END SEM

by Sumanbabu Sir.

Date 9/10/23
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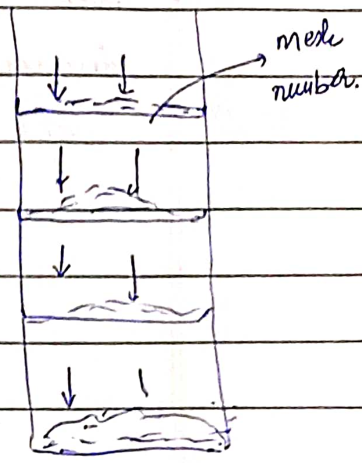
Storage ✓
Transport ✓
Size distribution.



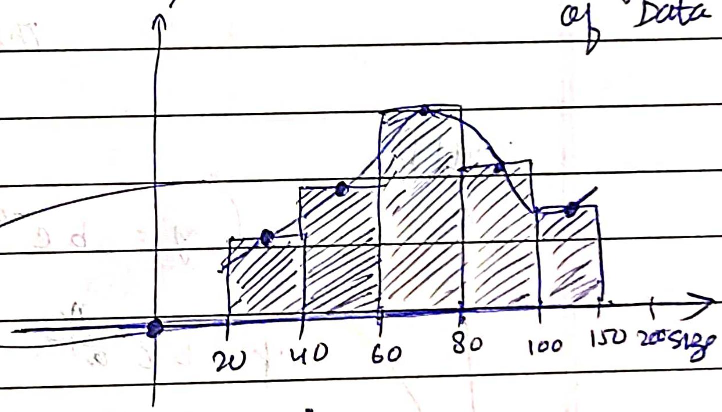
Mesh size | % retained

150µm – 100µm | x

100µm – 80µm | y

Differential form

Histogram of Data



100

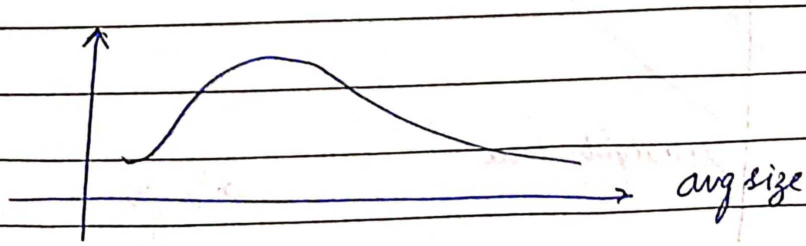
I want to represent this data into mathematical form

a continuous" Curve needed.

Take avg size & join the points

or

we can also change x axis to average size

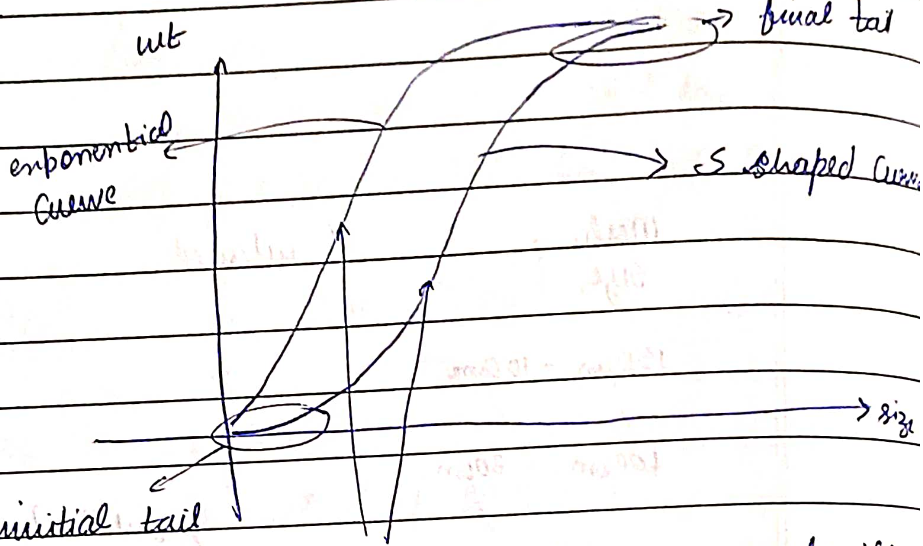


Histogram

TEM : 1 nm

SEM : Size > 10 nm

But still it is not much desired. We need cumulative graph to ease out our work.

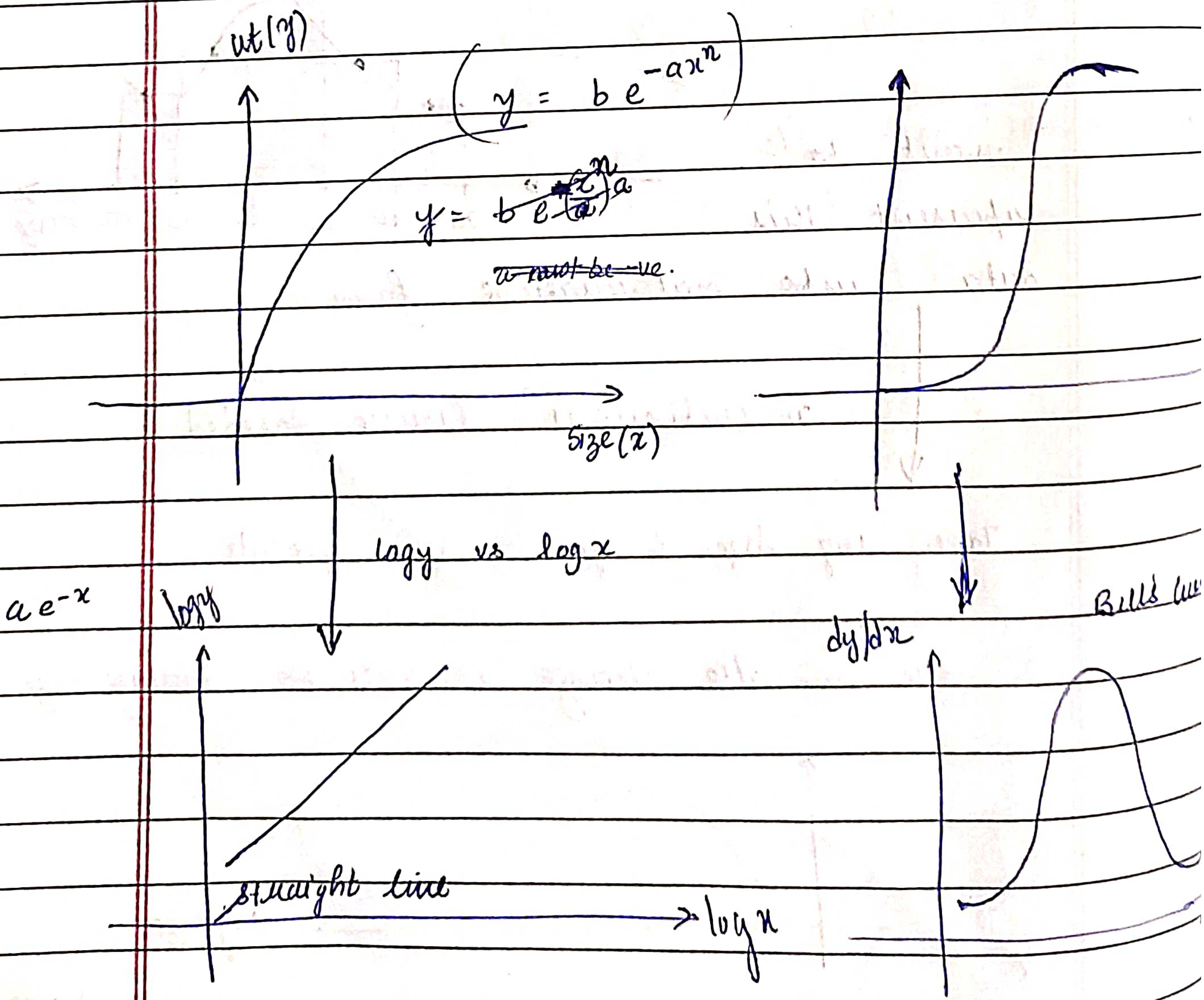


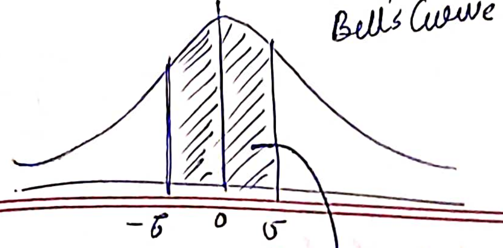
These two forms are possible.

