

# FILTRATION

**FILTRATION:** It may be define as a process of separation of solids from a fluid by passing the same through a porous medium that retains the solids but allows the fluid to pass through.

## APPLICATIONS OF FILTRATION :

- 1) Production of sterile products
- 2) Production of bulk drugs
- 3) Production of liquid dosage formulation o Dewaxing of oils
  - Removing suspended oils from aqueous solutions
  - Removing of undesirable solids
  - Clarifying the potable water
- 4) Effluents and waste water treatment

## THEORIES OF FILTRATION :

- 1) The flow of liquid through a filter follows the basic rules that govern the flow of any liquid through the medium offering resistance.

The rate of flow may be expressed as-  $\text{Rate} = \text{driving force} / \text{resistance}$

- 3) The rate of filtration may be expressed as volume (litres) per unit time (dv/dt).

- 4) Driving force = pressure upstream – pressure downstream □ Resistance is not constant.

- **POISEULLIE'S EQUATION**

- Poiseullie's Equation is-  $V = \frac{\pi \Delta P r^4}{8 L \eta}$

Poiseullie considered that filtration is similar to the streamline flow of liquid under pressure through capillaries

Where,  $V$  = rate of flow,  $m^3 /s$  (l/s)

$\Delta P$ = Pressure difference across the filter, Pa

$r$  = radius of capillary in the filter bed, m

$L$  = thickness of filter cake (capillary length), m

$\eta$  = viscosity of filtrate, Pa.s

## **2. DARCY'S EQUATION**

1) Poiseullie's law assumes that the capillaries found in the filter are highly irregular and nonuniform.

. Therefore, if the length of capillary is taken as the thickness of bed, a correction factor for radius is applied so that the rate is closely approximated and simplified.

2) The factors influencing the rate of filtration has been incorporated into an equation by Darcy, which is:

$$V = \frac{KA\Delta p}{nl}$$

,  $K$  = permeability coefficient of cake,  $m^2$

A = surface area of porous bed (filter medium), m<sup>2</sup>

K depends on characteristics of cake, such as porosity, specific surface area and compressibility.

### 3. KOZENY-CARMAN (K-C) EQUATION •

Kozeny-Carman equation is widely used for filtration.

$$V = \frac{A}{\eta S^2} \times \frac{\Delta P}{K L} \times \frac{\epsilon^3}{(1-\epsilon)^2}$$

Where,  $\epsilon$  = porosity of cake (bed)

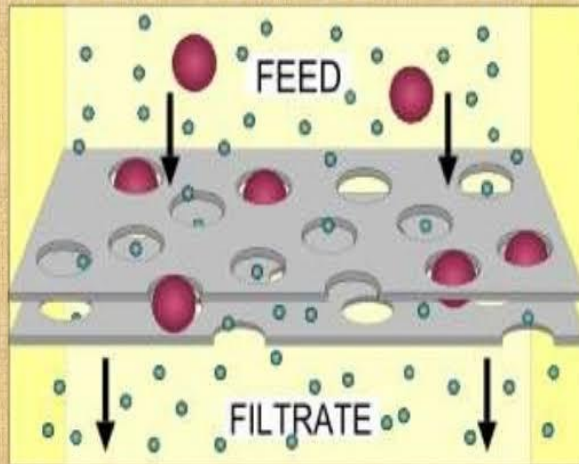
S = specific surface area of particles comprising the cake m<sup>2</sup> / m<sup>3</sup>

K = Kozeny constant (usually taken as 5)

