FILTRATION

Definition of Filtration

- Filtration is the process, whereby solid particles are separated from the liquid or gas by passing it through a porous medium which retains the solid but allows the fluid to pass.

Slurry: It is a suspension to be filtered.

Filter medium: It is a porous medium used to retain the solids

Filter cake: The solids which are present on the filter

Filtrate: Clear liquid passing through the filter.

Applications of filtration

1. Production of sterile products:- (HEPA) filters (or) laminar air bench provide sterile environment during manufacture of sterile products.
2. Bacteria proof filters are used for filtration of thermo labile substances where heat sterilization is not applicable.
3. Production of bulk drugs:- Filtration is an essential step in the removal of impurities from the products.
4. Production of liquid orals:- Filtration is very important in the production of liquid orals and other for obtaining clear solutions. Eg. In aromatic water preparations, syrups, elixirs, and eye drops, where removal of foreign impurities is very important.
5. Effluent and waste water treatment

(HEPA-High-efficiency particulate arrestance)

Factors affecting on Filtration

1. Pressure
2. Viscosity
3. Surface area of filter media
4. Temperature of liquid to be filtered
5. Particle size
6. Pore size of filter media
7. Thickness of cake
8. Nature of solid material

Theory:
Darcy equations

Darcy's law:

$$V = \frac{KA\Delta P}{\eta l}$$

Where,

V= Volume of filtrate

K= Permeability coefficient and is dependent on the nature of the precipitate to be filtered and the filter medium

A= Area of filter bed

ΔP= Pressure difference on the liquid and below the filter medium

η= Viscosity of the liquid

l= Thickness of filter cake

Kozeny- Carman Equation

Kozeny-Carman equation is widely used for filtration

$$V = \frac{A}{nS^2} \times \frac{\Delta P}{KL} \times \frac{\Sigma^2}{(1-\Sigma)^2}$$

Where,

Σ=Porosity of the cake(bed)

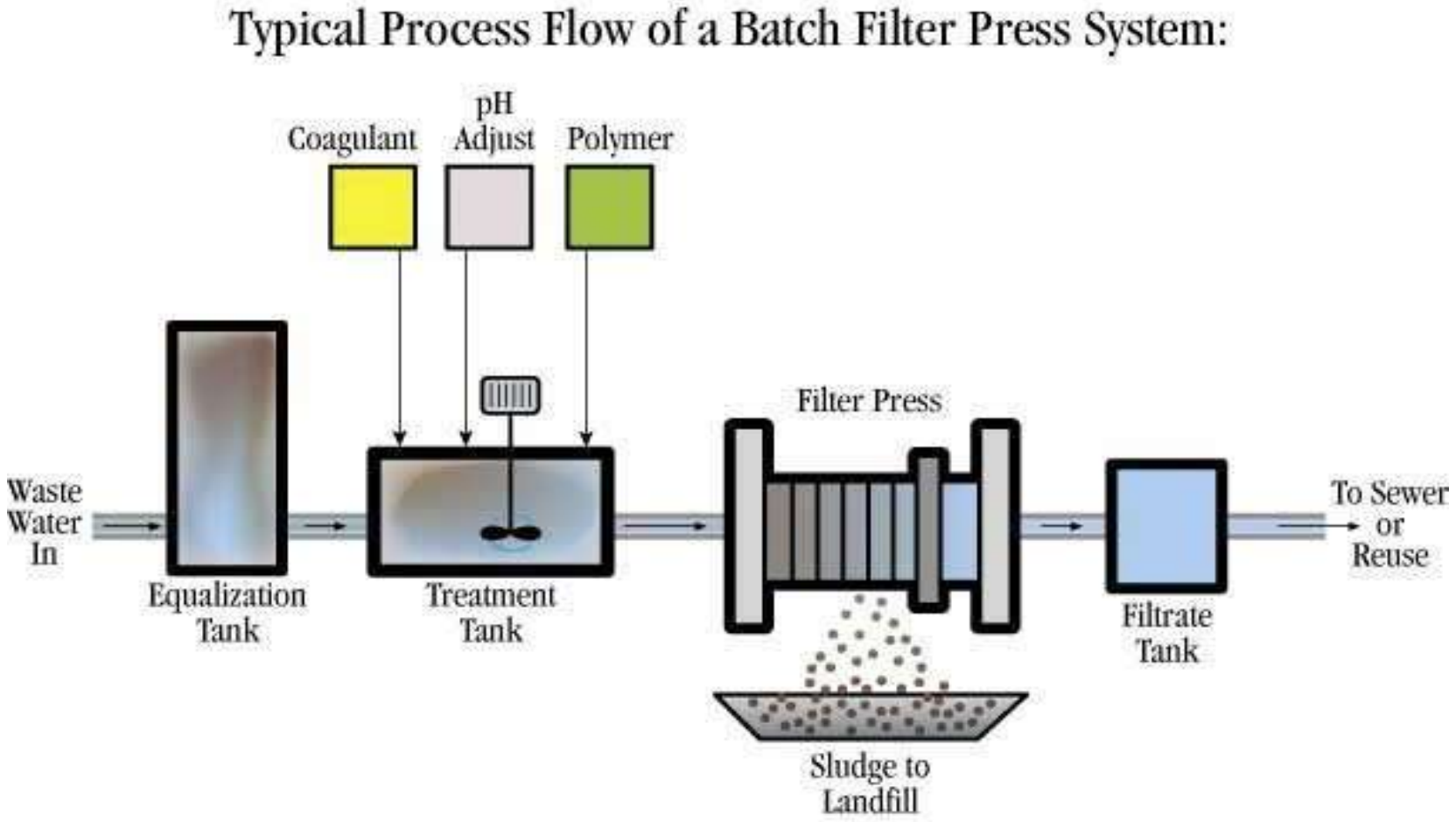
S=Specific surface of the particles comprising the cake