$$y = b\,e^{-ax^n}$$

$$y = b\,e^{-\left(\frac{x}{a}\right)^n}$$

~~a must be -ve.~~

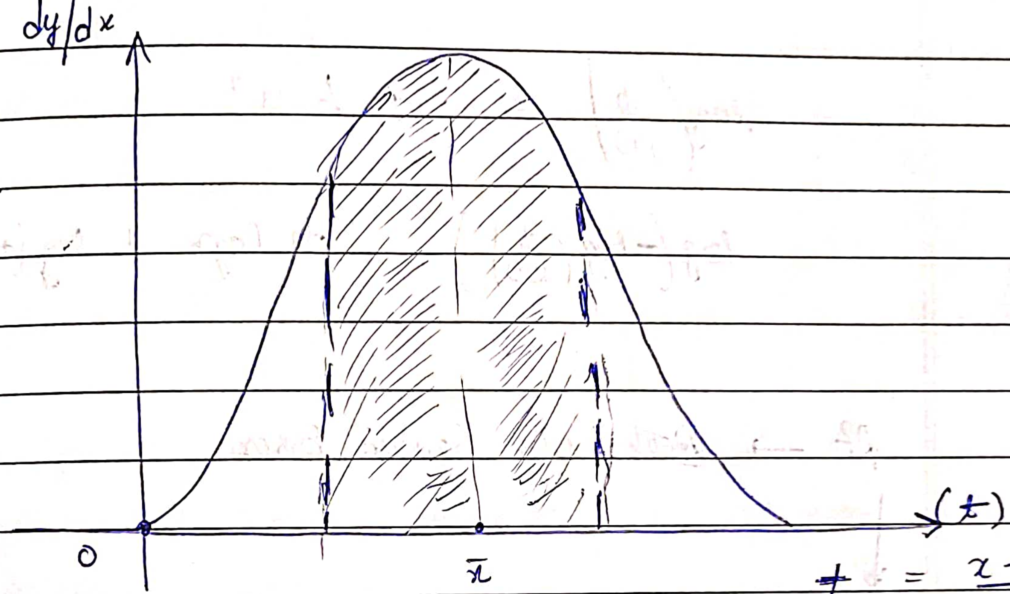




σ = standard deviation

63 % of data points lie here within $[-\sigma, \sigma]$

Shifted Normal distribution.



$$t = \frac{x - \bar{x}}{\sigma}$$

$$y = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{x - \bar{x}}{\sqrt{2}\,\sigma}\right)^2$$

x	y (%)
2	10
4	15
6	~~20~~ 20
8	5
10	50
	100

$$\bar{x} = \frac{\sum x_i y_i}{\sum y_i}$$

$$\sigma = \sqrt{\frac{\sum y_i (x - \bar{x})^2}{\sum y_i}}$$

Question Rosan Rambe distribution

$$\phi = 100\left[e^{-bx^n}\right]$$

100% if ϕ is wt %.
or 1 if ϕ is wt frac.

$$\log\left(\frac{\phi}{100}\right) = -bx^n$$

$$\log\left(-\log\left(\frac{\phi}{100}\right)\right) = n\log x + \log(+b)$$

$R^2 \rightarrow$ ~~Root~~ mean Square Error

Large R (close to 1) $\rightarrow$ Good fit curve
R close to 0 $\rightarrow$ Bad fit curve.

for S curve above procedure is not Recommended as R^2 comes out to be very low.

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Problem Solving steps →

1 Plot ϕ vs x.

2. Observe the plot, If the plot is an S curve then Calculated $d\phi/dx$ & Express size distribution as normal distribution Calculate $\bar{x}$ & σ & then express

$$\frac{d\phi}{dx} = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{x-\bar{x}}{\sigma}\right)^2\right)$$

3 If plot looks like Exponential Curve, we go for rosen rammler distribution.

4. Estimate b & n.

5. Plot between $\log\left(-\log\left(\frac{\phi}{100}\right)\right)$ vs $\log x$

$$\log\left(-\log\left(\frac{\phi}{100}\right)\right) = \log b + n\log x.$$

Fine Particle Characterization

size $\leq 10\mu m$.

If particle size is larger, mg (body force) is considerable

If particle size is small, mg is not much effective but surface forces are considerable

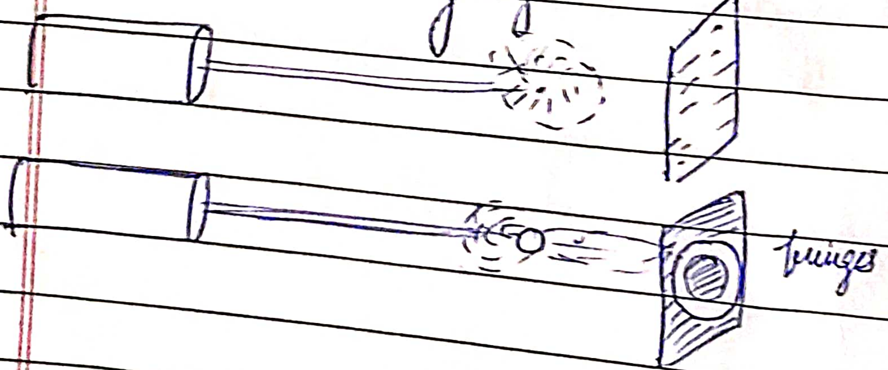
Laser Diffraction

Rayleigh Scattering $\rightarrow$ Particle size $< \lambda_{light}$

$$I = I_0 \left(\frac{1 + \cos^2\theta}{2R^2}\right)\left(\frac{2\pi}{\lambda}\right)^4\left(\frac{n^2-1}{n^2+2}\right)^2\left(\frac{d}{2}\right)^6$$

Mie scattering $\rightarrow$ Particle larger than λ.

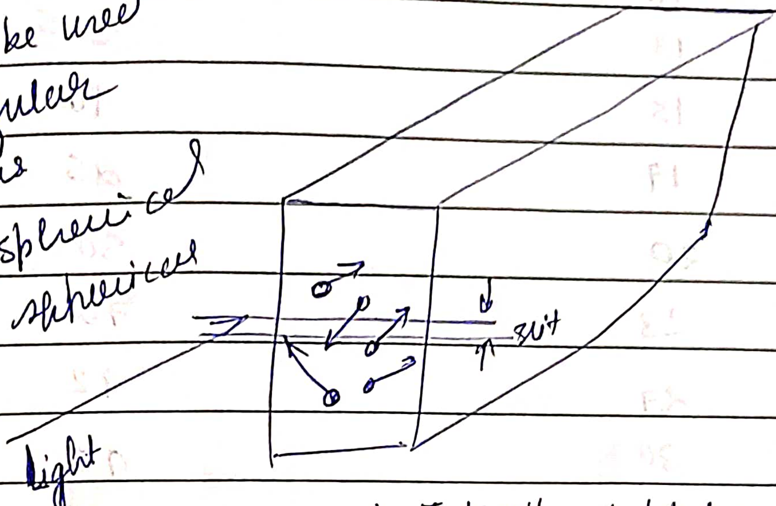
Rayleigh

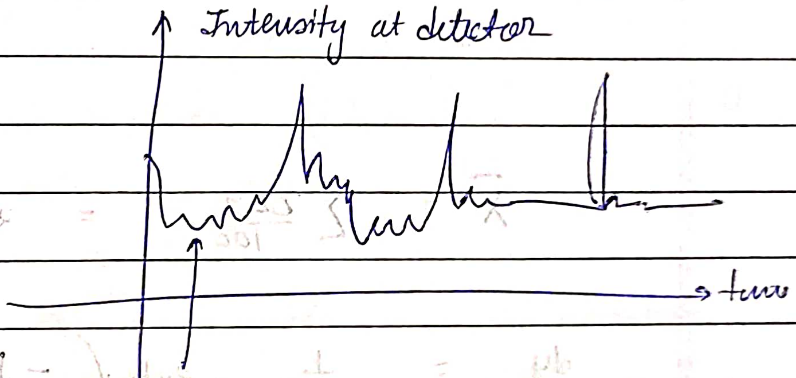


only for particle size $\leq 2.5\,\mu m$ else they settle.