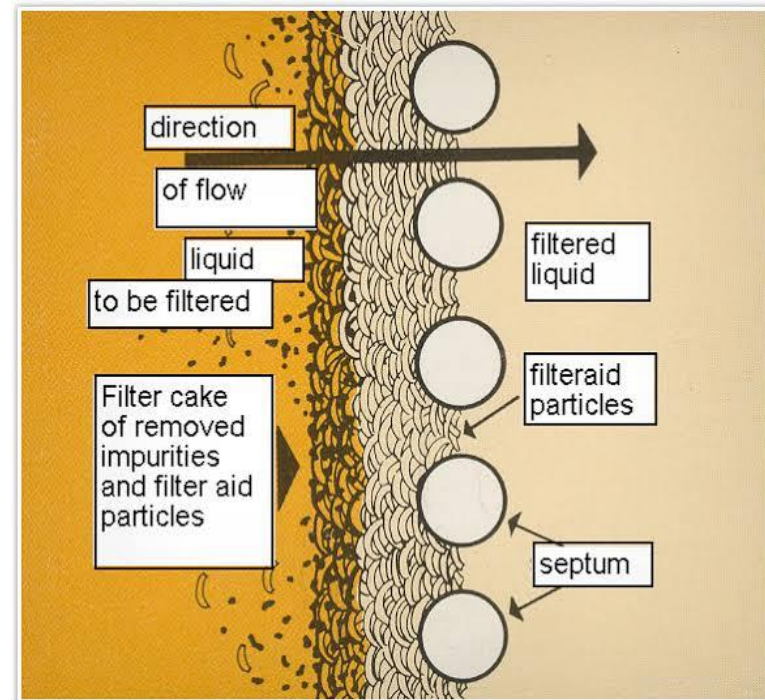
**FILTER MEDIA** : The surface upon which solids are deposited in a filter is called the “Filter medium”

**FILTER AIDS** : Filter aid forms a surface deposit which screens out the solids and also prevents the plugging of .

## Filter Aids



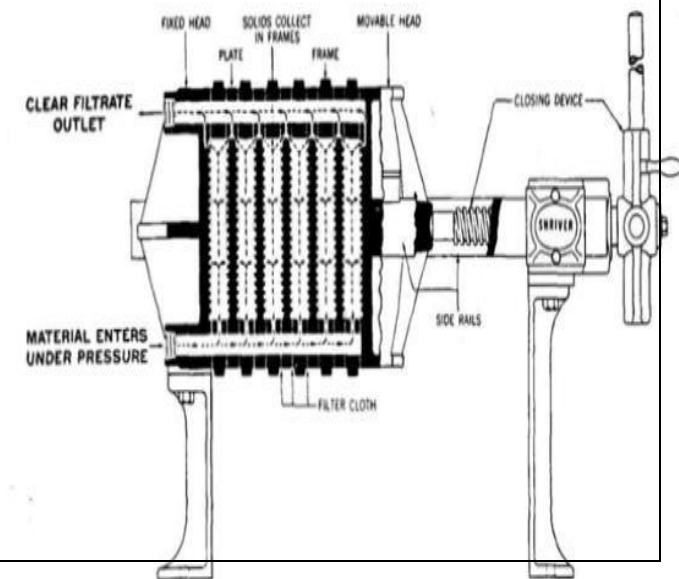
- Devyani Joshi



## EQUIPMENT

### 1) PLATE AND FRAME FILTER PRESS

**PRINCIPLE:** Mechanism is surface filtration. The slurry enters the frame by pressure and flows through filter medium. The filtrate is collected on the plates and



send to outlet. A number of frames and plates are used so that surface area increases and consequently large volumes of slurry can be processed simultaneously with or **without washing**.

. **WORKING** : Working can be divided into two steps

### **1. Filtration operation Frame-**

1) Marked by 2 dots .Plate – marked by 1 dot .

2) Slurry enters the frame from the feed channel and passes through the filter medium on the surface of the plate . The solid forms a filter cake and remain in the frame .

3) The thickness of the cake is half of the frame thickness, because on each side of frame filtration occurs . Thus two filter cakes are formed , which meet eventually in the centre of the frame . The filtrate drains between the projections of the surface of the plate and escape from the outlet .

4) As filtration proceeds, the resistance of the cake increases and filtration rate decrease .At a certain point process is stopped and press is emptied and cycle is restarted. 2.

**2) Washing of cake (if desirable)** : When washing of cake is also required modified plate and frame filter is used. For this purpose an additional channel is included called as washing plate and are identified by 3 dots .

**USES** : Sterile filtrate can be obtained by using asbestos and cellulose filter sheet (for this, whole filter press and filter medium have been sterilized previously).

