

3.4.3 Filtration Operations-Basic Equations

The general filtration equation, equation (3.4-12), after substitution of L from equation (3.4-14), es

$$\frac{dV}{dt} = \frac{A^2 \Delta p}{\mu r c (V + V_m)}$$

3.4-15

where V_m is the medium resistance, which is equal to $\frac{L_m}{A}$

Equation (3.4-15) can be rewritten

$$(V + V_m)dV = \frac{A^2 \Delta p}{rc\mu} dt$$

3.4-16

3.4.4 Constant pressure filtration

For compressible cakes r is independent of the pressure drop and of position in the cake. If Δp is constant, the equation (3.4-16) can be integrated

$$V^2 + 2VV_m = \frac{2\Delta p A^2}{\mu r c} t$$

3.4-17

Using equation (3.4-17) either t or V can be calculated from the value of the other variable.

It is useful for the mathematical simplicity of the final equations to define a constant K .

$$K = \frac{2\Delta p}{\mu r c}$$

3.4-18

Substitution of K from equation (3.4-18) in equation (3.4-17) gives an equation for constant pressure filtration:

$$V^2 + 2VV_m = KA^2t \quad 3.4-19$$

The equation of the constant pressure filtration (3.4-19) can also be in the other form

$$q^2 + 2qq$$

3.4-19 a

Where the volume of filtrate per unit filtration

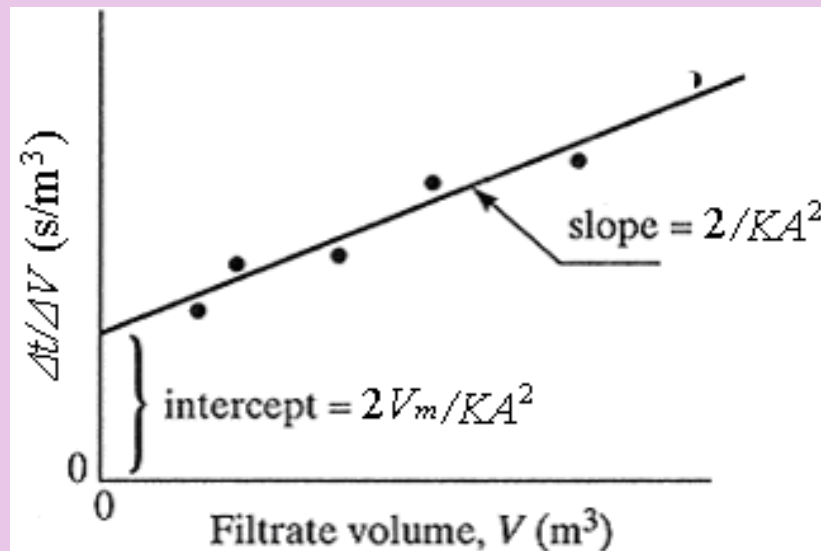
area $q = \frac{V}{A}$

For experimental determination of filtration constant K and specific resistance r , equation (3.4-19) is often put in the form

$$\frac{\Delta t}{\Delta V} = \frac{2}{KA^2}V + \frac{2V_m}{KA^2}$$

3.4-20

Which gives a straight line if $\Delta t/\Delta V$ is *plotted against* V , shown in figure. The equation (3.4-20) and the figure are used to predict the filtration constants.



3.4.5 Constant rate filtration

If the flow rate $Q=dV/dt$ is kept constant and the pressure Δp varied, equation (3.4-15) es

