



TOPIC:Drying

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The logo of Galgotias University is a circular emblem with a stylized 'G' shape in the center. The 'G' is composed of three curved segments in shades of yellow, blue, and red. The background of the emblem is a gradient of light blue and white.

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Introduction

All foods and biomaterials need some form of preservation to

- Reduce or stop spoilage
- Make them available throughout the year
- Maintain desired levels of nutritional and bioactive properties for the longest possible time span and
- Produce value added products

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Drying Methods

This requires the development of operations that minimize the adverse effects of processing

There have been various advances in the drying of foods with respect to quality, rehydration, and energy minimization

Some of the improvements and advancements made leading to the new developments in drying .

Importance of drying

1. To avoid or eliminate moisture which may lead to corrosion and decrease the product or drug stability.
2. To improve or keep the good properties of a material, e.g. Flowability, compressibility.
3. To reduce the cost of transportation of large volume materials (liquids).
4. To make the material easy or more suitable for handling.
5. Preservative.
6. The final step in Evaporation, Filtration, Crystallization

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Equipments

1. Drum dryer (Film drying)
2. Spray dryer
3. Freeze Dryer
4. Tray drier
5. Fluidized Bed Dryer
6. Vacuum Dryer



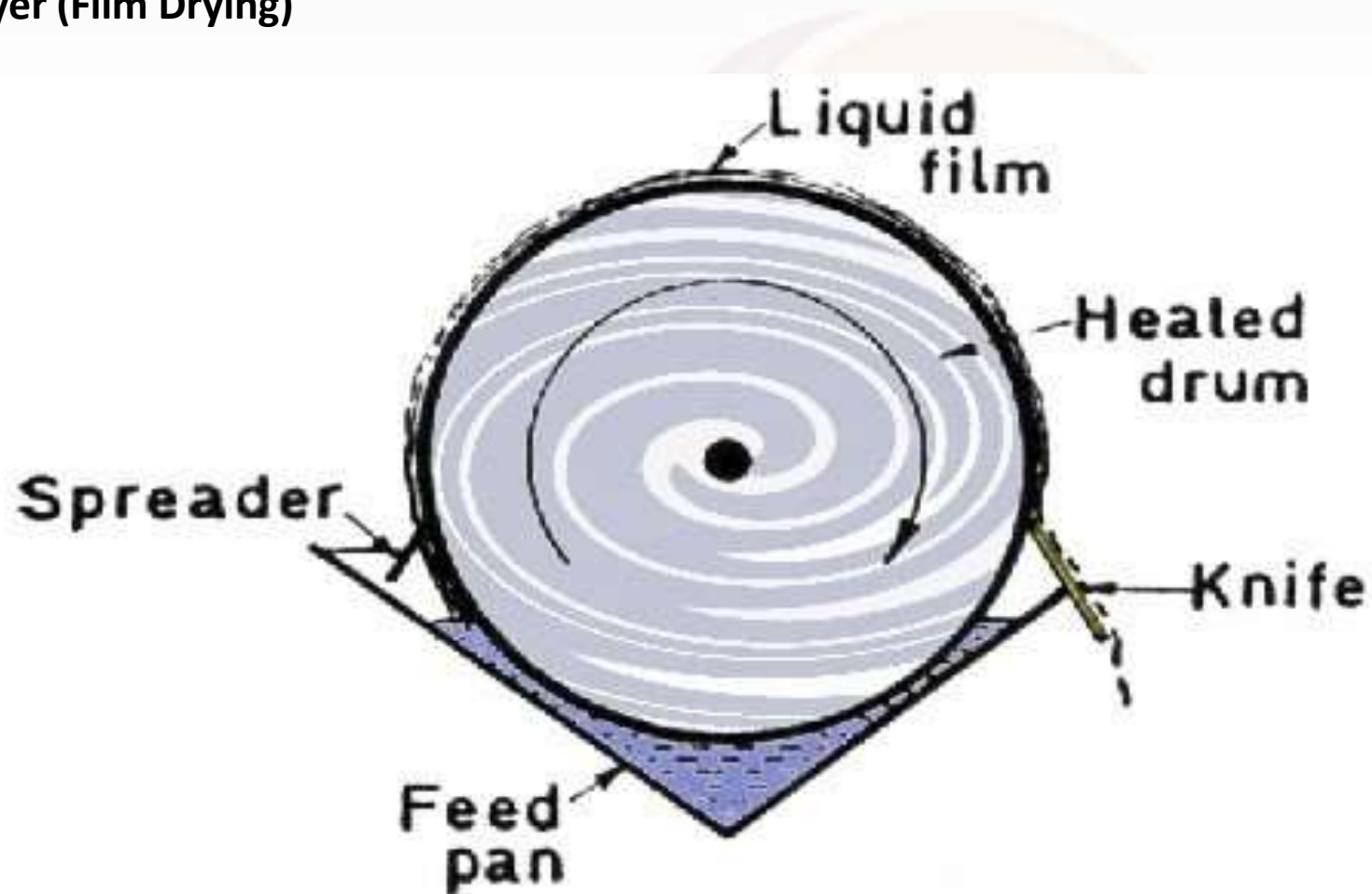
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Drum Dryer (Film Drying)