### **2) FILTER LEAF :**

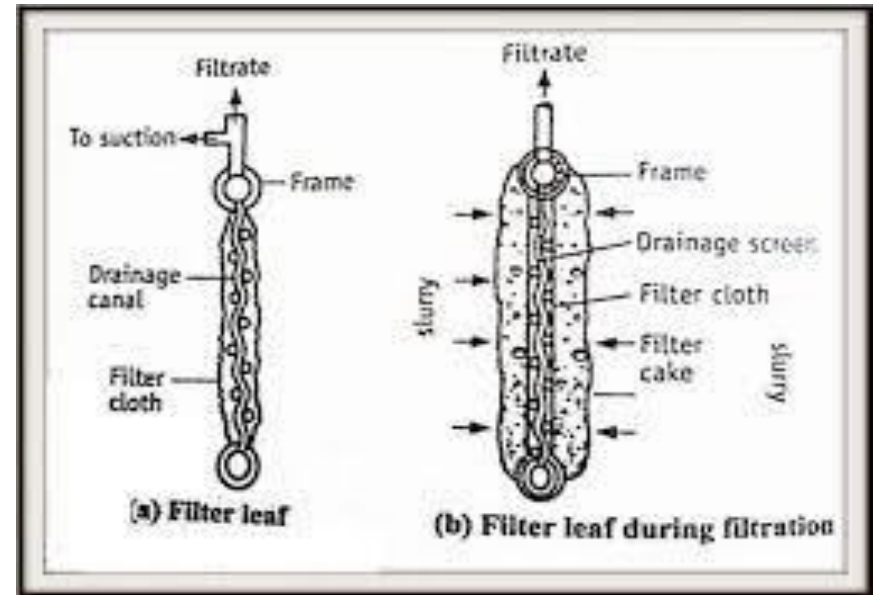
**PRINCIPLE:** It is an apparatus consisting of a longitudinal drainage screen covered with a filter cloth. The mechanism is surface filtration and acts as sieve or strainer. Vacuum or pressure can be applied to increase the rate of filtration.

**WORKING :**

- 1) The filter leaf is immersed in the slurry
- 2) Vacuum system is connected to the outlet
- 3) The slurry passes through the filter cloth
- 4) Finally filtrate enters the drainage canal and goes through the outlet into receiver
- 5) Air is passed to flow in reverse direction which facilitates

**USE :**

- 1) Use for the filtration of slurry which do not contain high solid content, about 5%, i.e. dilute suspensions.

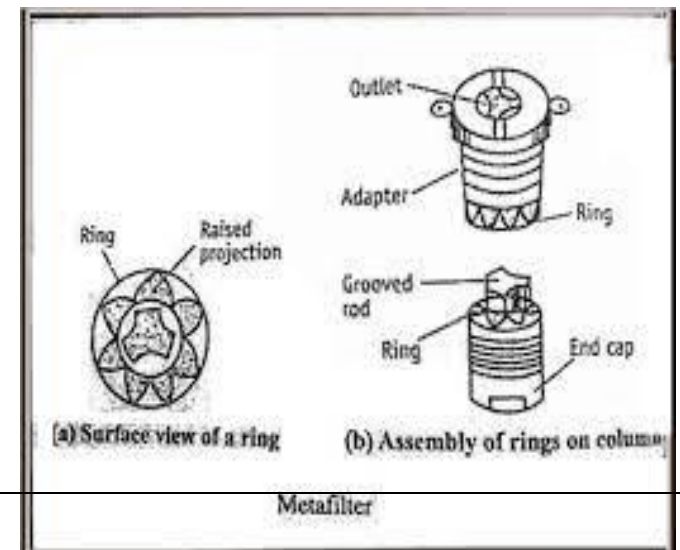


**3) META FILTER**

**PRINCIPLE :** Mechanism is surface filtration. In this, metal rings contain n semicircular projections, which are arranged as a nest to form channels on the edges. This channel offers resistance (strainer) to the flow of solids (coarse particles). The clear liquid is collected into receiver from the top.

**WORKING**

- 1) Filters are placed in a vessel .
- 2) Slurry is pumped under pressure or occasionally by applying reduced pressure to outlet side.



- 3) Slurry passes through the channels formed on the edges between the rings
- 4) The clear liquid rises up and is collected from the outlet into a receiver
- 5) For separation of fine particles, a bed of suitable materials such as kieselguhr is first built up.
- 6) The pack of rings serves essentially as a base on which the true filter medium is supported.

