Module 10: Filtration

Lecture 35: Plate and frame press filter, Rotary filter

- Filtration
- The plate and frame press filter
- Principles of filtration (cake)

Previous Next

Module 10: Filtration

Lecture 35: Plate and frame press filter, Rotary filter

Filtration

- Removal of solids from fluid (gas or liquid) by a filtering medium on which solid particles are deposited.
- For filtration, external force is applied to a $2-\phi$ (gas or liquid + solid) mixture to make it flow through the medium.
- Filtration, when applied to gas cleaning, usually refers to the removal of fine particles $(\mu m \text{ size})$ like dust from air or flue gas. In such case, a polymeric fiber or cloth is wrapped over a pretreated metallic cylinder, capable of capturing micron size particles, including soot and fly-ash.
- Very large size ceramic based filters for high temperature applications are also commercially available.

In this and the next lectures we will confine our discussion to liquid – solid filtration .

- The liquid–solid filtration is often called “cake–filtration”, because the separation of solids from the slurry by the filtering medium is effective during the initial stages of filtration. Later, the ‘cakes' or deposits collected over the medium act as the filter. Therefore, cake thickness increases during filtration and the resistance (hydraulic) offered by the cake–material is larger than that by the filtering medium.
- There are two types of operation:
    a. Constant-pressure
    b. Constant filtering rate

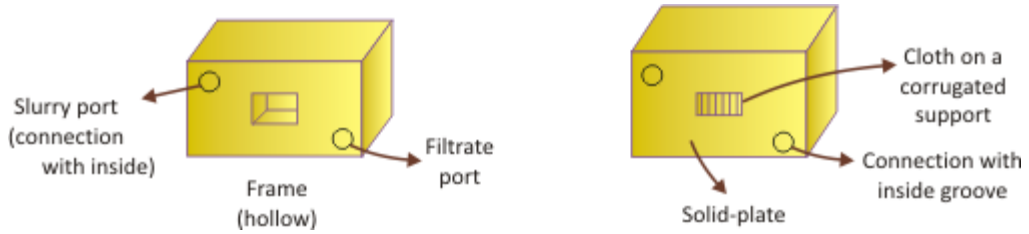
Previous Next

In the 1st case, filtering rate varies with time, whereas in the 2nd case, pressure–drop increases with time.

- For ideal cake filtration, cake should be stable and large porosity. There are two common types of filters:
  a. The plate and frame press
  b. Rotary-drum filter

The plate and frame press filter

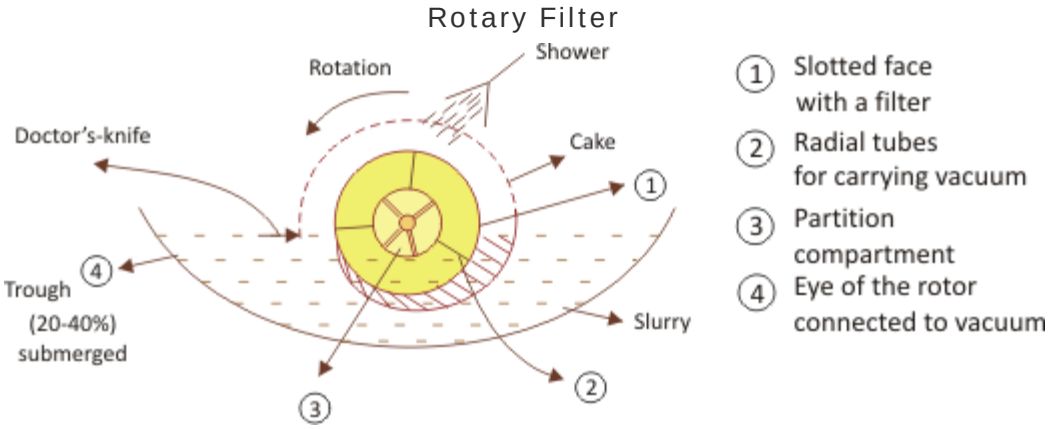
- Consists of series of plates and frames sandwitched alternatively; cakes are built-up inside the frame–clamber. Cloth, filtering medium, is supported on a corrugated material. There are slurry and filtrate ports.



(Fig. 35a)

Previous Next

While designing the plate and frame press filter, dismantling and re–assembling times, removal of cake from each frame, and other operations such as washing and drying of cakes should also be taken into consideration.



(Fig. 35b)

See the schematic above. The portion of the cylinder (rotary drum) submerged in the trough is subjected to vacuum. A layer of solids builds upon the drum as the liquid is drained through cloth, slots, compartments, pipe to the tank, which collects the filtered water.

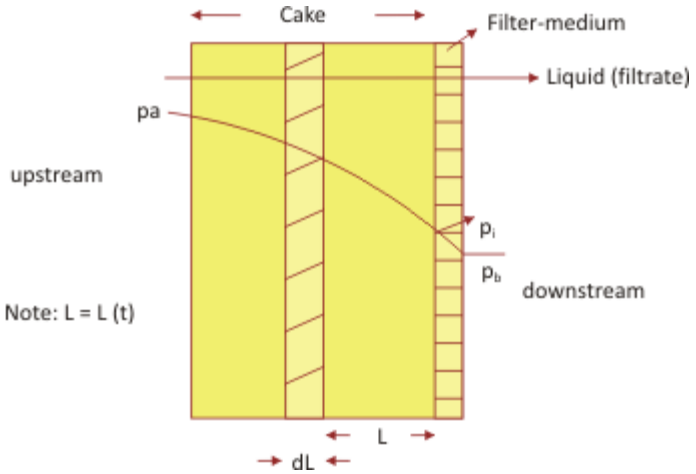
In the washing/drying zone; vacuum is removed; cakes are removed by scrapping it off with a knife, doctor blade. The process is continuous whereas the plate and frame press filter is a batch process.

Previous Next

Module 10: Filtration

Lecture 35: Plate and frame press filter, Rotary filter

Principles of Filtration (cake)



(Fig. 35c)

- Pressure–drop is applied across the filter: $p_a > p_b$

Assuming that the flow of filtrate is under laminar conditions (low Re and viscous flow), one can apply the Ergun's equation, neglecting the inertial forms:

$$\Delta p \ \alpha \ \frac{\mu v_o}{r_w}$$

Consider a differential thickness of cake = 'dL' at a distance of L from the filter-medium.

$$\frac{dp}{dL} = \frac{k_1 \mu_f v_o (1-\epsilon)^2}{\epsilon^3} \left(\frac{S_p}{V_p}\right)^2$$

where, $\mu_f =$ viscosity of the filtrate

$\epsilon =$ bed-porosity or porosity of the cake

$S_p, V_p =$ surface area and volume of the cake-particles (solids of the slurry), respectively

(Important to note is the time–change of pressure and cake–thickness)

$v =$ superficial velocity of filtrate

Previous Next