K=Kozeny constant(usually taken as 5)

Batch filters

- Batch filter presses are known industry wide for their thoroughness in dewatering wastewater with high solids content.
- Unlike funnel, vacuum, and belt filter presses, these are designed to apply high pressure directly to the slurry in between the press plates, expelling nearly every bit of liquid.
- What remains is a solid, compact, sludge cake ready for the landfill and water that’s fit for reuse or expulsion into the sewer after filtering.

Batch filters

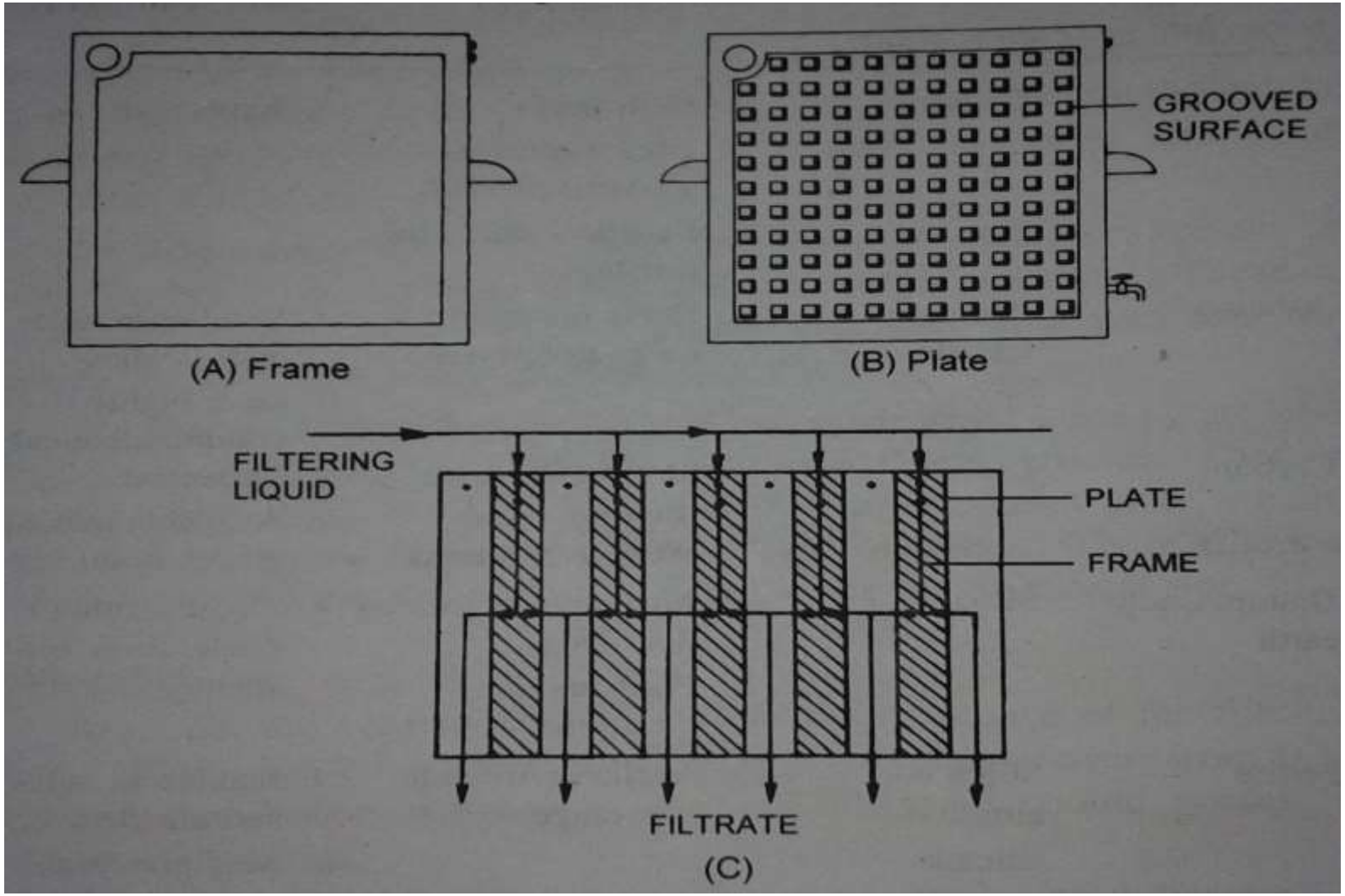


Classification of filtration equipment

- Various filtering devices used in pharmaceutical industry are:

