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FILTRATION AND CLARIFICATION



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DEFINITIONS

- **Filtration:** The separation of solid from a fluid by means of a porous medium that retains the solid but allows the fluid to pass.
- **Clarification:** This term is applied when solid do not exceed 1.0% and filtrate is the primary product.

Introduction (cont.)

- **Ultra-Filtration:** Separation of intermicellar liquid from solid by the use of pressure on a semi permeable membrane.
- **Cake Filtration:** If recovery of solid is desired, the process is called cake filtration.

TERMINOLOGIES

- ❖ **Feed or Slurry:** The suspension of solid and liquid to be filtered is known as **the slurry or feed**.
- ❖ **Filter Medium:** The porous medium used to retain the solids is described as **the filter medium**.
- ❖ **Filter Cake:** The accumulation of solids on the filter is referred to as the **filter cake**.
- ❖ **Filtrate:** The clear liquid passing through the filter is the **filtrate**.

MECHANISM OF FILTRATION



- ❖ The flow of solid is resisted by the filter medium while the liquid is allowed to pass.
- ❖ As the filtration proceeds the retention of the solid on the filter media goes on increasing which acts as a secondary and some times more efficient filtering media.

Theory of Filtration

Darcy's law:

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

Where:

V= Volume of filtrate

T= Time

A= Filter area

P= Total pressure drop through cake and filter media.

μ = Filtrate viscosity

α = Average specific Cake resistant

W= Weight of dry cake solids.

R=Resistant of filter medium and filter.

FACTORS AFFECTING RATE OF FILTRATION

1. Area of filter surface.
2. Particle size of cake solids.
3. Pore size of filter media.
4. The resistant of the filter cake and filter media.
5. Viscosity of liquid to be filter.
6. Temperature.
7. Pressure difference across the filter.

FILTER MEDIA

“The surface upon which solids are deposited in a filter is called the Filter medium”.

PROPERTIES OF IDEAL FILTER MEDIA:

1. Chemically inert.
2. High retention power.
3. Sufficient mechanical strength.
4. Absorbs negligible amount of material.
5. Resistant to the corrosive action of liquid.

Selection of filter media depends on followings:

1. Size of particle to be filtered.
2. Amount of liquid to be filtered.
3. Nature of product to be filtered.
4. Purpose of filter.

TYPES OF FILTER MEDIA

➤ Filter paper:

Filter paper is a common filter medium since it offers controlled porosity, limited absorption characteristic, and low cost

- It has different grades and qualities different pore size such as coarse medium and fine.

Disadvantages:

- They shed very fine particle to the filtrate.
- Absorb small quantity of liquid.



➤ **Woven Material:**

Cotton silk wool nylon & glass etc.

❖ **Nylon cloth:**

- Superior to the cotton cloth.
- Not affected by molds, fungus and bacteria.
- Has negligible absorption properties.
- It is extremely strong as compared to cotton cloth.

❖ **Woven wire cloth:**

- Made from stainless steel.
- Easily cleaned.
- Long lasting.
- Resistant to the chemicals.

➤ **Cotton Wool:**

- Commonly used.
- Small tough of cotton wool placed in the neck of funnel.

➤ **Glass wool:**

- Use for filtering highly corrosive chemicals.
- May contaminate the filtrate with glass fibers