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- It consists of a drum of about 0.75-1.5 m in diameter and 2-4 m in length, heated internally, usually by steam and rotated on its longitudinal axis.
- **Operation:** The liquid is applied to the surface and spread to a film, this may be done in various ways, but the simplest method is that shown in the diagram, where the drum dips into a *feed pan*. Drying rate is controlled by using a suitable speed of rotation and the drum temperature. The product is scraped from the surface of the drum by means of a doctor knife.

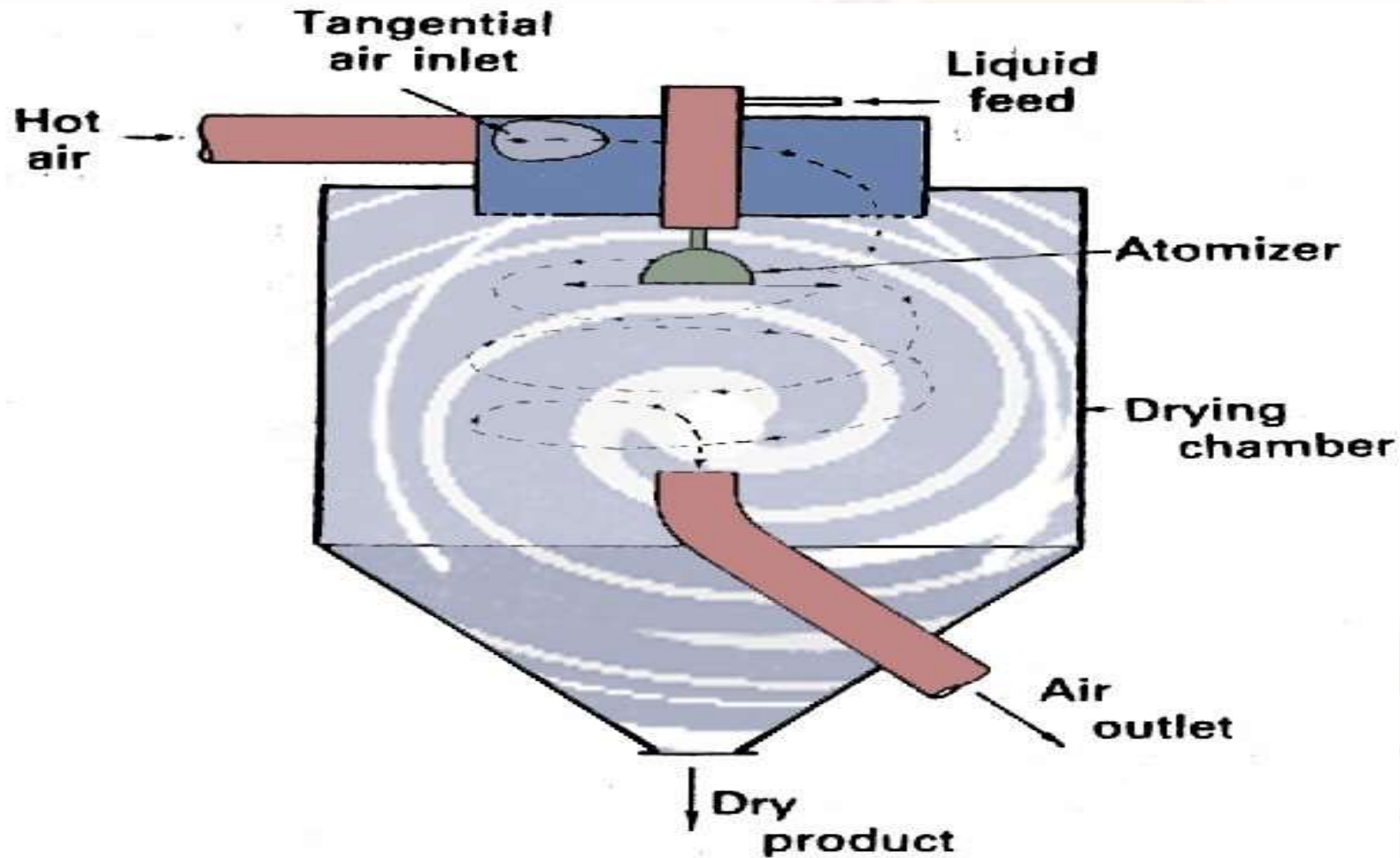
Spray Dryer

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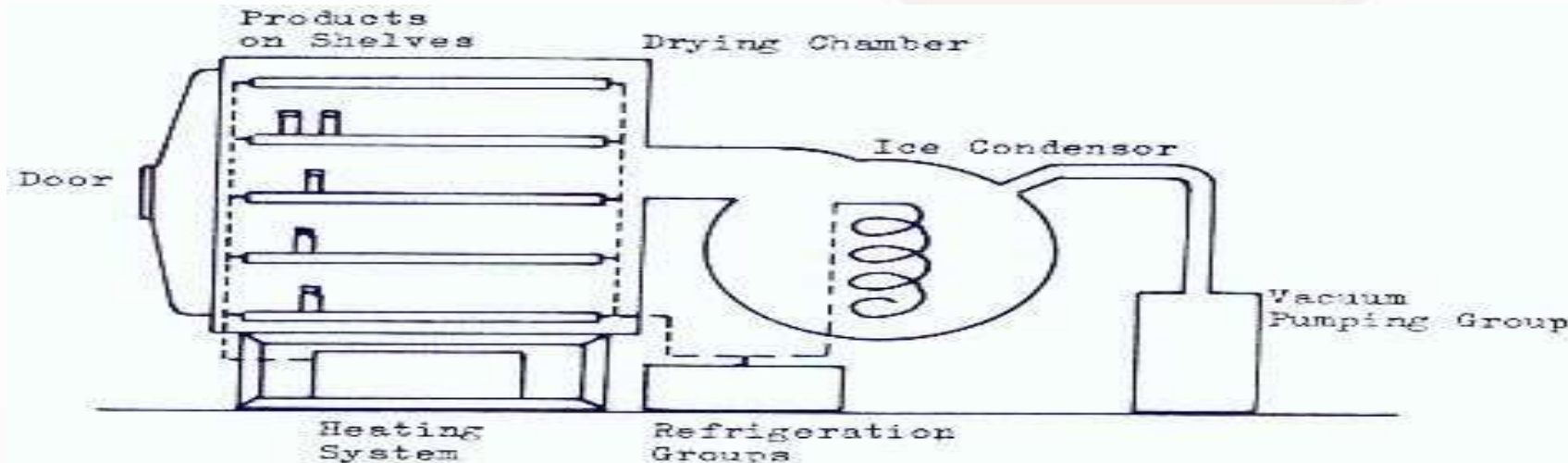
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- The spray dryer provides a large surface area for heat and mass transfer by atomizing the liquid to small droplets.
- These are sprayed into a stream of hot air, so that each droplet dries to a solid particle.
- The drying chamber resembles the cyclone ensuring good circulation of air, to facilitate heat and mass transfer, and that dried particles are separated by the centrifugal action.
- Spray dryer can be operated efficiently at various feed rates.

Freeze Dryer



Freeze drying is a process used to dry extremely heat- sensitive materials. It allows the drying , without excessive damage, of proteins, blood products and even microorganisms, which retain a small but significant viability.