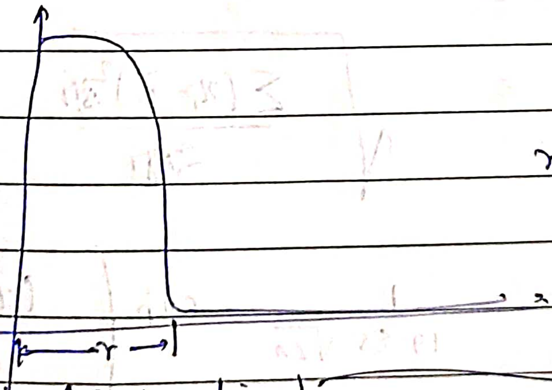
Dynamic Light Scattering (DLS)

can not be used for irregular particles (Good for spherical or near spherical particles)





very frequent changes for small particles



$\Gamma = D_T\, q^2$

(Decay time) → more for larger size particle.

electron microscope

Solid particles filtered & sticked on a conductive plate of carbon (sticky carbon tape) & this specimen is placed under a e^- microscope whenever e^- hit on it, back scattered electrons are captured and an image is generated.

Ques

Size (μm) (x)	Cumulative wt (y)	Δy
10	0	0
13	3.5	3.5
15	10	6.5
17	25	15
20	50	25
23	75	25
27	92	17
30	98	6
35	100	2

$$\bar{X} = \sum \frac{x \Delta y}{100} = 21.82 \ \mu m$$

$$\frac{dy}{dx} = \frac{1}{\sigma \sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2} (x-\bar{x})^2 \right)$$

To calculate σ

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2 \Delta y_i}{\sum \Delta y_i}}$$

$$\therefore \frac{dy}{dx} = \frac{1}{17.85 \sqrt{2\pi}} \exp\left(\frac{(x - 21.82)^2}{2 \times 17.85^2} \right)$$

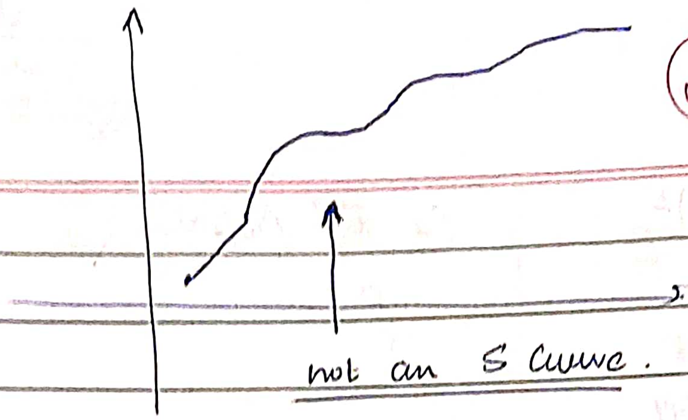
$x \cdot \Delta y$	$(x-\bar{x})^2$	$(x-\bar{x})^2 \cdot \Delta y/100$
0	476.112	0
0.455	456.46	
0.975	434.514	
2.55	371.33	
5	282.91	
5.75	258.24	
4.59	296.87	
1.8	400.80	
0.7	446.05	

$\sqrt{Sm} = 17.85067 = \sigma.$

$\frac{1}{100}\sum y = 1$

Que: Expresses the suitable size distribution Expon for the given data.

Size (μm)	wt % (Δy)	Cumulative wt % (y)
X2	10.4	10.4
5	16	26.4
7	16.1	42.5
10	7.5	50
15	6.7	56.7
20	18.6	75.3
25	6.1	81.4
30	7.9	89.3
35	10.3	99.6
40	0.4	100



not an S curve.

⇒ we go for Rosen Rambler Expression.

$$y = 100 \exp\left(-b x^{n}\right).$$

$$\frac{y}{100} = e^{-bx^{n}}$$

$$-\log\left(\frac{y}{100}\right) = b\, x^{n}$$

$$\underbrace{\log\left(-\log\left(\frac{y}{100}\right)\right)}_{Y} = \underbrace{\log b}_{C} + \underbrace{n}_{m}\,\underbrace{\log x}_{X}$$

$\ln(-\ln(y/100))$	
⋮	Eqⁿ: $Y = -1.5867\,X + 2.7851$ $R^2 = 0.6366$.

moving $\longrightarrow$ due to ext. force (Like Gravity)

Diffusing $\longrightarrow$ Due to inherent thermal energy go here & there

D_T = translational diffusional coefficient.

$$\text{Flux} \propto \frac{dc}{dx}$$

$$\text{Flux} = D_T \frac{dc}{dx}$$

depends upon particle size.

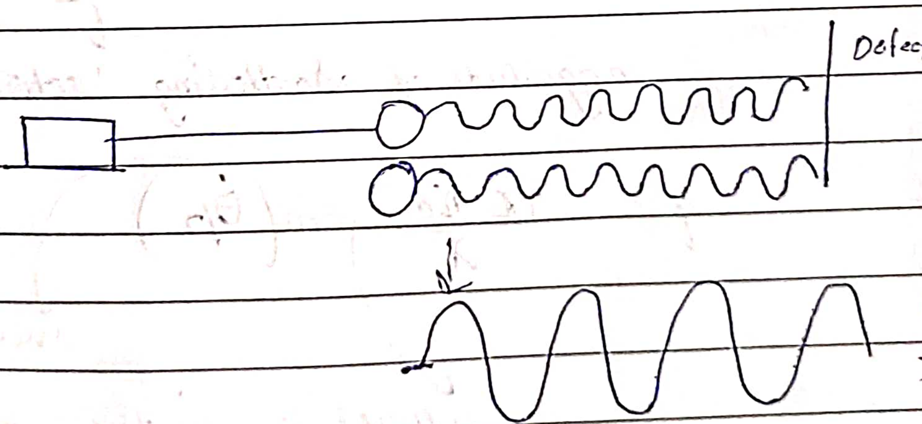
Stoke Eqn : Radius of Particle = R_P

$$R_P = \frac{KT}{6\pi \mu D_T}$$

Stefan Boltzmann Constant.

To measure D_T we use light Scattering

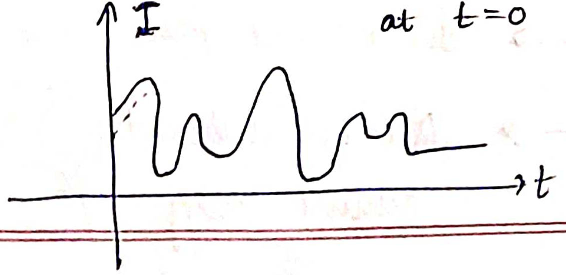
Expt.



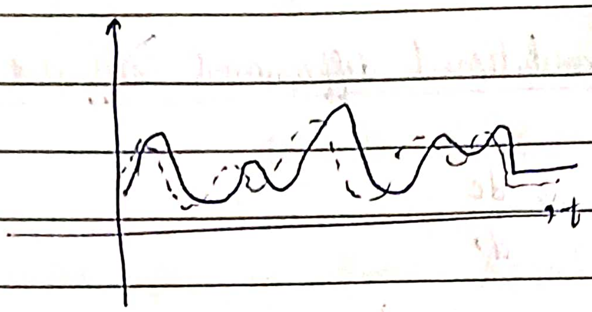
I vs t $\longrightarrow$ correlation function

Delay time = 500 ns

at $t=0$ Image

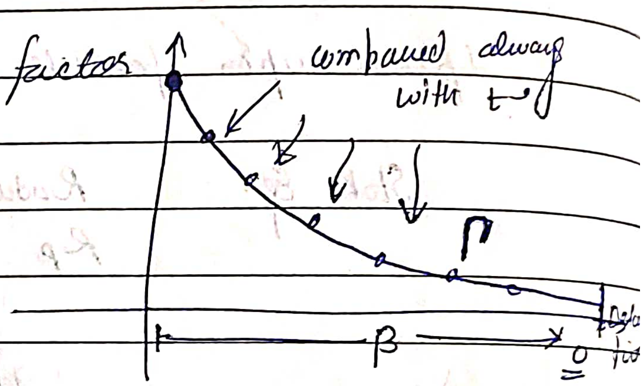


$t = 500$ ns



$t = 1000$ ns

correlation factor



correl^n fn

$$g = 1 + \beta e^{-\Gamma t}$$

decay rate $\Gamma = \frac{D_T}{q^2}$

magnitude of scattering vector.