1. Filter press
2. Meta filters
3. Filter leaf
4. Membrane filters
5. Filter candles
6. Sintered filters

1. Filter press



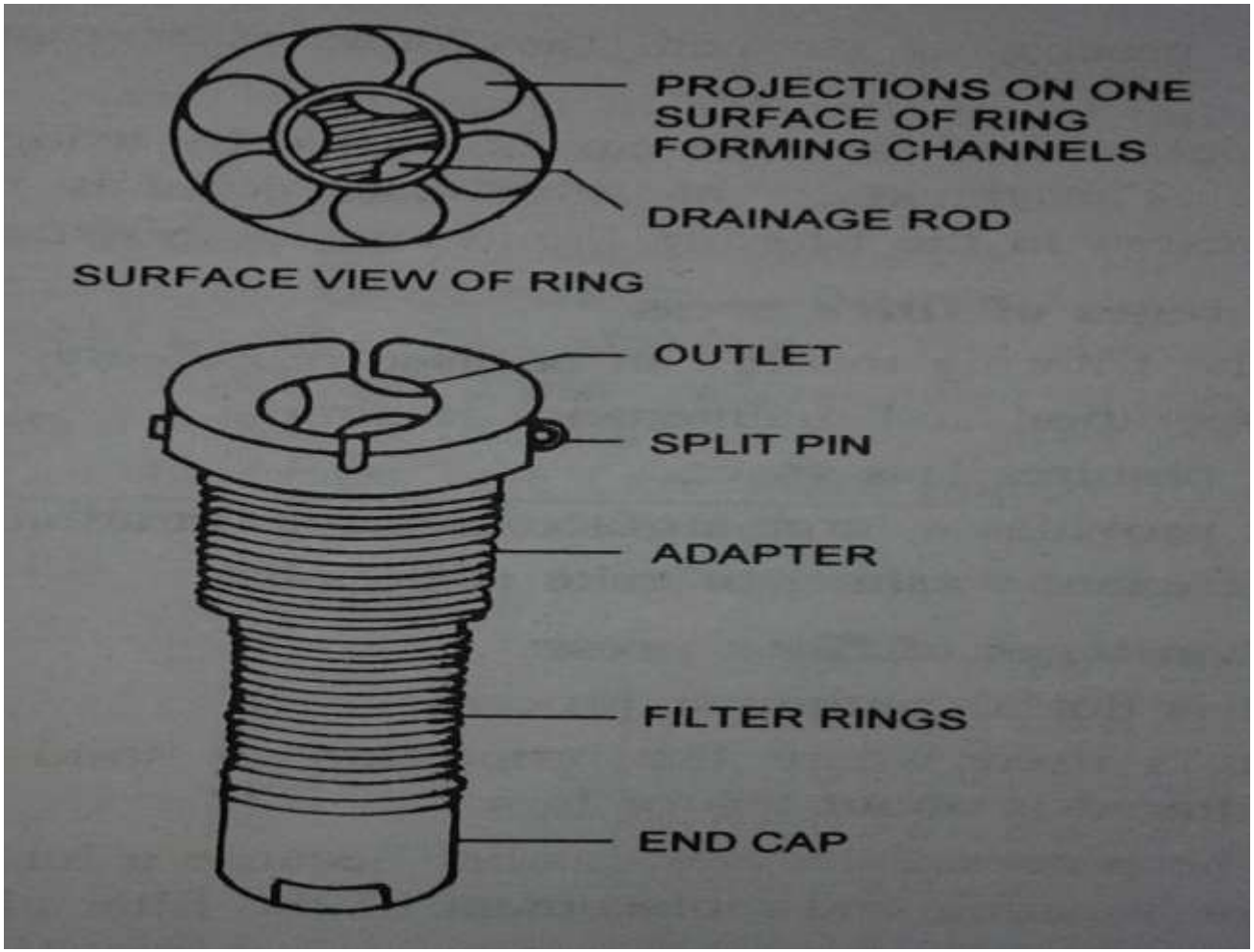
1. Filter press

- **Construction:** It consists of plates and frames. The frame is open and is used as an inlet for the material to be filtered. Plate has a grooved surface which gives support to the filter cloth. The plate and frame my be made of various metals which provide resistance to corrosion or prevent metallic contamination of the filtrate. Filter cloth is fitted on each side of the plate. The plates and frames are placed alternatively and fitted in the outer frame of the press. Each plate acts as a single filtration unit. The outlet of each plate is connected to a common outlet pipe.

1. Filter press

- **Working:** The filtrate is collected in the plates from where it is collected through common outlet pipe. The cake is deposited in the frames. The process of filtration is continued until the frame is filled with filter cake. When the process is stopped, the frame is emptied and the cycle is restarted.
- The thickness of the cake can be varied by using frames of different thickness. The thickness of filter cake depends mainly on the solid content present in the filtering liquid and the resistance of filter cake.