In this process the initial liquid solution or suspension is frozen, the pressure above the frozen state is reduced and the water removed by sublimation.

- Thus a liquid-to-vapour transition takes place, but here three states of matter involved: liquid to solid, then solid to vapour.

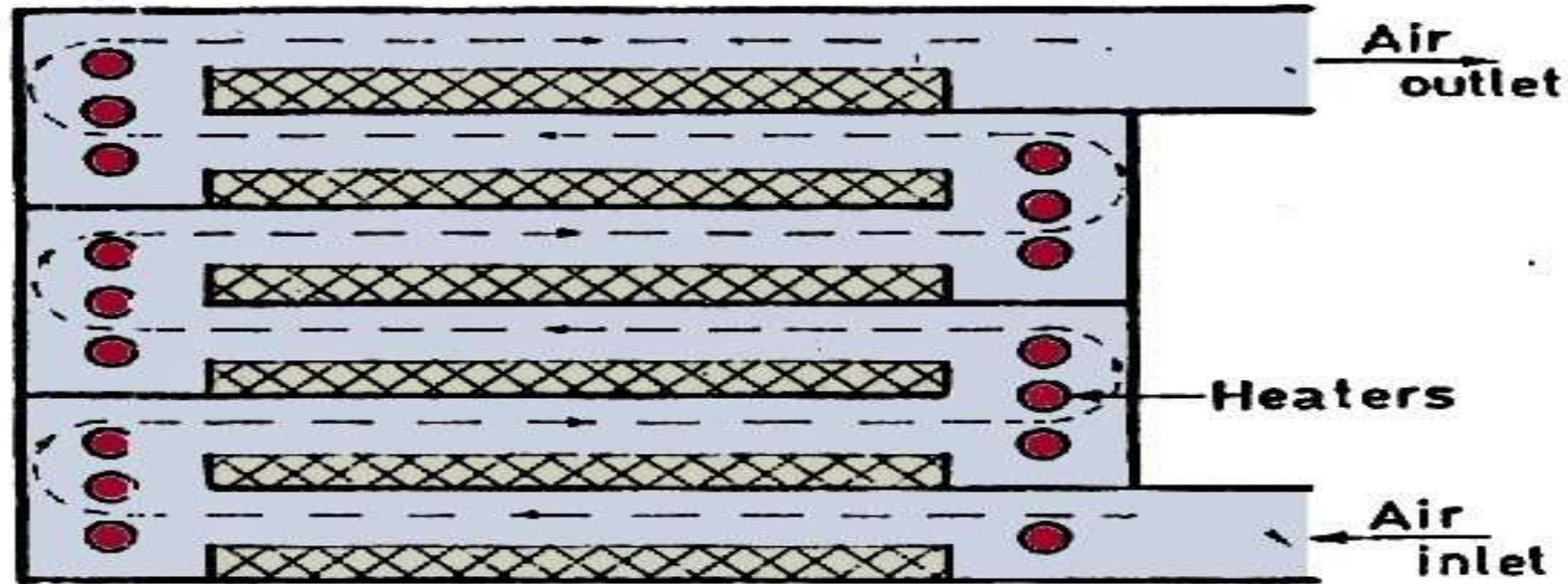
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Tray Dryer



Directed-circulation tray drier

- Air flows in direction of the arrows over each shelf in turn.
- The wet material is spread on shallow trays resting on the shelves.
- Electrical elements or steam-heated pipes are positioned as shown, so that the air is periodically reheated after it has cooled by passage over the wet material on one shelf before it passes on the next.