$$q = \frac{4\pi n_0}{\lambda} \sin(\theta/2)$$

Incident angle

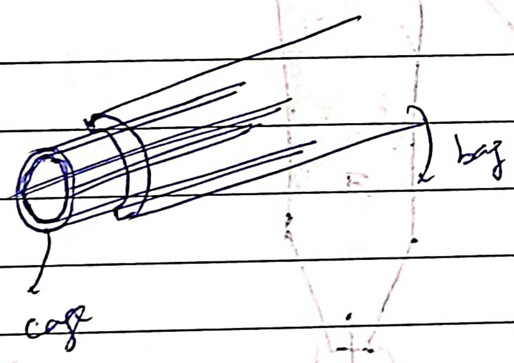
refractive index of liquid

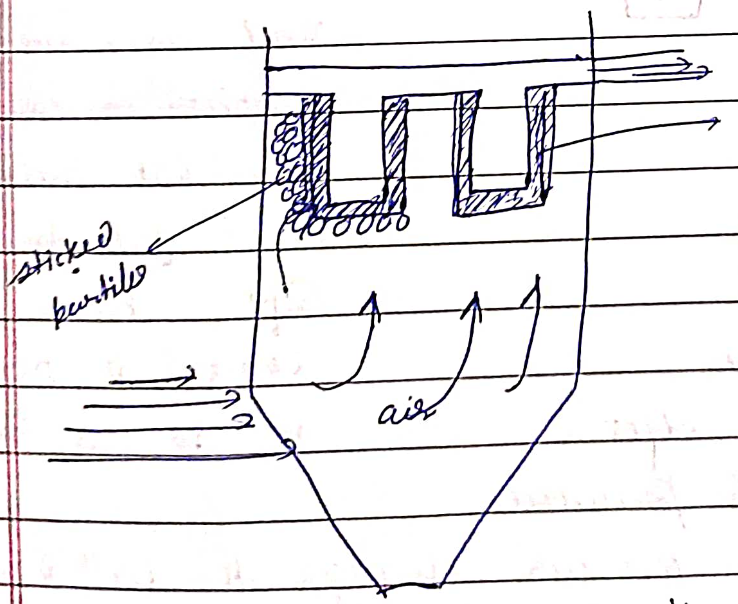
DLS for particle size ≤ 2.5 μm

Separation of Solids from Gas.

- IC engines
- masks.
- Catalyst in a Reactor.
- Air Conditioner

Bag filter.





pore size reduces due to particle sticking. So vacuum must be ↑ ⇒ more cost.

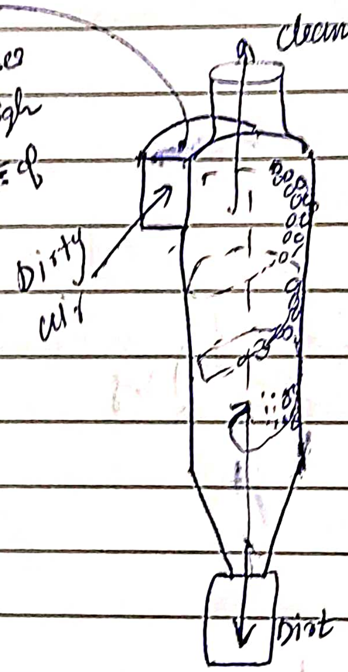
So they vibrate the pipe to clean the bag. or they disconnect from vacuum & connect to blower & blow air in opposite dirn

Permeability of any filter = volumetric flow rate / area

Cyclone Separator (Reverse flow cyclone separator)

→ 1. Reverse flow cyclone sepr → gives more ΔP.
→ 2. Axial flow cyclone separator.

wake formation / boundary layer form takes place too & frictional losses are very high
$\Delta P \uparrow\uparrow \Rightarrow$ lots of energy losses



Centrifugal force acts.

$$F = \frac{mv^2}{r}$$

more mass ⇒ force higher

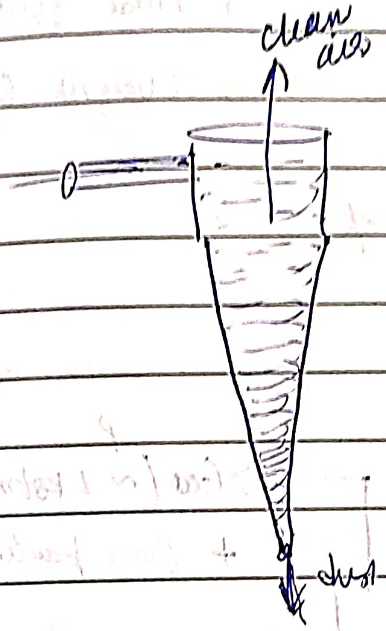
Particles (solid) hit the wall as more force applied on them. As they hit their velocity = 0 & fall down & get sepr. Hence a conical portion helps to do this faster.

The center region of tube has become a vaccum and the edges have air at high pressure.

At the dead point the air changes its dirn & moves from bottom to top

Separation of Particles from air
↳ Cyclone Sepr

Hydrocyclone ⟶ when density difference is less
more turbulence is required
∴ smaller cylindrical tube &
Longer conical part required



1. Gravity Separator :→ particle size > 100 μm
2. Filter bags & Centrifugal Separator. 2.5 μm < size < 100 μm

3. Scrubber & Electrostatic Precipitator → very fine particles

(Theory)

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Performance of Separators.

Performance
- efficiency
  - Grade Efficiency — cut p... → specific to particle size
  - Overall Efficiency
- Pressure Drop ✓

Feed → Separator → Gas ($\rho \sim 1\ kg/m^3$) + finer particles

Separator → particles ($\sim \rho \approx 10^3\ kg/m^3$)

dispersion { Gas + particles

usually we have mixture or (powder sample)

Small particles won't settle down due to gravity.

v (small velocity enough to fluidize them)

mg

Size (μm)	%
a — b	x
b — c	y
c — d	z

→ Histogram Represent...

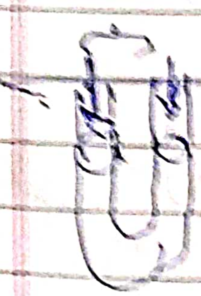
Cumulative collection efficiency = $\frac{\text{mass of particles collected}}{\text{mass of particles fed}} \times 100$

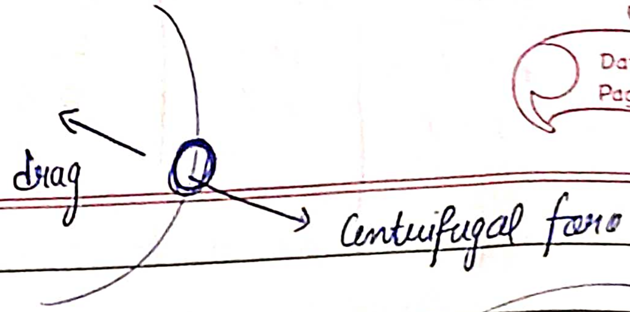
particle size corresponding to 50% collection efficiency = Cut particle Diameter.

Even though efficiency is good, but if cut particle diameter is high then its problem along with these two the operating cost must be taken into account ⇒ (Pressure Drop decides it).

Desired
- cut particle diameter ≈ Avg particle size of powder
- Collection efficiency = 90%
- ΔP = 100 mm of water

manometer to be used.





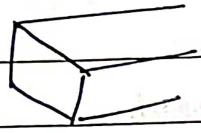
$$d_{pc} = \left(\frac{9 \mu B_c}{2\pi N V_i (\rho_p - \rho)} \right)^{1/2}$$

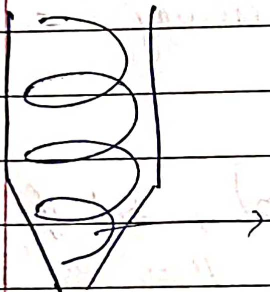
(for 2D-2D.)