2. Meta filters



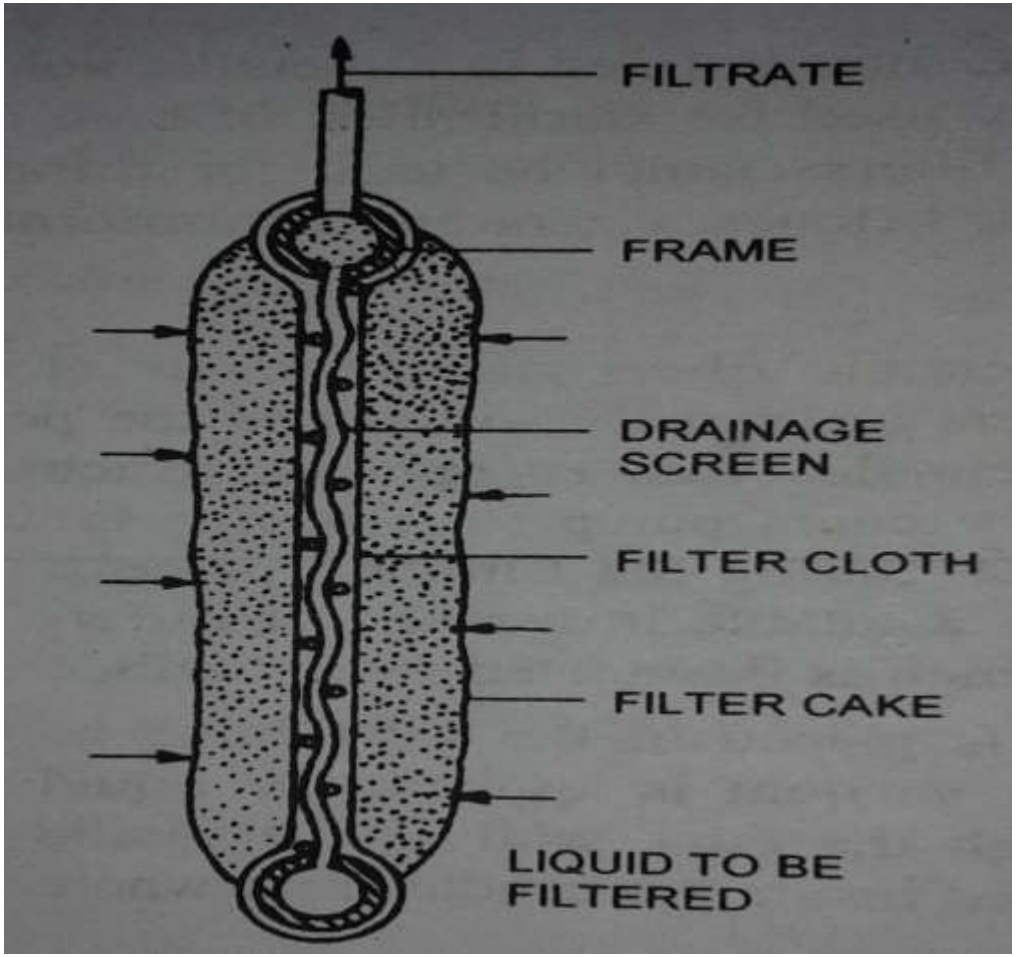
2. Meta filters

- **Constriction:** It consist of a grooved, drainage rod on which are packed a number of metallic rings. These rings are usually for stainless steel and have 0.8 mm thickness, 15 mm inside diameter and 22 mm outer diameter. These rings have a number of semicircular projections on one surface and when they are packed on the rod, the opening between the rings is about 0.2 mm.

2. Meta filters

- **Working:** The entire assembly is placed inside a pressure vessel, containing the liquid to be filtered. When vacuum is applied, liquid will flow from outside to inside. In this form a metafilter can only be used as strainer for coarse particles. But for separation of finer particles, a bed of suitable materials such as Kieselguhr is used. In this way the pack of rings acts as a base on which the true filter medium is supported.
- **Uses:** The meta filter are mostly used for clarification of syrups, elixirs and parenteral solutions.

3. Filter leaf



3. Filter leaf

- **Construction:** It is the simplest for of filter. It consists of a frame enclosing a drainage screen or a grooved plate. Filter cloth is used as the filtering medium, the whole unit being covered with filter cloth. The frame used may be of any shape i.e. square, rectangular or of a circular shape.

3. Filter leaf

Working: The filter leaf is placed in a vessel containing the liquid to be filtered. When vacuum is applied, the pressure inside the leaf is decreased. Due to the difference in external pressure and pressure inside the leaf, the liquid moves inside the filter through filter cloth. The filtrate is collected in the receiver, whereas the cake gets collected on outside of the cloth.

Uses: This method has the advantage that the liquid can be filtered from any vessel and cake can be washed by immersing it in a vessel containing water. The cake can be removed just by flowing air in the reverse direction.