$$Q = \frac{dV}{dt} = \frac{A^2 \Delta p}{\mu r c (V + V_m)} = \text{const}$$

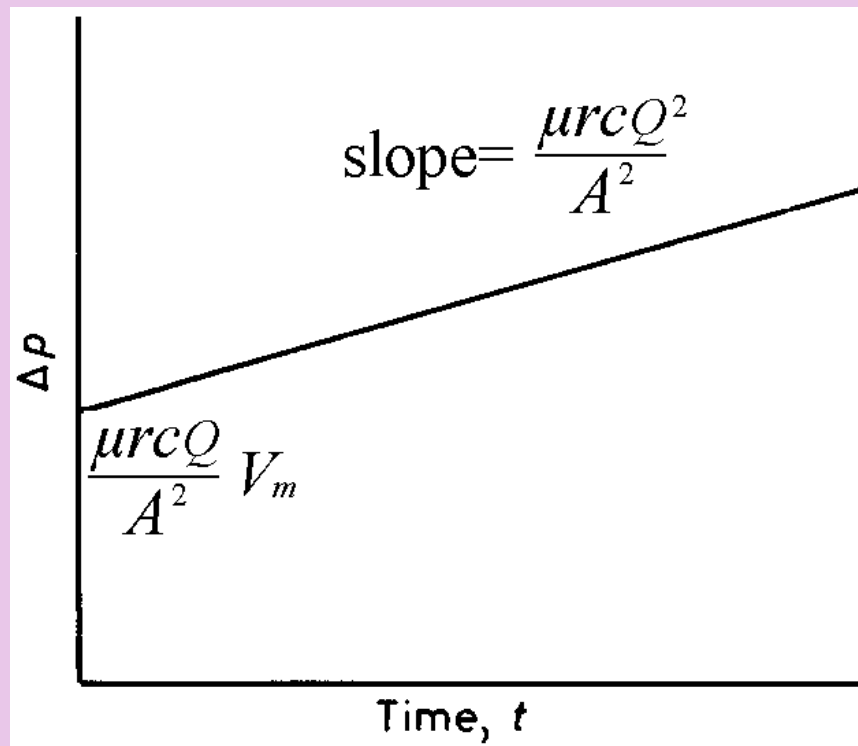
Where V is simply

$$V = Q t \quad 3.4-21$$

thus

$$\Delta p = \mu r c \frac{Q^2}{\quad} \quad (3.4-22)$$

- A plot of Δp against t as in figure 3.22, will, from equation (3.4-22), be a straight line.



3.4.6 Constant rate followed by constant pressure operation

In many cases, the early stages of filtration are conducted at a nearly constant rate.

- As the cake gets thicker and offers more resistance to the flow, the pressure developed by the pump becomes a limiting factor and the filtration proceeds at a nearly constant pressure.

For such a combined operation, the plot Δp versus time is as shown in figure 3.23 .

For constant rate filtration

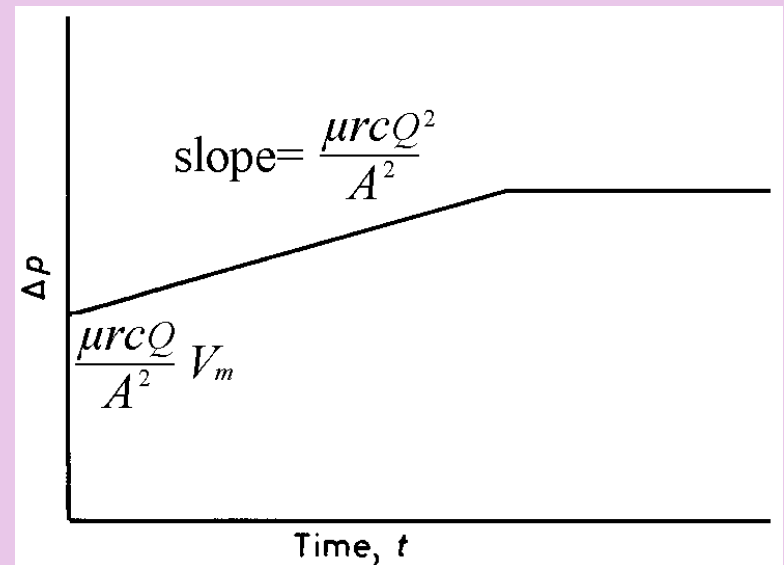
$$\Delta p = \mu r c \frac{Q^2}{A^2} t + \mu r$$

