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# *Evaporation:* Basic principles of evaporators, construction and operation

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# Outline

- Introduction
- Vapourization and evaporation
- Construction and operation of evaporation
- Evaporator systems
- Types of evaporators
- Different types of evaporators used in dairy Industry
- Different types of evaporators



## Introduction

# Vapourization and evaporation

**Table-1.1: Differences between evaporation and vaporization**

	Vapourization		Evaporation
(i)	Vapourization occurs when entire mass of liquid is raised to the boiling point.	(i)	It is only a surface phenomenon with only surface molecules escaping at a rate depending upon area of open surface.
(ii)	It is a much faster process for the production of vapours.	(ii)	It is a relatively slow process and depends mainly on temperature difference and on difference of vapour pressure between air and liquid.
(iii)	Boiling point is related to the pressure above the liquid surface and the amount of solute.	(iii)	Evaporation occurs at normal room temperature and application of heat is not necessary under normal evaporation



## Factors important for evaporation process

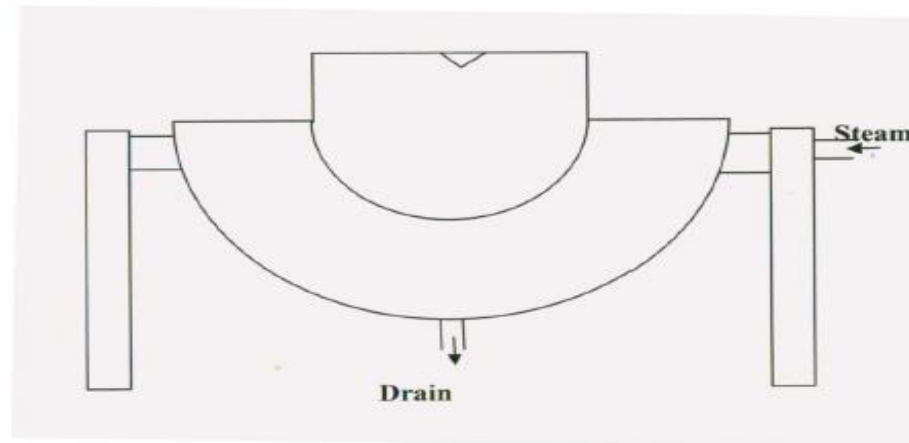
- 1) Concentration
- 2) Foaming
- 3) Heat sensitivity
- 4) Scale formation/Fouling
- 5) Material of construction
- 6) Specific heat
- 7) Gas Liberation
- 8) Toxicity
- 9) Viscosity
- 10) Capacity
- 11) Economy



## Evaporation Systems

Basically an evaporator system consists of a heat exchanger, supplying the sensible heat to raise the product to its boiling point and provide the latent heat of vaporization, a separator for the separation of vapour and concentrate, a condenser to remove the resultant vapour as condensate and a vacuum system as the process is carried out under reduced pressure. The heating medium is steam.

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**Fig-2.1: Evaporator System**



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Based on the nature of the heat transfer surface, evaporators can be classified as:

- (1) Tubular surface with natural or forced circulation.
  - a. Horizontal tube evaporator
  - b. Vertical short tube evaporator
  - c. Falling film evaporator
  - d. Rising /Ascending / climbing film evaporator
- (2) Flat heating surface: plate evaporator
- (3) Stationary cylindrical surfaces with scraped surface evaporator.



## Types of Evaporators

Evaporators used in food industry may also be classified in different ways as under.

1. Operating pressure – Vacuum and Atmospheric
2. Number of effects – Single effect and multiple effect
3. Type of convection – Natural convection and forced convection
4. Continuity of operation – Batch and continuous
5. Type of heat exchanger – Tube type, plate type, scraped surface etc.



- I. Horizontal Tube Evaporators
- II. Vertical Tube Evaporators
- III. Basket Type Evaporators
- IV. Vapor and Entrainment Separators

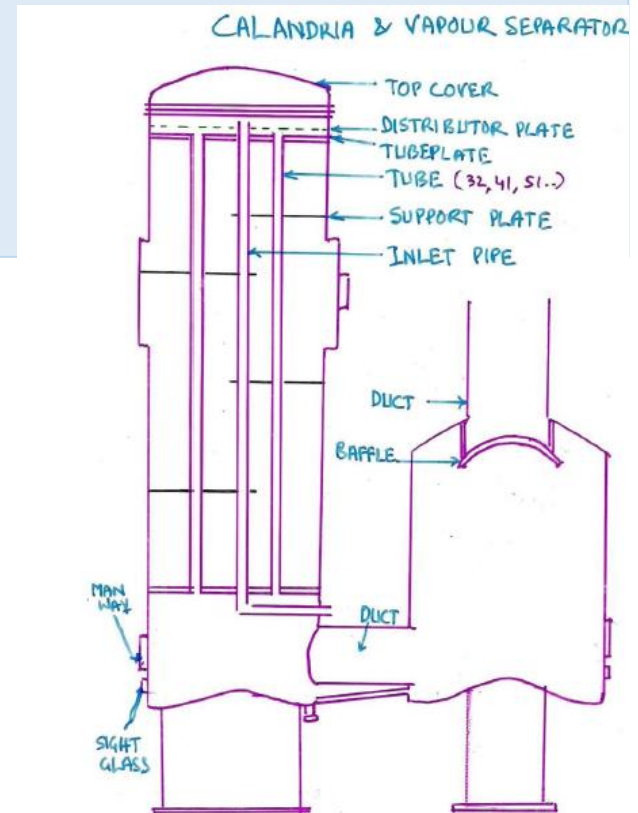


Fig. Evaporator with vapor separator and Entrainment Separator





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Thank you