4. Membrane filters

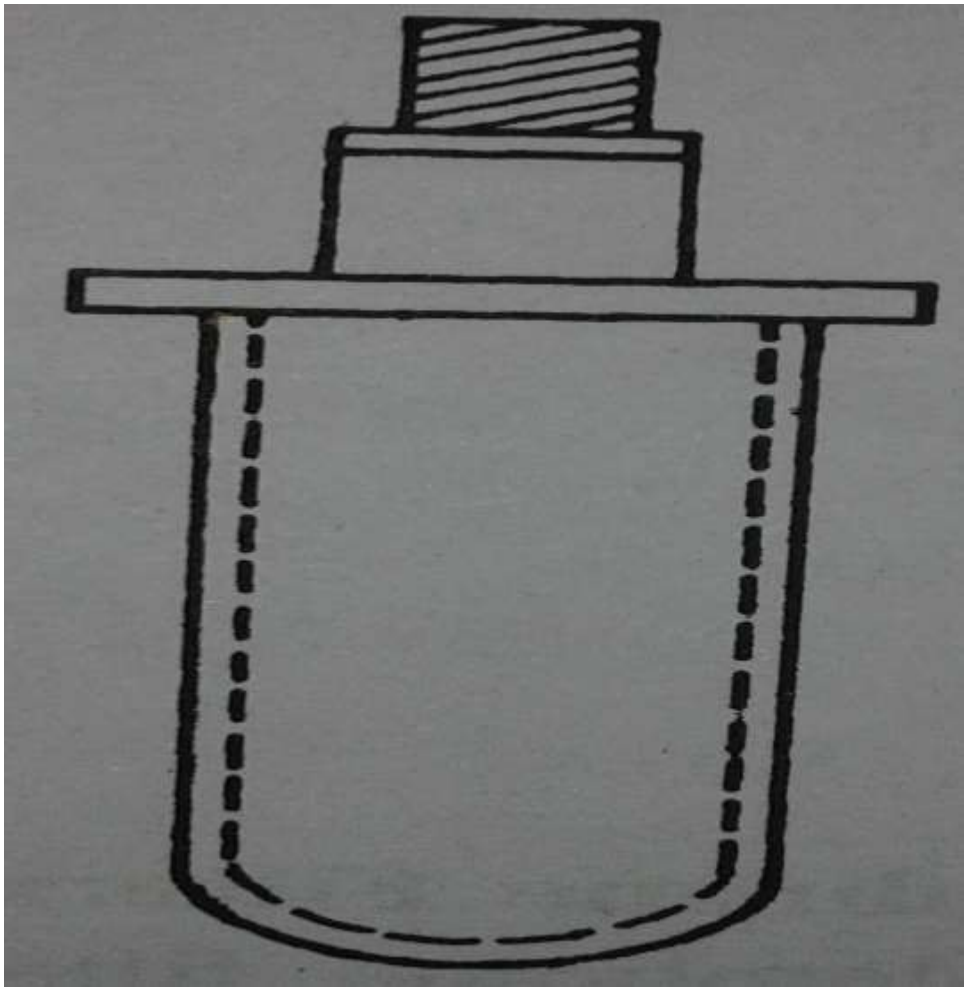
4. Membrane filters

- **Construction:** Membrane filters are made of thin and flat membranes of cellulose derivatives, such as, cellulose acetate and cellulose nitrate. These filters are brittle when in dry condition and can be stored for an indefinite period. The filters are between 50 and 150 μ thick and are available in sizes upto 60 cm^2.

4. Membrane filters

- **Working:** A membrane filter has 400 to 500 million pores per square centimetre of filter surface. The pores are absolutely uniform in size and occupy about 80% of filter volume. To avoid rapid clogging of a membrane, pre-filtration is often required. The selection of a membrane filter for a particular application depends on the particles to be removed.
- **Uses:** These filters are mainly used for sterilization of both aqueous and oily liquids. The membrane filters cannot be used for filtration of organic solvents, such as alcohols, ketones, esters and chloroform.

5. Filter candles



5. Filter candles

- **Construction:** These are ceramic filters and are made of porcelain or Kieselguhr. Kiesel-guhr filters are usually softer than the porcelain variety. These are cylindrical candles with an opening which is connected to vacuum pump for reducing the pressure under it, during the filtration process. The candles are available in a range of different pore size which is designed by a number.

5. Filter candles

- **Working:** The candle is placed in the solution to be filtered. When vacuum is applied, the liquid will pass through the thick wall of the candle and gets collected inside the candle from where it is removed.
- The filter candle gets blocked with continuous use. This can be cleaned by scratching the external surface with a nail brush and passing water through it in the reverse direction.
- **Uses:** These candles are used for sterilization of solutions. It has the tendency to absorb materials from aqueous solutions. Therefore, it is not used commonly.