N → effective number of turns

V_i → inlet Gas velocity

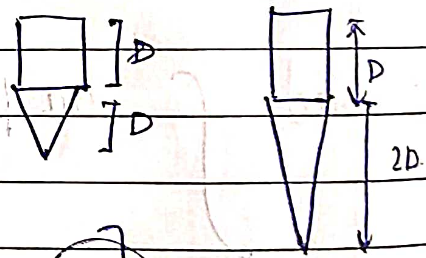
B_c → inlet Width or dia in case of circular opening





→ increase cone length to get more turns to separate fi...

Cyclone Separator types ~~names~~: 1D 1D 1D 2D



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$$\underset{\text{(turns)}}{N_e} = \underset{\substack{\text{(Height} \\ \text{of inlet duct)}}}{\frac{1}{H}} \times \left[L_c + \frac{Z_c}{2} \right]$$

L_c → length of Cyclone body

Z_c → length of cyclone c...

* *

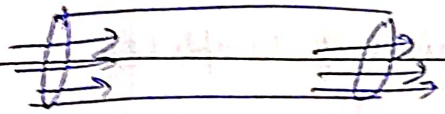
$$\underset{\text{(Grade efficiency)}}{E} = \frac{1}{1 + \left(d_{pc}/d_p \right)^2}$$

d_p → avg. particle size.

** Pressure drop.

Shepard & Lapels equation

$$\Delta P = 0.8\, \rho g \frac{V_i^2 (ab)}{D_o^2}$$ → area of inlet



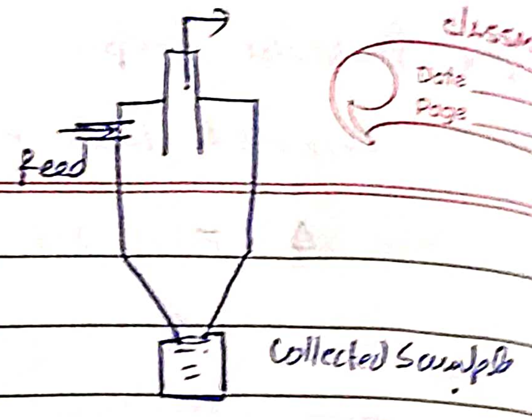
$$\Delta P = \frac{4f}{2D} \rho L v^2$$

for straight pipes

$$\Delta P = 0.8 \cdot \rho g \cdot \frac{v_i^2\, ab}{D_o^2}$$

particle

30/10/23

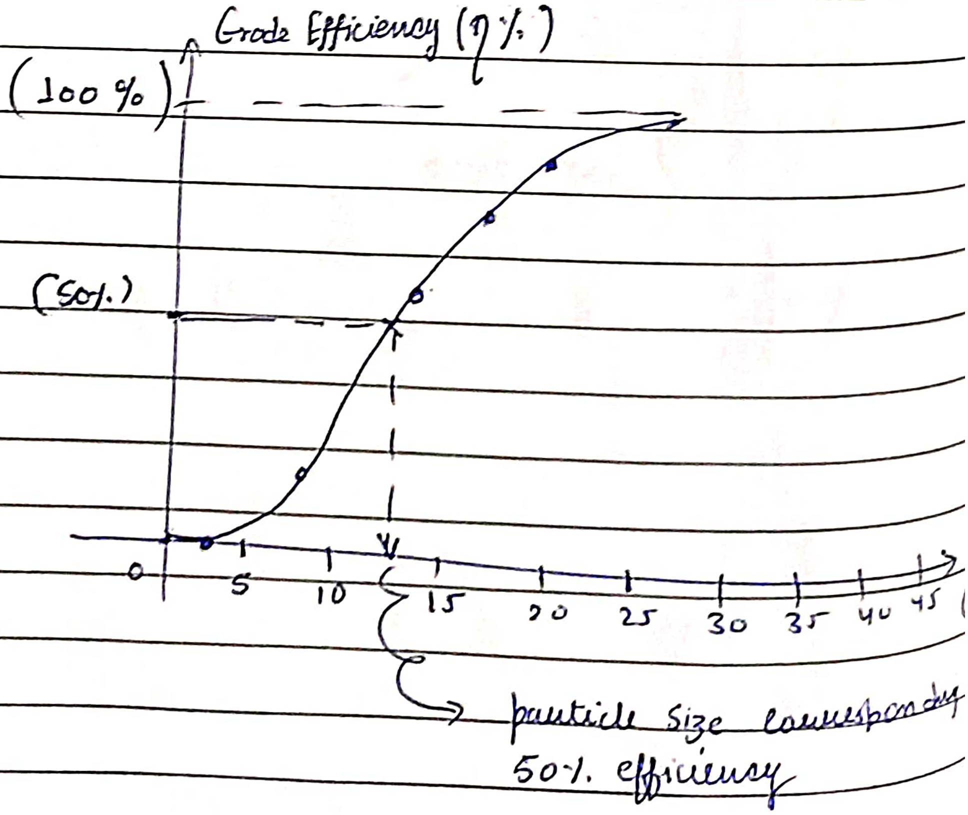


Weight of sample (g)

Size (μm)	Avg size	Feed	Collected Powder	Grade
0-5	2.5	10	0.1	1%
5-10	7.5	15	3.53	23.53
10-15	12.5	25	18	72%
15-20	17.5	30	27.3	91
20-25	22.5	15	14.63	97.5
25-30	27.5	5	5	100

total feed weight = 100 g   68.36 g.

Overall efficiency $= \frac{68.36}{100} \times 100 = 68.3$



$d_{50} \approx 9\mu m$

d_{50} can also be theoretically calculated by :-

Large particles are separated

small particles are not efficiently separated

$$d_{pc} = \left(\frac{9 \mu \underbrace{B_c}_{\text{inlet width}}}{2\pi \underbrace{N}_{\text{effective number of turns.}} V_i (\underbrace{\rho_p}_{\text{particle density}} - \underbrace{\rho}_{\text{gas density}})} \right)^{1/2}$$

Ques2 :→ (short length not needed here)

$B = 15 \times 10^{-2}$ m.	$d_{avg} = 10 \mu m.$
$L = 25 \times 10^{-2}$ m	$\rho_p = 1.2$ g/cm³. $= 1200$ kg/m³
$D = 0.5$ m.	$\rho_{gas} = 1.2$ kg/m³
$N = 5.$	$\mu_{gas} = 0.0745$ kg/m h.
$V_i = 20$ m/s.	

(a) cut particle Diameter.

$\frac{kg}{m\,s} \cdot \frac{1}{360}$

$$d_{pc} = \left(\frac{9 \times \frac{0.0745}{3600} \times 15 \times 10^{-2}}{2 \times \pi \times 5 \times 20 \times (1200 - 1.2)} \right)^{1/2}$$

1.2×10^3 kg/m³

$d_{pc} = 6.09 \mu m.$

(b) :- Pressure drop :-

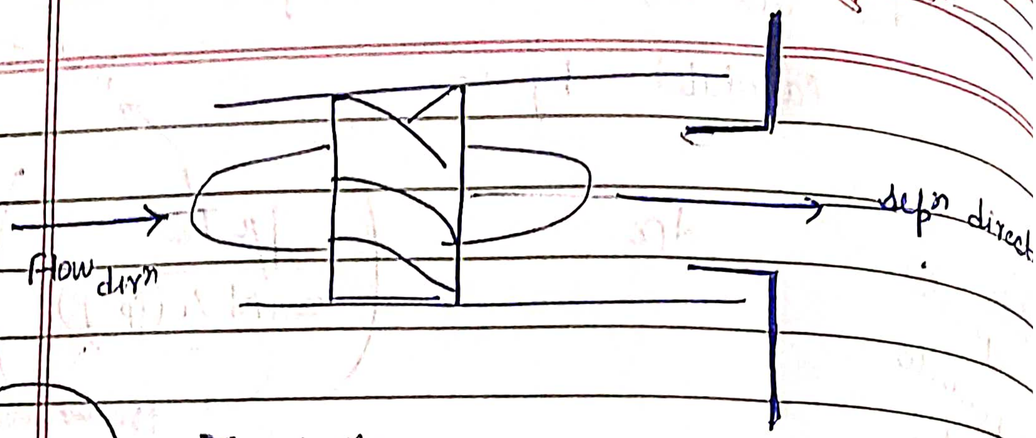
Size (μm)

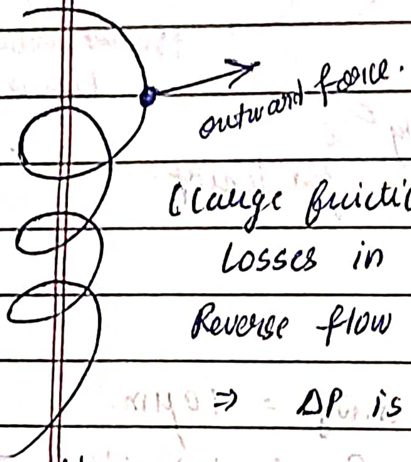
$$\Delta P = 0.8 \rho_g \times \frac{V_i^2 \times \text{area of inlet}}{D_o^2}.$$

$= 34.56$ Pascal.