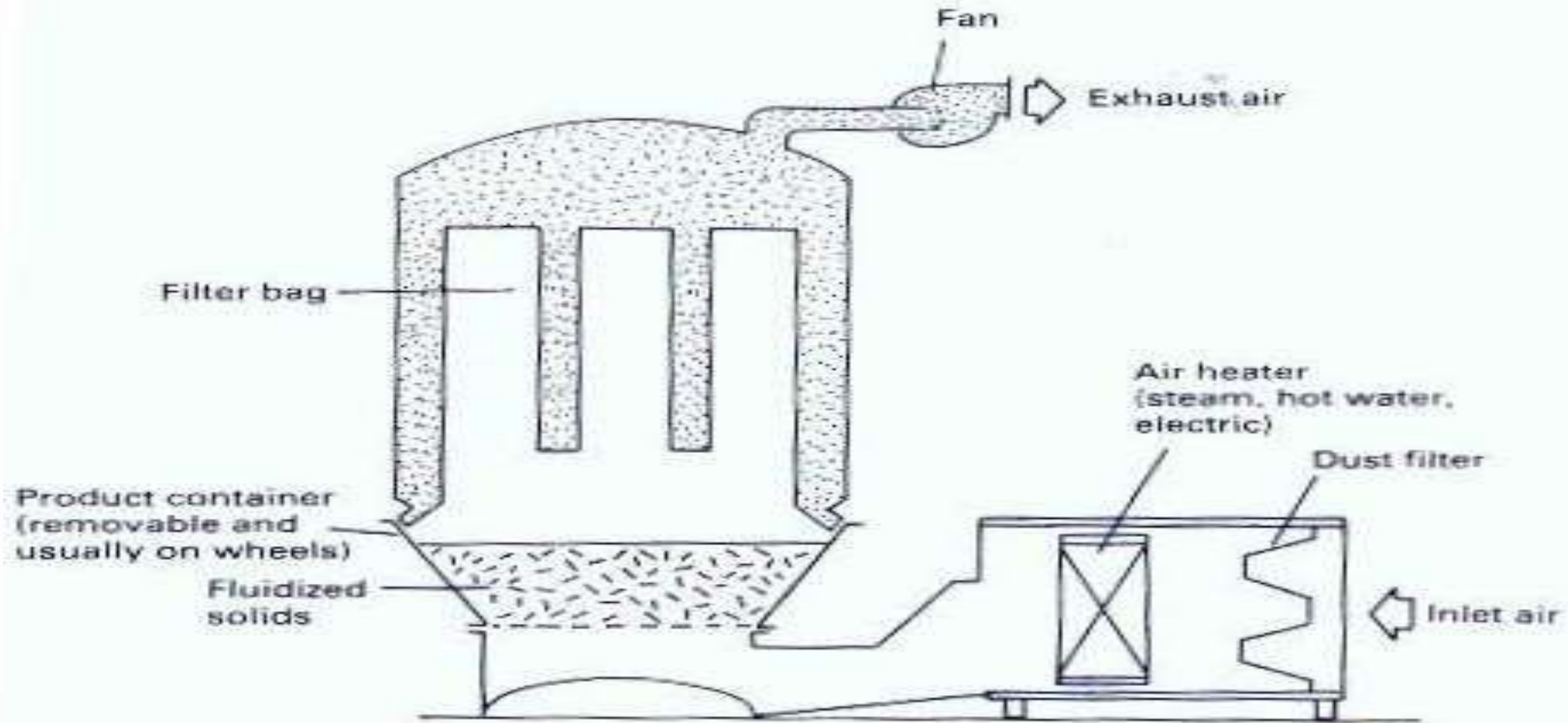
Fluidized Bed Dryer

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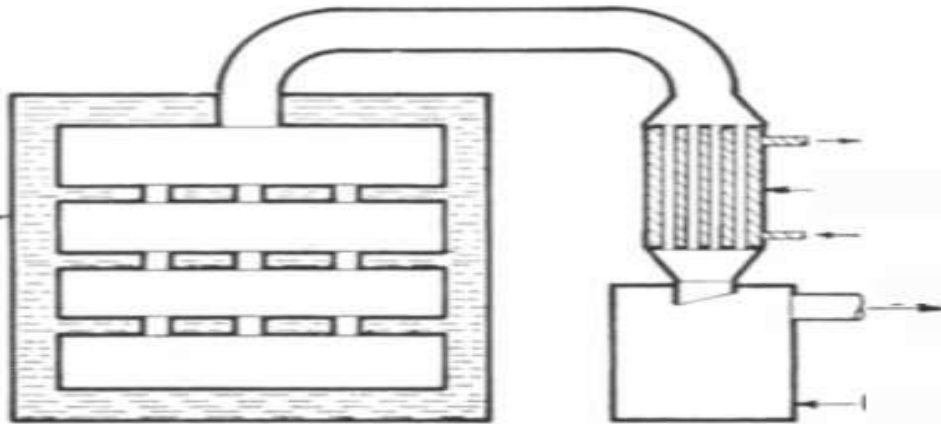
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- Fluidized' means something that behaves like liquid. In the fluidized bed dryer, the mixture of solids and gas behave like a liquid and solid are called fluidized.
- It provides good contact between hot air and particles to obtain efficient drying.
- The hot air is passed through a mesh, which supports the conical vessel with a porous base.
- This vessel is filled with powder to be dried.
- It has wheels and can be clipped to the central plate by means of a rapid acting ring closure.