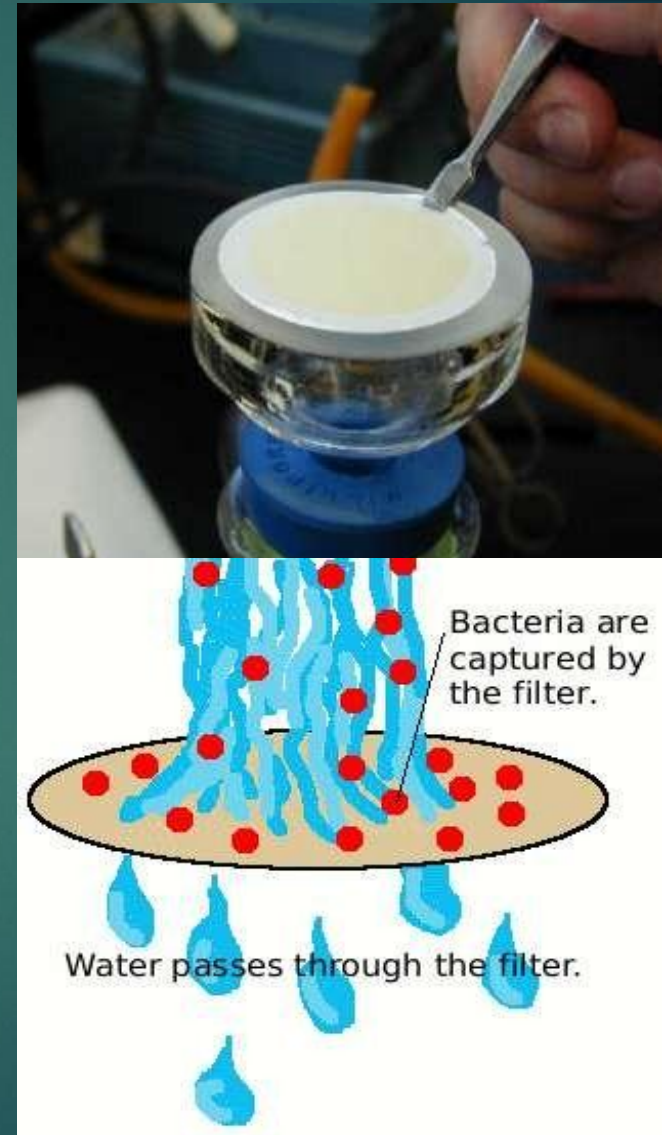
➤ Asbestos:

- Also used for filtering the corrosive liquid.
- They impart alkalinity to the filtrate.
- Alkaloids may get absorbed.
- May contaminate the filtrate.



➤ Membrane Filter:

- These are very common among the ultra filtration methods.
- Made up of cellulose, Polyvinylchloride, Nylon and other cellulose derivatives.
- They are very fine having a very wide range of pore size from 8μ down to 0.22μ .



Pore size (in μ)	Particles removed
0.2	All bacteria
0.45	All coliform group bacteria
0.8	All air born particles
1.2	All Non living particles considered dangerous in I.V.Fluid.
5	All Significant cell from body fluid

❖ **Advantages:**

- Bacteria are removed by sieving
- Absorption of medicament is negligible
- In every new operation, a new disc is used
- Filtration is quite rapid
- Don't liberate particles to the filtrate.

❖ **Disadvantages:**

- Fine pores may get clogged easily
- Soluble in certain organic solutions e.g. ketones and esters
- Very brittle when dry.

➤ **Craft Paper:**

- Mainly used in plate and frame filters.
- They offer controlled porosity
- Limited absorption.
- Quite cheap.

➤ **Sintered Glass:**

- Consist of Pyrex glass powder.
- Used for filtering parenteral preparations.
- Useful for filtering the corrosive liquid and oxidizing agent.
- Don't shed particles.
- Don't absorbs any liquid.
- Can be easily washed.

FILTER AIDS

“The substances which when added to the liquid to be filtered, reduce the resistance of the filter cake and increase the filtration”.

❖ **Properties of Filter Aids:**

- Chemically inert
- Low specific gravity
- Insoluble in liquids
- Form a porous cake
- Free from impurities
- Suitable particle size with irregular shape
- Able to remain suspended in liquids
- Free from moisture

FILTER AID MATERIALS

Materials	Chemical composition	Advantages	Disadvantages
Diatomaceous earth	Silica	Wide size range	Slightly soluble in acid and alkalies
Perlite	Silica +Aluminosilicate	Wide size range	More soluble
Asbestose	Aluminosilicate	Very good retaintion on coarse screen	More soluble
Cellulose	Cellulose	Chemically inert	Expensive
Carbon	Carbon	Non reactive with strong alkalies	Expensive