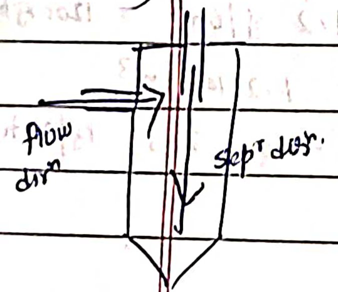
$$\rightarrow \frac{0.8 \times 1.2 \times (20)^2 \times (0.15 \times 0.15)}{(0.5 \times 0.5)}$$

Axial flow Cyclone Separator

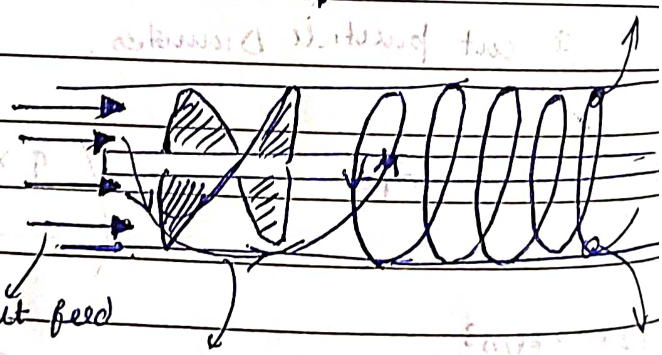




(Large frictional losses in Reverse flow separator ⇒ ΔP is huge).



concept



feed is spinned so a similar cyclon separator like motion occurs, Boundary particles get separated & particles near the central axle are trav[illegible] apart for further treatm[illegible]

Electrostatic Precipitator

↳ to use only when mole of the particles are fine (fine dust)

↳ corona discharge is used.
Electrons stick to the surface of dust particles & thus these stick to the positively charged plates.
After the operation the stuck particles are removed either by vibration of plates or by the use of water.

Necessary voltage :-

$$V = 10\left[1 + \frac{0.3}{R_1^{0.4}}\right] R_1 \ln\left(\frac{R_2}{R_1}\right) \text{ kV}$$

R_1 = Radius of wire electrode
R_2 = Radius of collecting electrode

Velocity of collection particles :

1. conducting particles :- $W = 0.10\left(\frac{d_p V^2}{\mu}\right)$

2. non conducting particle $W = 0.093\,\frac{d_p V^2}{\mu}$

$$\eta_c = 1 - e^{\left(\frac{AW}{Wdc}\right)}$$

Electrostatic Precipitator

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↳ to use only when most of the particles are fine. (Fine Dust)

crude oil refineries

↳ Corona discharge is used.
Electrons stick to the surface of dust particles & these then stick to the positively charged plates.
After the operation the stick particles are removed either by vibration of plates or by the use of water.

Necessary voltage :-

$$V = 18\left[1 + \frac{0.3}{R_1^{0.5}}\right] R_1 \ln\left(\frac{R_2^2}{R_1}\right) \text{ kVolts}$$

R_1 = Radius of wire electrode.
R_2 = Radius of collecting electrode.

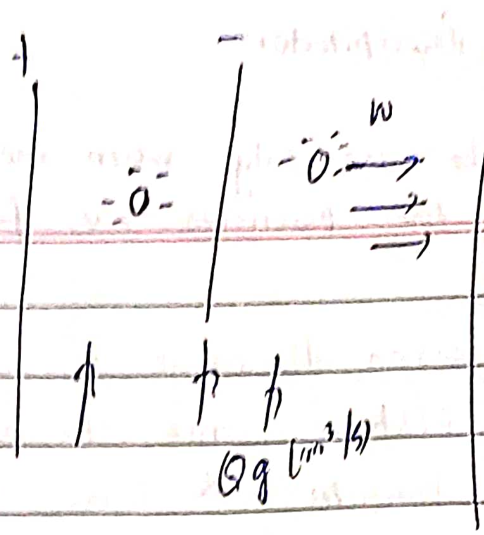
Velocity of collection Particles :

1. Conducting particles :- $W = 0.16\left(\frac{d_p^2 V^2}{\mu}\right)$

2. non conducting particle. $W = 0.075 \cdot \frac{d_p^2 V^2}{\mu}$.

Col

$$\eta_c = 1 - e^{\left(\frac{Q_g}{WAc}\right)}$$



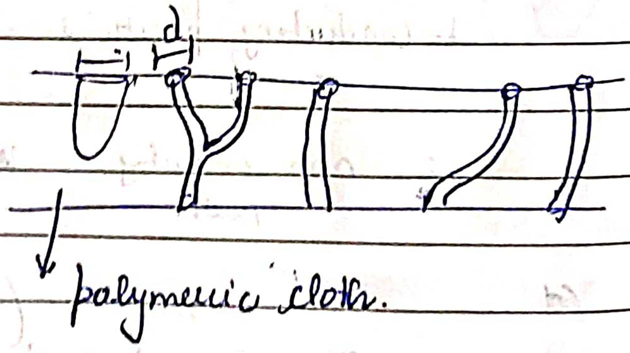
Residence time = $\frac{\text{volume}}{\text{volumetric f}}$

filtration
(separation of Solids from the Liquids)

Eg. wastewater treatment in Cities
Crystallisation.
Ore beneficiation. (By washing & filtering).

1. Membrane filtration (for smaller filtration).
2. Normal Filtration.

Filter media :-



Concept

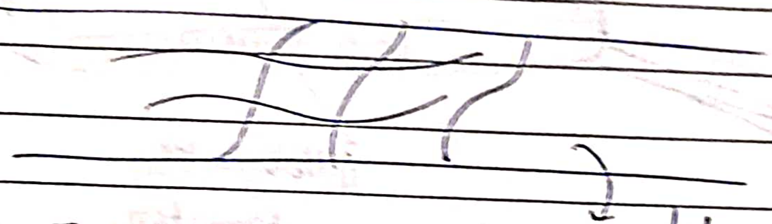
if particle size > pore size → excluded particle (Size Exclusion)

Summary 25 M — 5 M endsem

5 m before ms — 20 M endsem

(Conceptual / Basic Questions)

In case of Reverse Osmosis (RO) membrane



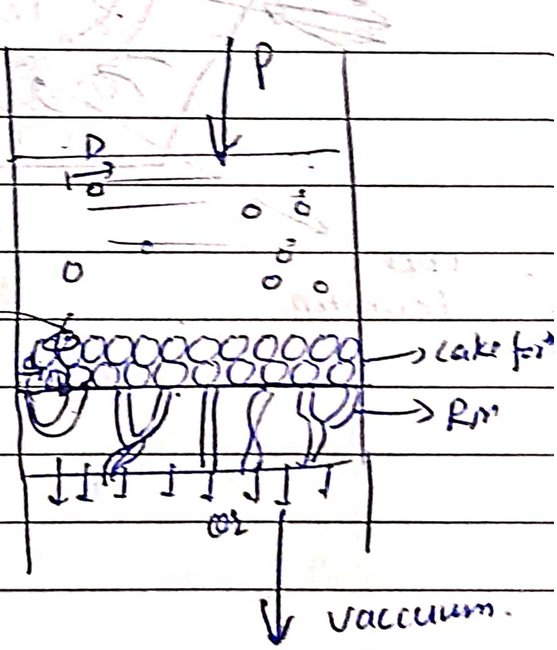
polymer chain (very very small pores)

Concept : Individual molecule diffuse through this membrane (it has very very small pores)

Because of Random movement of polymer chains particles will diffuse. Hence it is very slow.

