



SNS COLLEGE OF PHARMACY AND HEALTH SCIENCES

Sathy Road, SNS Kalvi Nagar, Vazhiyampalayam, Coimbatore, Tamil Nadu 641035



Evaporation

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EVAPORATION

Defination:-

Theoretically,

- “Evaporation means simply vaporization from the surface of a liquid. Vaporization of a liquid below its boiling point is called evaporation.”
- Thus, no boiling occurs and the rate of vaporization depends on the diffusion of vapour through the boundary layers above the liquid.

- Thus a practical definition of evaporation is
- “The removal of liquid from a solution by boiling the solution in a suitable vessel and withdrawing the vapour, leaving a concentrated liquid residue.”
- This means that heat will be necessary to provide the latent heat of vaporization and, in general the rate of evaporation is controlled by the rate of heat transfer.
- Evaporators are designed, therefore, to give maximum heat transfer to the liquid, with the largest possible area, a suitable temperature gradient.

Mechanism

- When heat applied in solution the motion of molecules increase and molecules present in the surface overcome the surface tension of the liquid and it evaporates because surface molecules have less cohesive force than others.

Factors affecting the Evaporation

- There are seven factors to affect evaporation.
 1. Temperature
 2. Surface area
 3. Agitation
 4. Atmospheric aqueous vapour pressure
 5. Atmospheric pressure on the liquid under evaporation
 6. Type of product required
 7. Economic factors

- 1) Temperature:** The rate of evaporation is directly proportional to the temperature.
- 2) Surface area:** The rate of evaporation is directly proportional to the surface area of the vessel exposed to evaporation.
- 3) Agitation:** is necessary for evaporation.
- 4) Atmospheric aqueous vapour pressure:** The rate of evaporation is inversely proportional to the atmospheric aqueous vapour pressure.

5) Atmospheric pressure on the liquid under evaporation: The rate of evaporation is inversely proportional to the atmospheric pressure on the liquid under evaporation.

6) Type of product required: The selection of the method and apparatus to be used for evaporation depends upon type of product required.

7) Economic factors: When selecting the method and apparatus the economic factors are important

EVAPORATION UNDER REDUCED PRESSURE

- At reduced pressure evaporation increases.

Advantage:

1. Evaporation occurs at low temperature, with less risk of damage to heat sensitive materials.
2. A lower operating temperature gives higher temperature gradients, without the need of excessive steam pressures.
3. The lower the operating, temperature the lower the steam pressure that can be used.

EQUIPMENT USED FOR EVAPORATION

- Equipments which are used for evaporation are called Evaporators.

Types of Evaporator:

- Evaporators are divided mainly into three groups.

1. Natural circulation evaporator

❖ Types:

- i) Evaporating pans
- ii) Evaporating stills
- iii) Short tube evaporator.

2) Forced circulation evaporator.

3) Film evaporator

Types:

i) Wiped Film evaporator

ii) Long Tube Evaporator

a) Climbing film evaporator

b) Falling film evaporator

1) NATURAL CIRCULATION EVAPORATORS

- **Working principle:**
 - The movement of the liquid results from convection currents set up by the heating process.
- **Convection currents:** The process in which heat moves through a gas or liquid as the hotter parts rises and the cooler part sinks.