Vacuum Dryer



Heat exchangers: Heat exchangers are the devices used for transferring heat from one fluid (hot gas or steam) to

Vacuum Dryer

- This equipment is a good example of conduction drier. The vacuum oven consists of a jacketed vessel to withstand vacuum within the oven.
- There are supports for the shelves giving a larger area for conduction heat transfer. The oven can be closed by a door.
- The oven is connected through a condenser and liquid receiver to a vacuum pump.
- Operating pressure can be as low as 0.03-0.03 bar, at which pressures water boils at 25-35 °C.

Drying curve

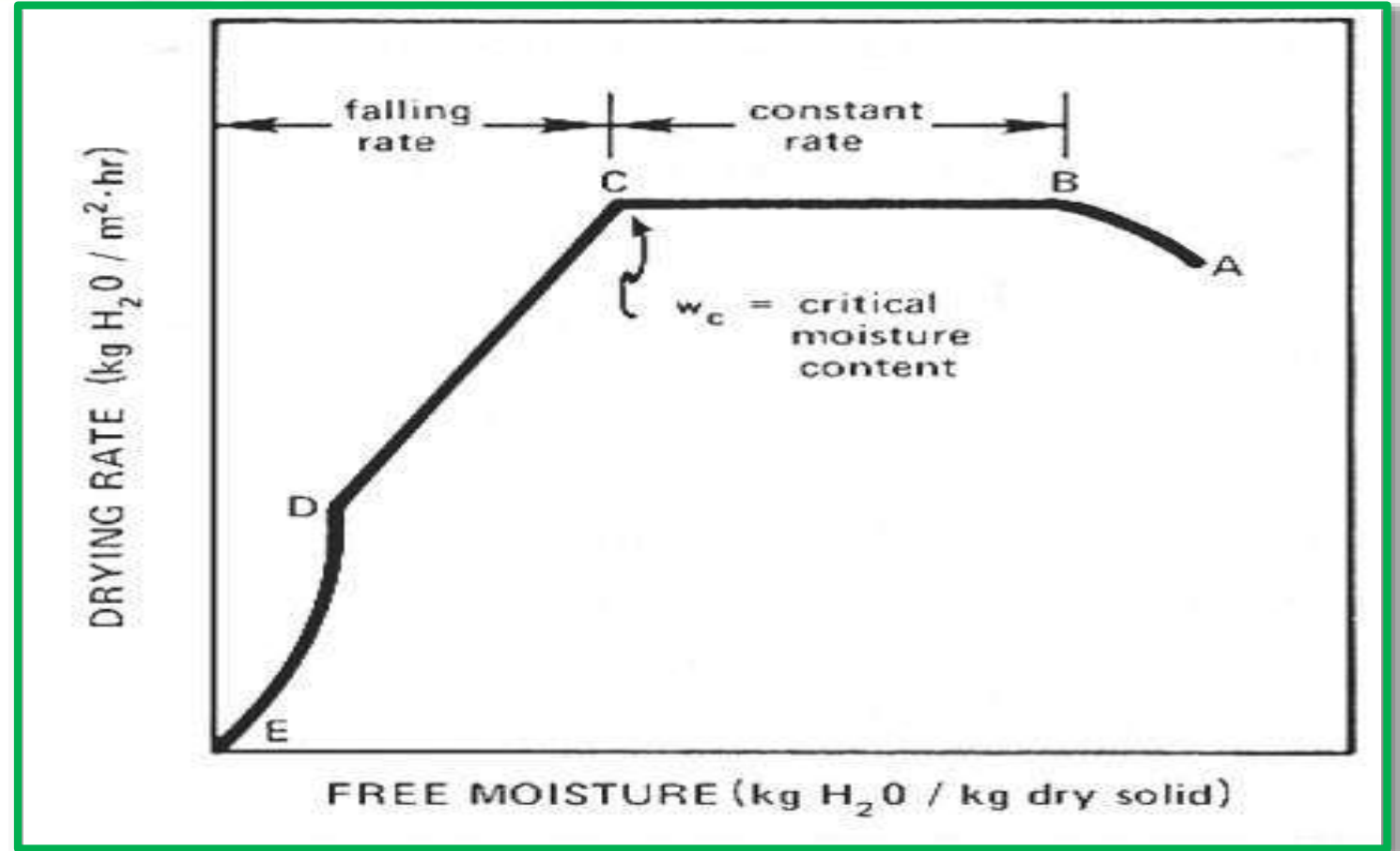
Drying curve is the plot of the drying rate Φ or N versus the remaining water content X . Water content X is expressed as kg of water per kg of dry matter. Drying process of a material can be described as a series of steps in which drying rate plays a key role.