Rm → Resistance offered by filter medium

Rc → Resistance offered by filter cake.



d < D

Initially only Rm

After some time the cake serves as a pore.

Rc > Rm → flow rate decreases with time

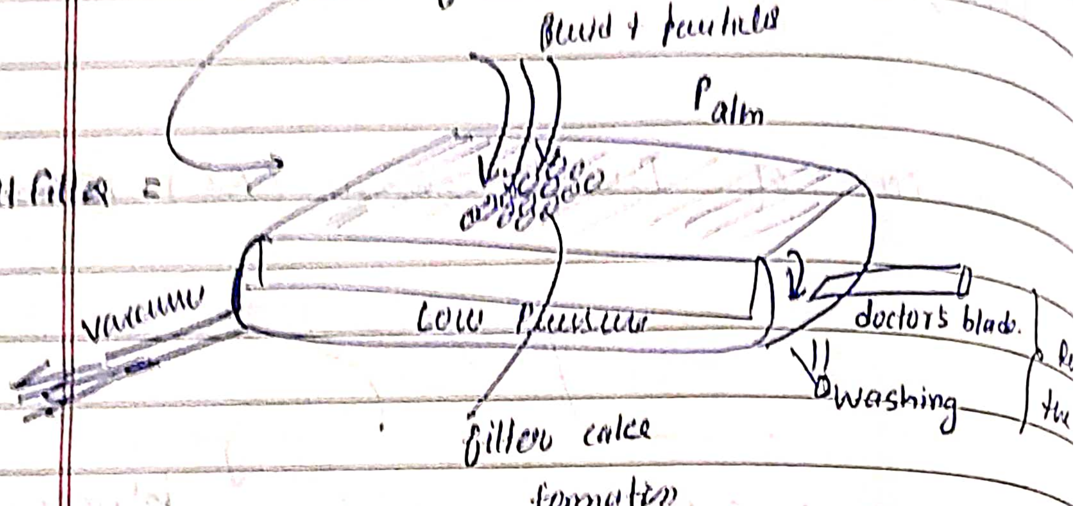
Filtration Equipment

→ Plate and frame filter Press

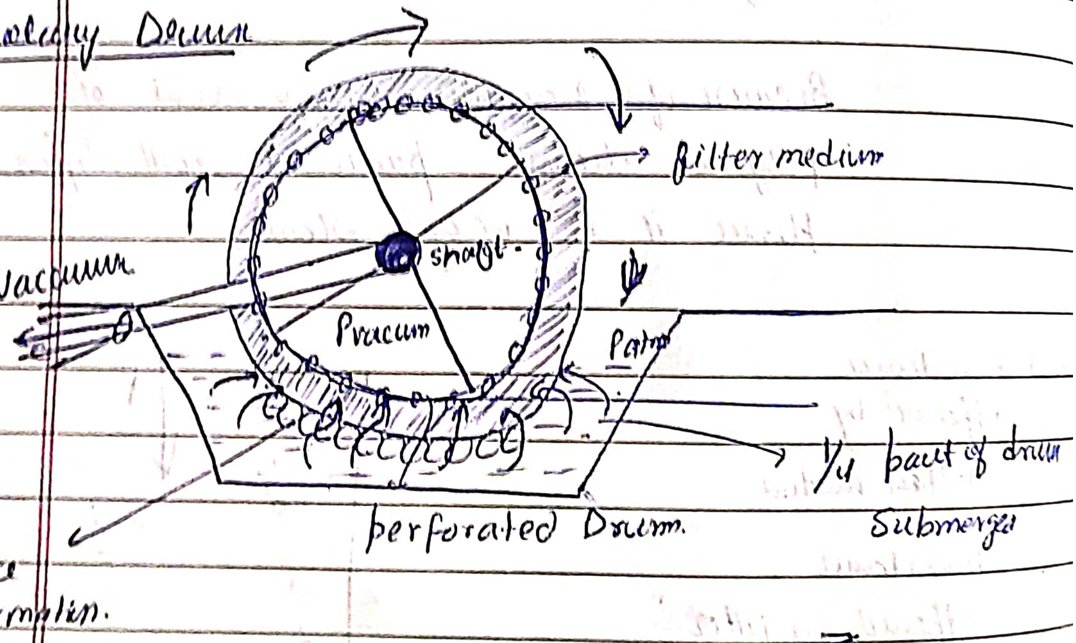
→ Rotary drum filter

→ Belt filter

Belt filter =

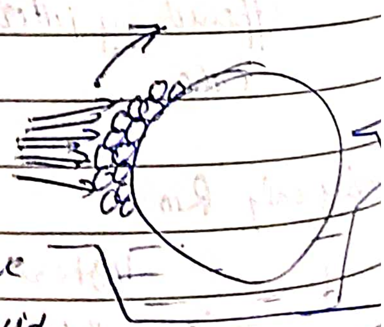


Rotary Drum



The Drum Rotates

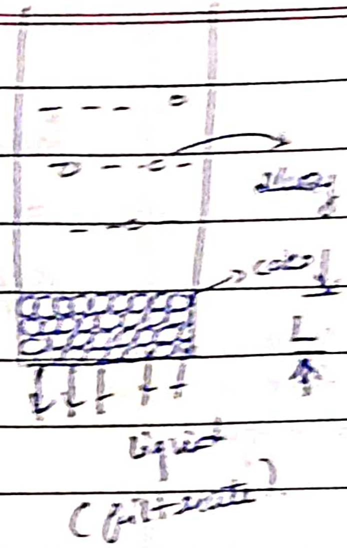
water is used to wash the cake & remove all the stuck fluid.



& after this the cake is removed using scrapping blade.

Filtration Eq:

Flow through cake

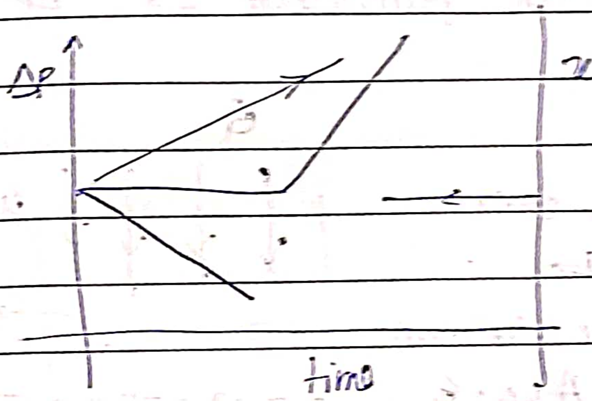


resemble flow through packed bed.

Usually 'Re' in filtration is low.

$$\frac{\Delta P}{L} = \frac{150 \mu v (1-\varepsilon)^2}{d_p^2 \, \varepsilon^3}$$

(at low Re)



as Pressure remain constant & more & more particle accumulate in the bed. Q↓.

ΔP, L, u → varies with time

→ scrapping plate

$$d_p = \frac{6}{(S_p/V_p)}$$

$$\frac{S_p}{V_p} = \frac{36}{d_p^2} \Rightarrow \text{Ident Page}$$

u → velocity of fluid passing through the cake.

$$\frac{\Delta P}{L} = \boxed{\frac{150}{36}} \mu u \cdot \frac{(1-\varepsilon)^2}{\varepsilon^3} \left(\frac{S_p}{V_p}\right)^2$$

* Valid for spherical particle

for other case $\frac{150}{36}$ is replaced by a constant 'K', which is to be determined experimentally.

Come from momentum balance eqn

$$\frac{\Delta P}{L} = K \mu u \frac{(1-\varepsilon)^2}{\varepsilon^3} \left[\frac{S_p}{V_p}\right]^2$$

for constant ΔP filtration → L, u variables

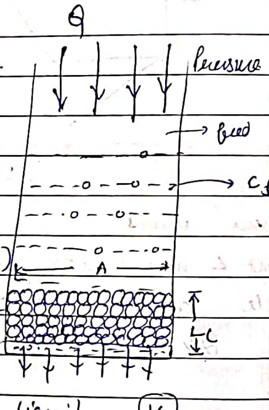
for constant Rate filteration → ΔP, L variable

mass → balance needed

Volume of cake $= A L_c$

Liquid volume in the cake $= A L_c \cdot \varepsilon$

Solid volume in the cake $= A L_c (1-\varepsilon)$



void fraction in the cake $= \varepsilon$

liquid (V)

2 components — Solid & Liquid

2 mass balance possible.