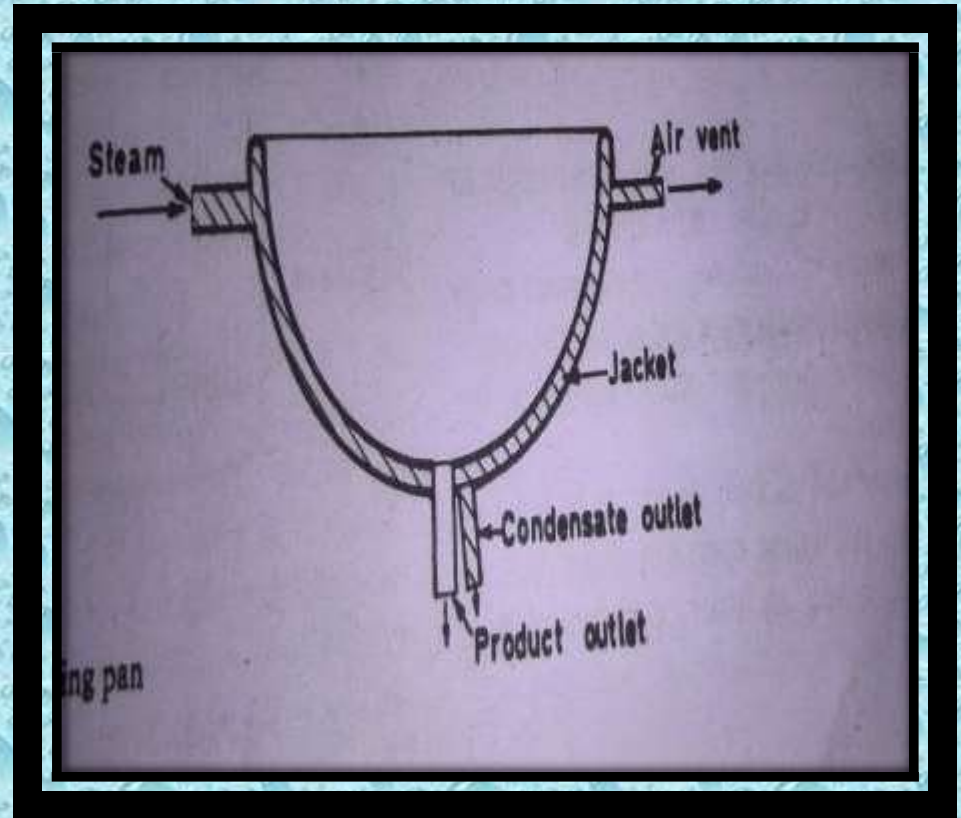
Evaporating Pans

- “On a manufacturing scale, liquid extracts containing water are evaporated in open pans called evaporating pans.”

Construction:

- The evaporating pan consists of
 - Hemispherical shallow made of
 - Copper
 - Stainless steel
 - Alluminium
 - Enameled iron
 - Steam jacket
- The hemispherical shape gives the best surface\volume ratio for heating and the largest area for the disengagement of vapour.

- **Working:**
- The dilute solution is taken in the pan. Steam is introduced through the steam inlet into the jacket to heat the pan. In these evaporators the movement of the liquid results from convection currents set up by the heating process. The concentrated liquid is collected through the outlet placed at the bottom of the pan.





Advantages

- 1) They are simple, easy and cheap to construct.
- 2) They are easy to use and clean.
- 3) Stirring of the evaporating liquids can be done easily.

Disadvantage

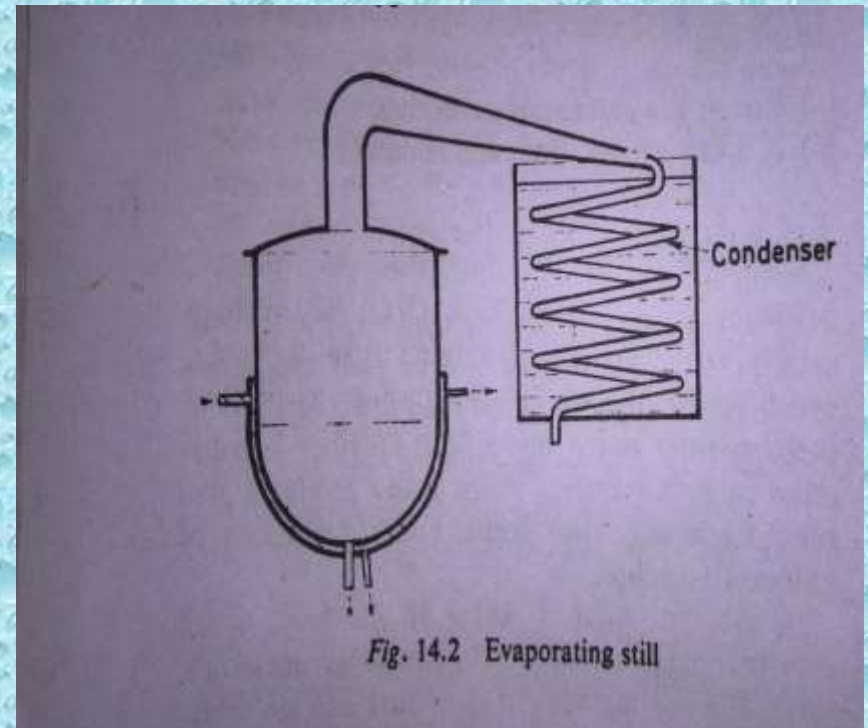
- 1) The whole of the liquid is heated all the time which may lead to decomposition of the components.
- 2) On the evaporating surface foam is rapidly formed which decreases evaporation. Solids may be deposited at the bottom which make the stirring necessary.
- 3) This pan can only be used for evaporating aqueous and thermostable liquid extracts.
- 4) They can not be used for evaporating extracts containing organic solvents like alcohol etc.

ii) Evaporating still

- **Construction**
- It consists of a jacketed-evaporating pan with a cylindrical *cover* that connects it to a condenser. The over all assembly is called *still*. The cover is clamped with the evaporating pan.

Working :

- The dilute liquid is fed into the still, the cover is clamped. Steam is introduced into the jacket. The liquid is evaporated and condensed in the condenser and collected. The product (i.e. concentrated liquid) is collected through the product outlet.



Advantages:

- Easy to clean and maintain.
- Allow the equipment to be used for solvents other than water. E.g. ethanol.

Disadvantages:

- All the liquor is heated all the time.
- The heating surface is limited.

APPLICATION OF EVAPORATION

- Evaporation is one of the most important processes in the manufacture of pharmaceuticals.
- It is used in the preparation of
 1. Liquid extracts, soft extracts & dry extracts.
 2. In the concentration of blood plasma & serum.
 3. It is also used in the manufacture of drugs containing, antibiotics, enzymes, hormones & many other substances.

- 4) Used in purification of vitamins.
- 5) Concentration of proteins.
- 6) Concentration of biological products.
- 7) Stripping of solvents from vegetable & plant or herbal extracts.
- 8) Removal of water & solvents from fermentation broths.
- 9) Concentration of penicillin & related products