=

for $t < t_s$

Then $\Delta p = \text{constant}$

for $t \geq t_s$



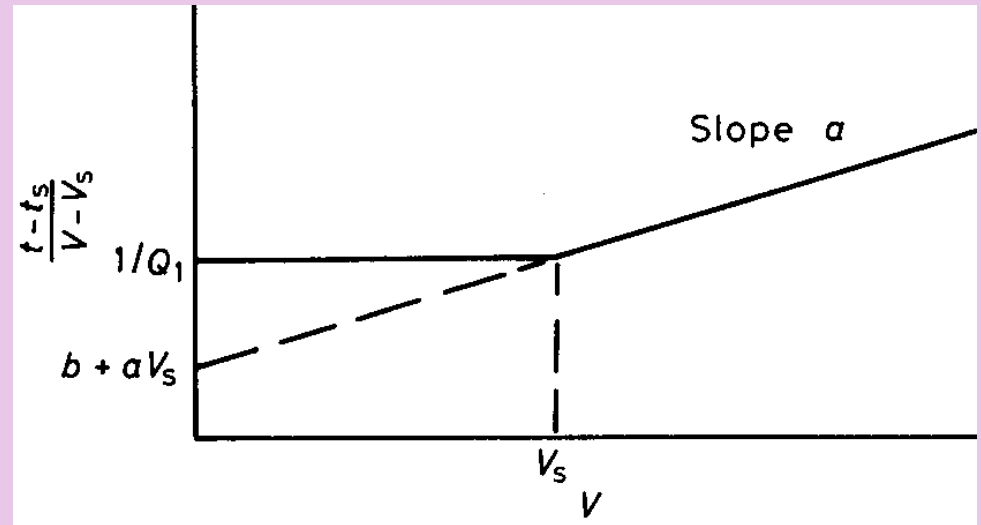
The plot of $\frac{\Delta t}{\Delta V} = f(V)$ will be as shown in figure