FILTER AIDS



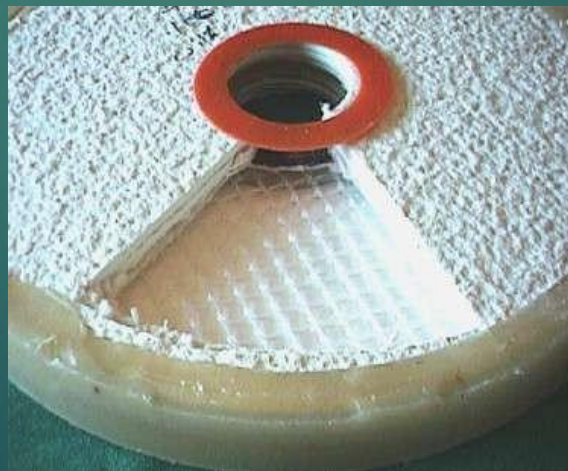
DIATOMACEOUS EARTH



PERLITE



ASBESTOSE



CELLULOSE



CARBON

Precoating: It requires suspending the filter aid in a liquid and circulating the feed until the filter aid is uniformly deposited on the filter septum.

Quantity required:

- 5-15 pounds / 100² feet of filter area.
- Or filter cake thickness=1/16 to 1/8 inch

Body Mix:

- Direct addition of filter aid to the filter feed.
- Ratio of filter aid=0.1 to 0.5 % of total liquid.
- OR 1 kg filter cake : 1-2kg of filter aid.

FILTRATION EQUIPMENTS

Selection of method and equipment required for filtration of a liquid depends on nature of the material and quantity to be filtered as well as the object of the operation.

FILTRATION EQUIPMENTS:

➤ FILTER FUNNEL:

- Funnels are conical shaped devices
- Made up of Glass, Aluminum, Polythene, Stainless steel OR any other suitable material.
- Neutral Glass made funnel are most commonly used.
- White filter paper of suitable pore size is folded in such a way that it fits in the funnel.

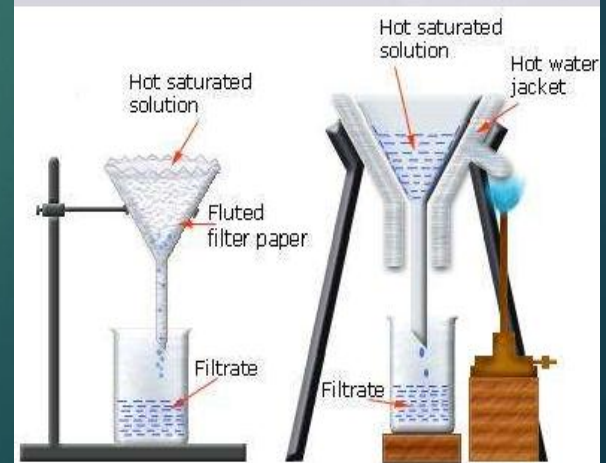


➤ BUCHNER FUNNEL:

- Made up of porcelain.
- It has a perforated plate.
- Used for filtration under reduced pressure.

➤ HOT WATER FUNNEL:

- These are doubled wall funnels made up of metals.
- Viscous substances such as liquid paraffin, Glycerin, Castor oil and fatty substances like wool fat, bees wax, ointments and cream etc are filtered easily from this filter.
- Boiling water or steam is circulated in jacketed funnel.



➤ SEITZ FILTER:

- Consists of two parts.
- Lower part fitted with a perforated plate over which compressed asbestos pad is placed.
- Upper part has a valve through which pressure can be applied.
- Both parts joined together by winged nuts.

❖ **Advantages:**

- No risk of contaminating the filtrate.
- Apparatus is very simple to use.
- For viscous solution they are more suitable.