### **USES**

#### **META FILTERS CAN BE USED FOR :**

- 1) Clarification of syrups
- 2) Filtration of injection solutions
- 3) Clarification of insulin liquors
- 4) Filtration of viscous liquids can be achieved by applying pressure.

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- 2) Dr. Ashok A.. Hajare , “Pharmaceutical Engineering” ,Principle and practices  
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- 3) Dr. Bharat Parashar , “Pharmaceutical Engineering”, Principle a nd practices ,  
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- 4) Dr. M. Senthil Kumar , “Pharmaceutical Engineering”  
First Edition , Thakur Publication , Page No – 187 – 204 .

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# CENTRIFUGATION

## DEFINITION OF CENTRIFUGATION-

Centrifugation is a method of separating molecules having different densities by spinning them in solution around an axis (in a centrifuge rotor) at high speed.

## APPLICATION-

- 1) It is used in diagnostic labs for blood and urine test.
- 2) It is used to separate colloidal particles from their solutions.
- 3) It is used to separate cream from milk and also butter from cream.
- 4) Centrifugation can be utilized to separate a mixture of two distinctive miscible fluids.
- 5) This technique can likewise be utilized to contemplate and examine macromolecules and their hydrodynamic properties.
- 6) Mammalian cells can be filtered with the assistance of an extraordinary sort of centrifuge.
- 7) Centrifugation is known to have an essential part in the fractionation of numerous subcellular organelles. Moreover, centrifugation is likewise valuable in the fractionation of layer portions and films.

## EQUIPMENT:

### 1) PERFORATED BASKET CENTRIFUGE

#### PRINCIPLE:

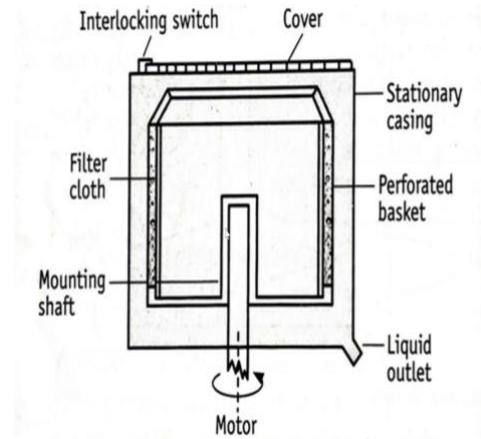
1. Perforated basket centrifuge is a filtration centrifuge. The separation is through a perforated wall based on the difference in the densities of solid and liquid phases. The bowl contains a perforated side-wall. During centrifugation, the liquid phase passes through the perforated wall while solid
2. phase is retained in the bowl.
3. The solid is removed by a blade.
4. In this centrifuge a basket is mounted above a driving shaft such arrangement described as under driven

## WORKING:

- 1) Liquid feed is inserted to the bowl/basket when it is stationary in such a way that it distributes evenly in the basket.
- 2) Power is supplied to start the rotation of basket. The basket should achieve its maximum speed quickly. It rotates at 1000 rpm.
- 3) During the process liquid passes through perforated walls and solid remains inside the wall.
- 4) The solid is collected after drying by spinning and liquid is collected from outlet.

**USES:** 1) Perforated Basket Centrifuge is usually used for dewatering waste water sludge in a slurry form.

- 2) This method is used for separation of solids from a liquid eg. Precipitated proteins are removed from insulin.



## 2. SEMI CONTINUOUS CENTRIFUGE

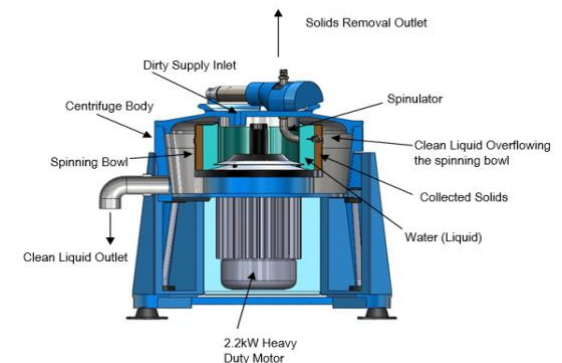
### PRINCIPLE:

1. This centrifuge is a filtration centrifuge. These separation is through a perforated wall based on the difference in the densities of solid and liquid phases. The bowl contains a perforated side wall. During centrifugation, the liquid phase passes through the perforated wall while solid phase is retained in the bowl.