The equations for constant rate followed by constant pressure filtration

$$V = Qt \quad 3.4-21$$

and

$$V^2 + 2VV_m = KA^2t$$

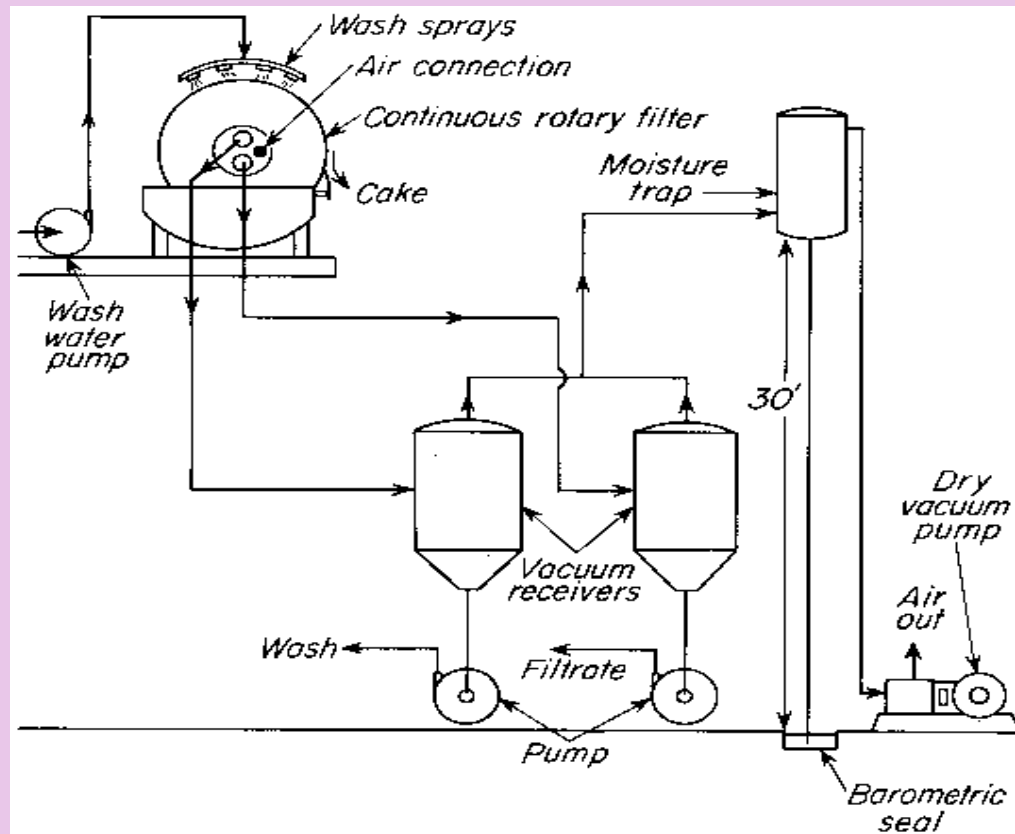


3.4.7 Vacuum Filtration-Drum Continuous Filtration

- *Drum Continuous filtration*

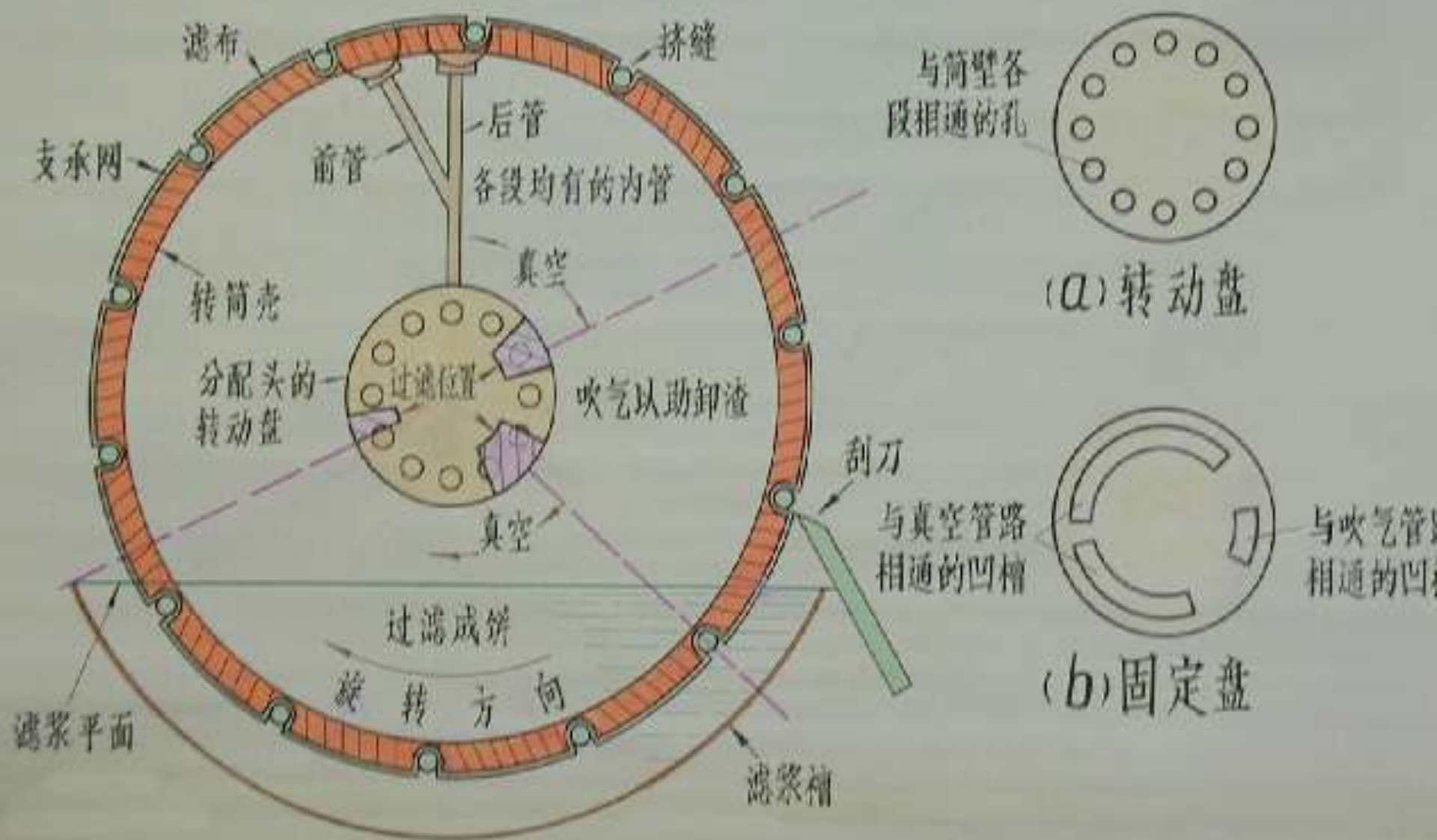
In a continuous filter, the feed, filtrate, and cake move at steady constant rates. For any particular element of the filter surface, however, conditions are not steady but transient.

The process consists of several steps in series — cake formation, washing, drying and discharging. The pressure drop across the filter during cake formation is, however, held constant.