Solids in the feed slurry = solids deposited on the filter medium.

C_f = conc. of solids in the feed

$$= \frac{\text{mass of solid}}{\text{Volume of slurry}} \quad \text{---} (*)$$

Feed flow rate $= Q$.

$$C_f \times Q \times t = A L_c (1-\varepsilon) \rho_s$$

(units of mass)

t → time for filtⁿ?

L_c → Length of cake at any time t

$Q \times t$ = Volume of slurry entered in time t.

If $C_f = \frac{\text{mass of solids}}{\text{Volume of liquid}}$

$$C_f \cdot V_f = A L_c (1-\varepsilon) \rho_s \quad \text{---} ①$$

L_c → Length of cake at any time t.

V_f ↳ volume of liquid in the feed at any time t

$C_f \cdot V_f$ → mass of solids entered into liq medm

Liquid Balance :—

Liquid in the feed slurry = Liq in the cake + filtrate

$$V_f = A L_c \varepsilon + V \quad \text{---} ②$$

$Au = \frac{dV}{dt}$

$$\therefore C_f (A L_c \varepsilon + V) = A L_c (1-\varepsilon) \rho_s$$

$$(C_f \cdot A \cdot \varepsilon) L_c + V C_f = A L_c \rho_s (1-\varepsilon)$$

Solids in the feed slurry =
solids deposited on the filter medium.

C_f = conc. of solids in the feed
= $\frac{\text{mass of solid}}{\text{Volume of slurry}}$ —— (*)

Feed flow rate = Q.

$C_f \times Q \times t = A\, L_c (1-\varepsilon) \rho_s$
(units of mass) ↓ Length of cake at any time t
time for filt^n?

$Q \times t$ = Volume of slurry entered in time t.

If $C_f = \frac{\text{mass of solids}}{\text{Volume of Liquid}}$ Length of cake at any time t.

$C_f \cdot V_f = A\, L_c (1-\varepsilon) \rho_s$ —— ①
↳ volume of liquid in the feed at any time t.
mass of solids entered into liq medium

Liquid Balance :-
Liquid in the feed slurry = Liq in the cake + filtrate

$V_f = A L_c \varepsilon + V$ —— ②

$Au = \frac{dV}{dt}$

$\therefore C_f (A L_c \varepsilon + V) = A L_c (1-\varepsilon) \rho_s$

$(C_f \cdot A \cdot \varepsilon) L_c + V C_f = A L_c \rho_s (1-\varepsilon)$

$$L_c = \frac{V C_f}{A\{(1-\varepsilon)\rho_s - C_f \varepsilon\}}$$

$$L_c = \frac{V \cdot C_f}{A\left[(1-\varepsilon)\rho_s - C_f \varepsilon\right]}$$

If C_f is given as (*) convert it as

$$\frac{C_f}{\rho_s} = \frac{\text{mass of Solid} / \rho_s}{\text{volm of Slurry}} = \frac{\text{Volume of Solid}}{\text{Volume of slurry}}$$

$$\frac{\rho_s}{C_f} = \frac{V_f + V_s}{V_s}$$

$$\downarrow$$

$$\boxed{\frac{V_s}{V_f} = \frac{C_f}{\rho_s - C_f} \cdot \rho_s}$$

$$L_c = \frac{V \cdot (v)}{A} \qquad v = \frac{\text{Volume of cake}}{\text{Volume of filtrate}}$$

$$\frac{\Delta P}{L_c} = K u \cdot \mu_f \frac{(1-\varepsilon)^2}{\varepsilon^3}\left(\frac{S_P}{V_P}\right)^2$$

$$\Delta P = \left[K \frac{(1-\varepsilon)^2}{\varepsilon^3}\left(\frac{S_P}{V_P}\right)^2\right] u \mu_f \cdot \frac{V v}{A}$$

$$u = \frac{dV/dt}{A} \qquad V \text{ — volume of filtrate at time } t.$$

$$= \alpha \frac{v \mu_f V}{A^2}\left[\frac{dV}{dt}\right]$$

Solid

slurry

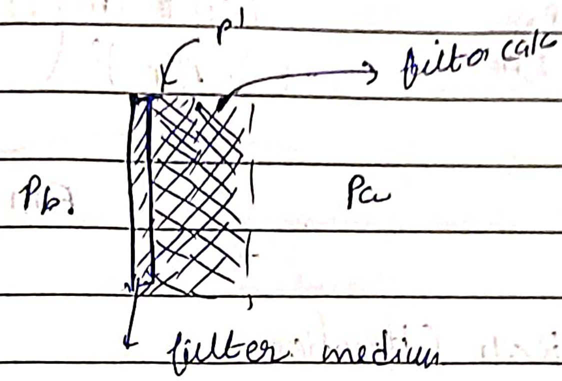
$\Delta P_m =$

General filtration eqn

Lab

Const

$$\frac{dt}{dV} = \frac{\alpha v \mu_f}{A^2} \cdot \frac{V}{\Delta P_c}$$



$$\Delta P = P_a - P_b$$

$$\Delta P = P_a - p' + p' - P_b$$

$$\Delta P = \Delta P_c + \Delta P_m$$

Solid

slurry

Applying filtration eqn for filter medium

$\Delta P \rightarrow \Delta P_m$

$$\Delta P_m = \frac{R_m}{A} \mu_f \frac{dV}{dt} \qquad \cancel{\frac{dt}{dV} = \frac{R_m \cdot \mu_f \cdot V}{A^2 \, \Delta P_m}}$$

If in Problem Given :- Neglect R_m ⇒ then $\Delta P_1 = \Delta P_c$

else consider R_m too.

$$\Delta P = \Delta P_c + \Delta P_m$$

General filtration eqn :→

$$\underset{(\text{Total})}{\Delta P} = \left[\underbrace{\frac{\alpha v \mu_f V}{A^2}}_{\text{cake Resistance}} + \underbrace{\frac{\mu_f R_m}{A}}_{\text{filter medium Resistance}} \right] \cancel{\frac{V \mu_f}{A^2}} \frac{dV}{dt}$$

Laboratory setup

Constant Pressure eqn → on Integration

$$\frac{t}{V} = \frac{\alpha v \mu_f V}{2 A^2 \Delta P} + \frac{R_m \cdot \mu_f}{A \, \Delta P}$$

Eqn : $\frac{\Delta P}{L} = \frac{150 \mu v (1-\varepsilon)^2}{\left(\frac{6}{Sp/Vp}\right)^2 \cdot \varepsilon^3}$

filter Medium.

$$\frac{\Delta P_m}{L_m} = \underbrace{\frac{150\, L_m}{\left(6/Sp/Vp\right)^2}\left(\frac{(1-\varepsilon)^2}{\varepsilon^3}\right)}_{R_m} \mu_f \frac{dV/dt}{A}$$

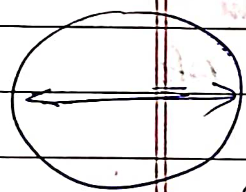
~~Liquid medium.~~

Constant Rate Filtration

$$\frac{dV}{dt} = \frac{V}{t}$$

$$\Delta P = \left[\frac{\alpha v \mu_f \cdot V}{A^2} + \frac{R_m \mu_f}{A}\right]\frac{V}{t}$$

Given constant pressure filtration



$$\frac{t}{V} = \frac{\alpha v \mu_f}{2A^2 \Delta P} V + \frac{R_m \mu_f}{A \Delta P}$$

filtration time

filtration area

$A = f \cdot A_T$

n = angular velocity (rpm)

Book:- Unit operations by McCabe Smith

Q:- Labratory filtn. Exp. is conducted at constant pressure drop, on a slurry of $CaCO_3$ in water. Following data is observed:- Filter area = 440 cm^2

Conc. of solids in the slurry = 23.5 g/lt

T = 25°C, Evaluate α & R_m of the Given cake & filter medium, ΔP = 6.7 psi,

V	t	t/V
0.5	17.3	34.6
1	41.3	41.3
1.5	72	48
2.0	108.3	54.15
2.5	152.1	60.84

$$\frac{\alpha v \mu_f}{2A^2 \cdot \Delta P} = 13.136.$$

$$\frac{R_m \mu_f}{A \Delta P} = 28.144$$