6. Sintered filters

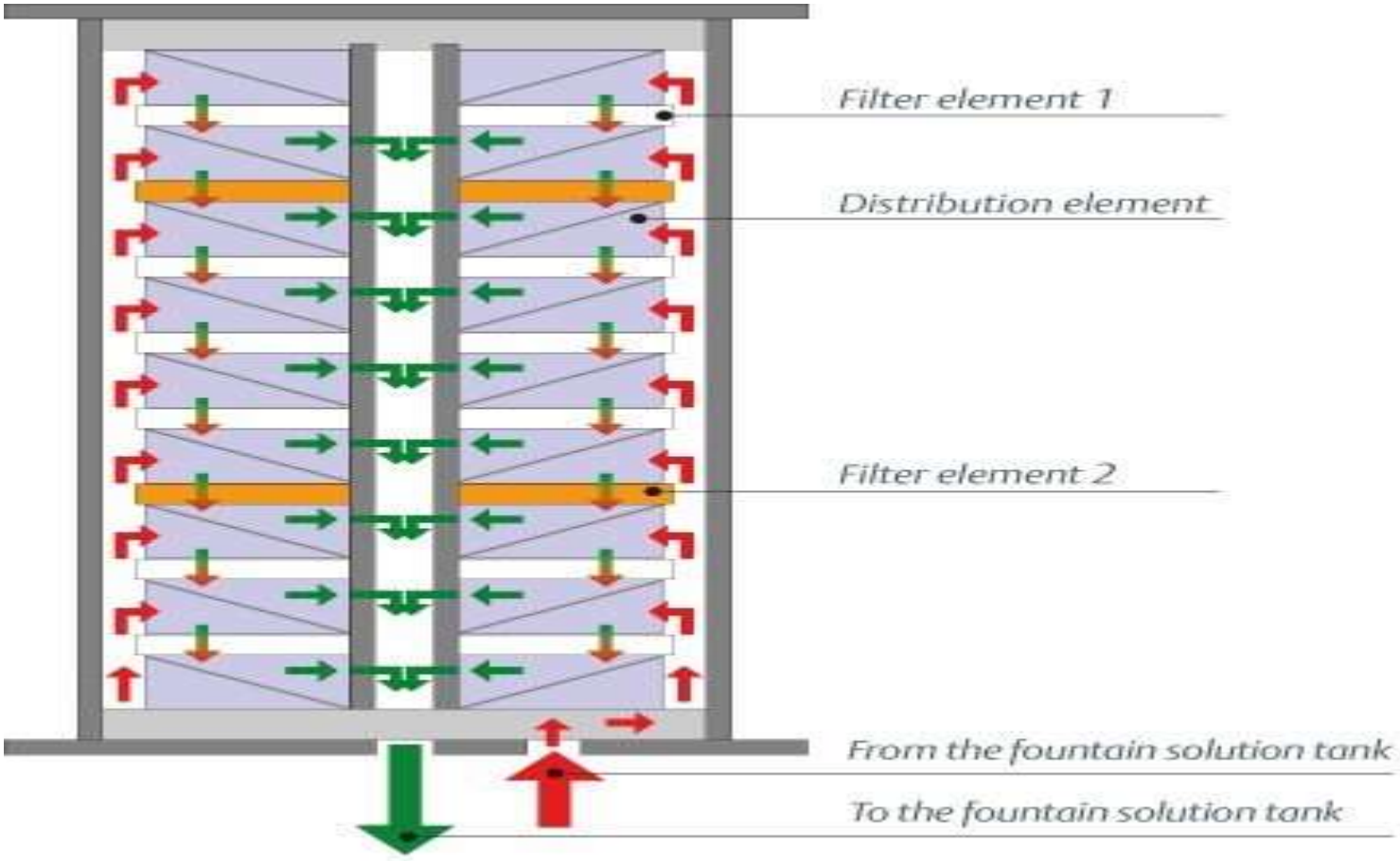
6. Sintered filters

- **Construction:** These are made of borosilicate glass. Borosilicate glass is finely powdered, sieved and particle of desired size are separated. It is then packed into a disc mould and heated to a temperature at which adhesion takes place between the particles. The disc is then fused to a funnel of suitable shape and size.

6. Sintered filters

- **Working:** The sintered glass filters are available in different pore size. Hence the funnel with a sintered filter is numbered according to the pore size. The filtration is carried out under reduced pressure. These funnel are used for bacterial filtration.
- **Uses:** Sintered filters are also available in stainless steel which has a greater mechanical strength. However these are very much liable to attack by the solutions passing through them.

Continuous filters



Continuous filters

- Continuous upstream filtration process where the filter media is washed continually.
- Cleaning of the filter media is operated by an air lift pump which pumps the filter media to the sand washer.