2. The solid is removed by cutting with a blade.

### WORKING ;

- 1) The perforated basket is allowed to rotate and Liquified is inserted to the bowl/basket from side pipe in such a way that it distribute in the basket.
- 2) During the process liquid passes through perforated wall sand solid remains inside the wall.
- 3) The cake is washed with water. The wash escapes from the basket through the filtrate outlet.
- 4) The solid is collected after drying by spinning and liquid is collected from outlet.
- 5) In this centrifuge after achieving the desired thickness about 50 to 70 mm the feeler cuts off the air supply to diaphragm valve that automatically cuts of the entry



## USES:

- 1) Crystals can be separated from mother liquor.
- 2) Liquids can be clarified by removing unwanted solids dirt from oils.

## 3)NON-PERFORATED BASKET CENTRIFUGE

### PRINCIPLE

This is sedimentation type centrifuge so separation takes place on the basis of difference in their densities without presence of perforated/porous medium. During centrifugation solid remains at side wall of the basket while liquid remains at the top which is collected by skimming tube.

### WORKING:

- 1) The suspension is fed continuously into the basket. During centrifugation solid phase is retained on the sides of the wall while liquid remains on the top.
- 2) The liquid is collected with skimming tube and solids are scraped off by using scraper from the basket.

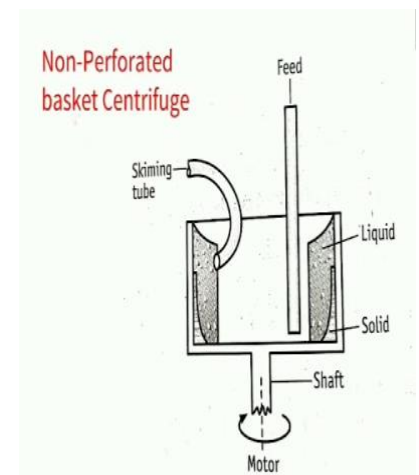
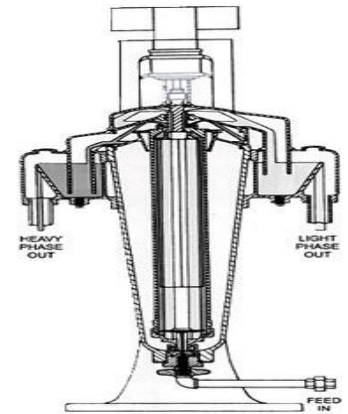
## USES:

1. It is useful when the deposited solids offer high resistance to the flow of liquid.
2. Cost is less than other centrifuges

## 4)SUPER CENTRIFUGE

### PRINCIPLE:

1. This is sedimentation type centrifuge so separation takes place on the basis of difference in their densities between to immiscible liquids. Centrifugation is done in the bowl of small centrifuge. During centrifugation the



heavier liquid is thrown against the wall, while lighter liquid remains as inner layer.

2. The two layers are simultaneously separated using modified wires.

**WORKING:** 1)The centrifuge is allowed to rotate on its vertical axis at about 2000 rpm. The feed is introduced at the bottom through nozzle under pressure.

2) During centrifugation , two liquid phases separated base on their densities.The heavier liquid moves towards periphery and the lighter liquid forms an inner layer .Both liquid climbs to the top of the vertical bowl. These two layers are simultaneously separately removed from different heights through modified outlets

**USES:** Super centrifuge is use for separating liquid phases of emulsion in foods and pharmaceutical product .

#### **REFERENCE :**

- 1) C.V.S Subhramanyam Pharmaceutical Engineering, Principle and Practices , First Edition ,Vallabh Prakashan, Page No . 276 -292
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- 4) Dr. Bharat Parashar,anshu Gupta,tripiti shukla,pharmaceutical engineering, Nirali prakashan, page no-10.1-10.9.

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