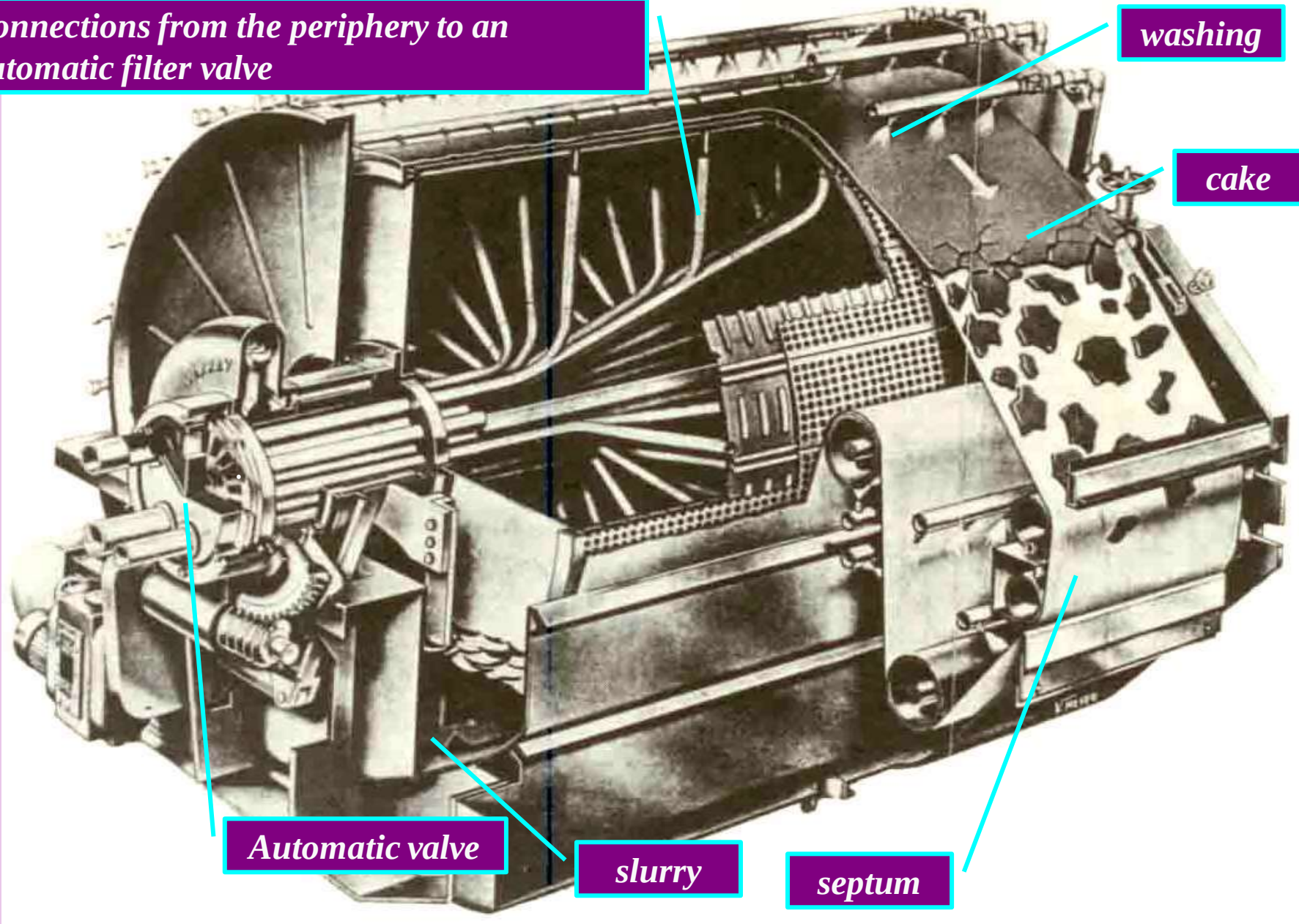


转筒过滤机上的转筒

转筒的分配头



Connections from the periphery to an automatic filter valve



If t is the actual filtering time (i.e., the time any filter element is immersed in the slurry), then from Eq. (3.4-19)

$$(V + V_m)^2 = \frac{2V_m^2 K_f c}{\Delta p} t \quad (3.4-23)$$

- where V is the volume of filtrate collected during time t . Solving Eq. (3.4-23) for V , as a quadratic equation, gives

$$V = \sqrt{KA^2t + V_m^2} - V_m \quad (3.4-24)$$

Where V is the volume of filtrate collected during time t that it is the actual filtration time. If the fraction of the drum submerged is φ , and drum speed is n

$$t = \frac{\varphi}{n} \quad (3.4-25)$$

Substituting t from Eq. (3.4-25) in Eq. (3.4-24) for the volume of filtrate

$$V = \sqrt{KA^2 \frac{\varphi}{n} + V_m^2} - V_m \quad (3.4-26)$$

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