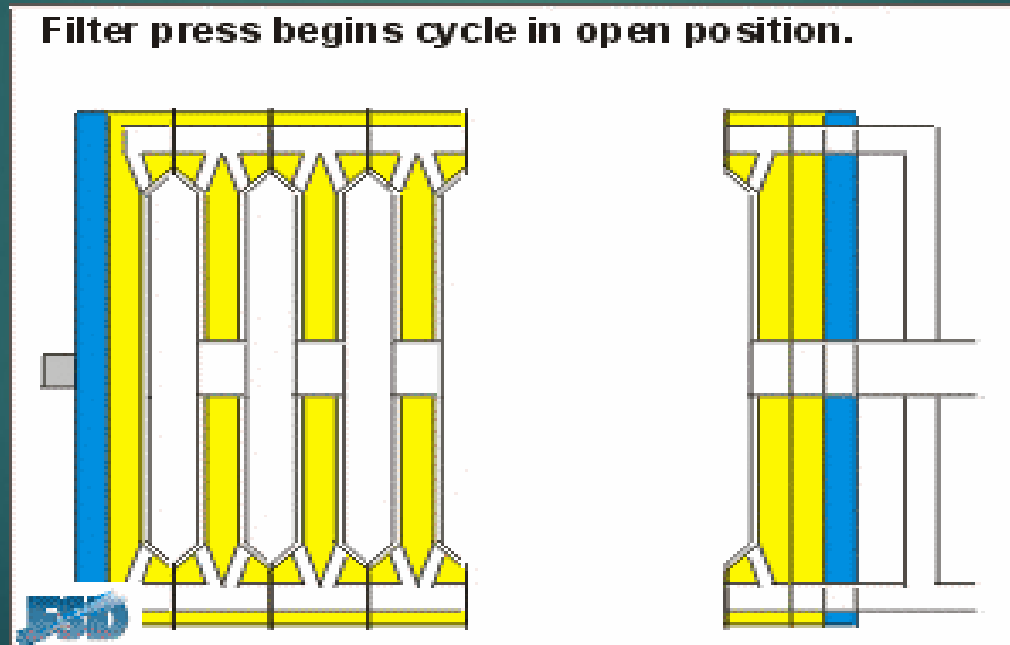
❖ **Disadvantages:**

- Asbestos may shed loose fibers.
- Pad may absorb sufficient amount of medicament.



➤ FILTER PRESS:

- It consists of hollow frames and solid plates.
- Plates have grooved surface to support the filter cloth.
- Each plate has an outlet for filtrate.
- Frames are opened with an inlet for the liquid to be filtered.





❖ **Advantages:**

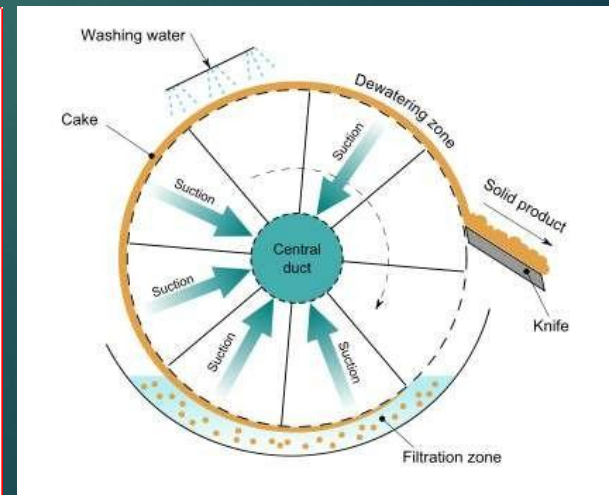
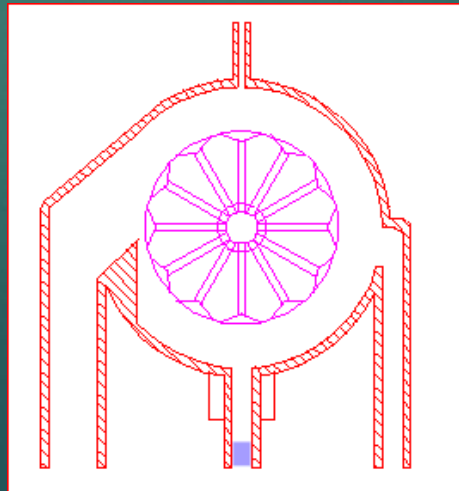
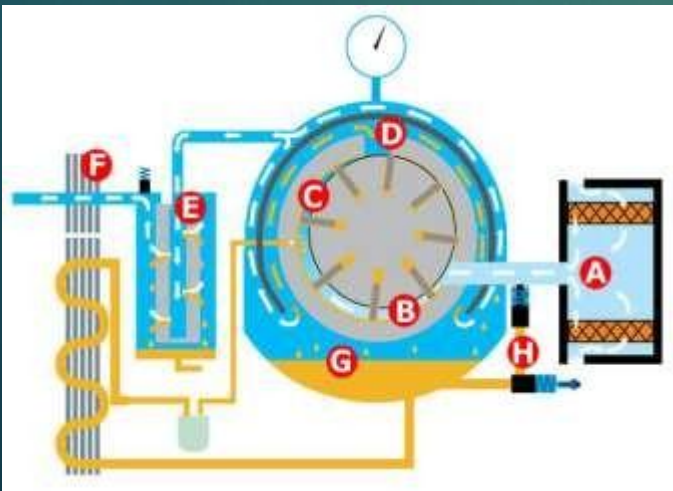
- Construction is very simple.
- Used for coarse to fine filtration.
- Operation and maintenance is easy.
- Filter cloth can be easily replaced.