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Constant rate period

- Point B represents equilibrium temperature conditions of the product surface.
- Section B to C of the curve, known as the constant rate periods, represents removal of unbound water from the product.
- The water acts as if the solid is not present. The surface of the product is very wet and water. And the water activity is equal to one.
- The constant rate period continues as long as the amount of water evaporates is equal to the amount of water

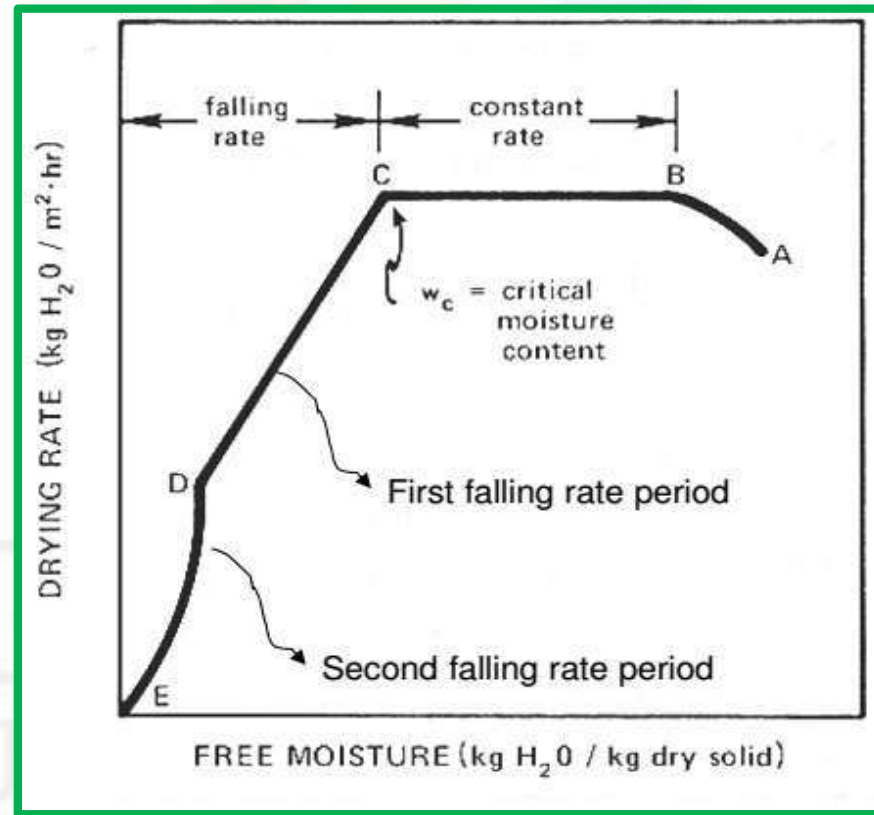
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Falling rate period

- The falling rate period is reached when the drying rate starts to decrease, and the surface water activity falls to less than one.
- The rate of drying is governed by the internal flow of liquid or vapor. This point is represented by C in the figure.
- At this point there is not enough water on the surface to maintain a water activity value of one.

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- The falling rate period can be divided into two steps.
- First falling dryingrate
- Second falling dryingrate



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