. Circulation evaporators, can operate over a wide range of concentration between feed and thick liquor in a single unit, and are well adapted to single effect evaporation. They may operate either with natural circulation, with the flow through the tubes induced by density difference, or with forced circulation with flow provided by a pump.

CIRCULATION EVAPORATOR





Once-Through Evaporators

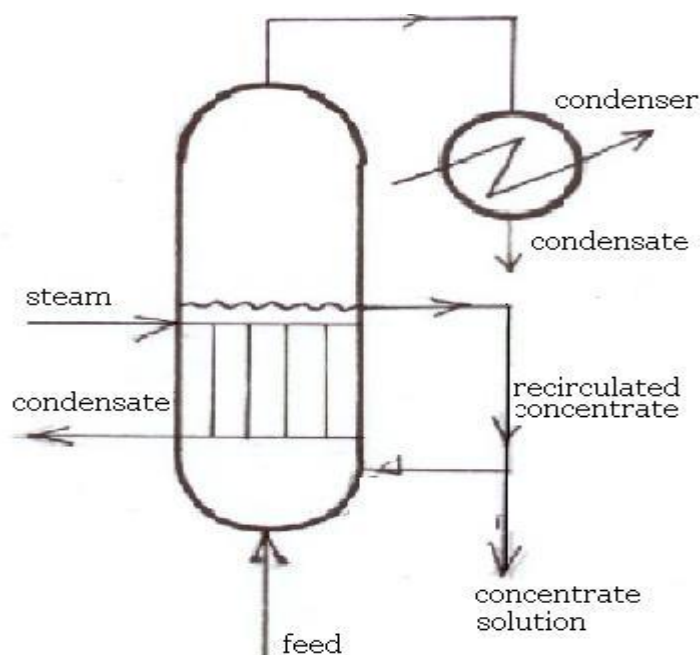
Advantages:

- **Simple design** with minimal moving parts.
- **Short residence time**, which is ideal for heat-sensitive materials.
- **Lower risk of product degradation** because the liquid passes through only once.
- Often **compact** and **easy to clean**.
- Suitable for continuous operations.

Disadvantages:

- **Lower heat transfer efficiency** due to limited contact time.
- Usually requires **higher flow rates**.
- Less flexibility in handling **viscous liquids**.
- May not achieve high concentration in one pass, requiring multiple stages.
- More prone to **scaling or fouling** if solids are present.

- ONCE THROUGHT EVAPORATOR





Circulation Evaporators

Advantages:

- **Better heat transfer** due to continuous circulation.
- Can handle **higher viscosity fluids** and **higher concentrations**.
- Less prone to localized **overheating**.
- Suitable for liquids that tend to **foam** or **scale**, as circulation reduces buildup.
- More efficient at reaching **higher final concentrations**.

Disadvantages:

- **More complex design** (pumps, piping, etc.).
- **Higher energy consumption** due to recirculation pumps.
- **Longer residence time**, which can degrade heat-sensitive products.
- Bigger equipment size.
- Higher **maintenance** costs.