❖ **Disadvantages:**

- Not economical for filtration of small quantities
- Leakage between the plates may take place
- Suitable when the slurry contain less than 5% solids.

➤ ROTARY FILTERS:

- They are used when the proportion of solid content in slurry is 15 to 30%.
- It consists of perforated matter drum wrapped with filter cloth.
- Drum is partially immersed in the tank containing the materials to be filtered.
- Drum rotates at the slow speed and creates vacuum due to which filtrate enters into the drum.
- Filter cake deposits on outer surface of the filter media.
- Cake is removed by scrapping with a knife.





❖ **Advantages:**

- Labour costs are very low.
- Area of filtration is very high.
- Thickness of the filtration cake is controlled by altering with the speed of rotation of drum.

❖ **Disadvantages:**

- Very expensive.
- Can't be used for slurries containing low percentage of solids.

➤ FILTER LEAF:

- It consists of frame in which drainage screen is enclosed.
- Whole unit is covered with a filter media.
- Outlet is connected to the vacuum pump.
- Frames may be shaped in round square or rectangular.



Vertical Pressure Leaf Filter





❖ **Advantages:**

- Liquid can be filtered from any vessel.
- Filter cake can be removed simply by washing or blowing air.
- It is very economical.

❖ **Disadvantage:**

- It is not effective when solid content in the liquid is more than 5%.

➤ **VACUUM FILTRATION:**

- Vacuum filtration is used primarily to collect a desired solid.
- Vacuum filtration uses a Buchner funnel and a side-arm flask.
- Vacuum filtration is faster than gravity filtration, because the solvent or solution and air is forced through the filter paper by the application of reduced pressure.

To perform a vacuum filtration:

- Clamp the flask securely to a ring stand.
- Add a Buchner funnel with a rubber funnel adaptor.
- Obtain a piece of filter paper in the funnel that is small enough to remain flat but large enough to cover all of the holes in the filter. If necessary, you can cut a larger piece of filter paper down to size.



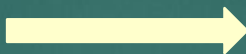
- Place the paper in the funnel.
- Connect the side arm flask to a vacuum source. Always use thick-walled tubes.
- Wet the paper with a small amount of the solvent to be used in the filtration. This causes the paper to adhere to the plate and keeps materials from passing under the paper during filtration.



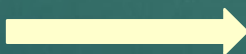
- Turn on the vacuum source.
- Pour the mixture to be filtered onto the filter paper. The vacuum should rapidly pull the liquid through the funnel.
- Rinse the cake with a small amount of cold fresh solvent to help remove impurities that were dissolved in the filtrate.



- Carefully disconnect the rubber tube.



- Remove the filter paper and the collected solid that is on it.



Dear Students,
All the Best
and
GOOD LUCK

Best Wishes From:-

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