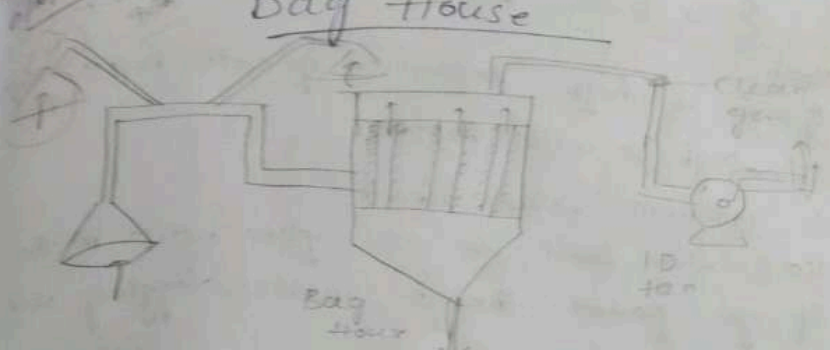
Bag House



→ $t = 0$, $Q = Q_0$; $\eta = \eta_0$
$t = t$: $Q = Q_t$, $\eta = \eta_0 + \eta_0 \simeq 0.99\%$.
$Q_1, Q_2, Q_3, \ldots \ldots Q_n$. (dust collected @ surface of bag filter)
- Negative Pressure

i. Const press operation.
↳ Avg of Q_0 & Q_n, will be avg flow rate for const press operation

ii. Const flowrate/capacity operation.
→ Press. changes → ↑s (↑ed press will be more)

$P = P_{atm} + \Delta P$
$P = P_{atm} + \Delta P + \Delta P_1$
$P = P_{atm} + \Delta P_0 + \Delta P_1 + \ldots$

→ rpm of IDM fan ↑s so resistance offered by filters is overcome.

→ Air to cloth Ratio is imp.

$$\frac{Q}{\underbrace{A_c}_{\text{Cloth Area}}}$$

- $A_{individual} = \pi D L + \frac{\pi}{4} D^2$
- $A_c = N \times A_i$

$\frac{Q\ (Nm^3/hr)}{A_c\ (m^2)} \Rightarrow m/time$

- If $\frac{Q}{A_c}$ is small, air won't move in through cloth.
- If $\frac{Q}{A_c}$ is high, expansion of cloth happens, rupture of baghouse will happen

So optimum value needed.
- 40% less load so no rupture would be there
- If gas passed through inside, clogging will happen
- If gas sent from outside, it is easy
  - ↳ No clogging

7/10/25 Filtration velocity $= \frac{Q}{A_c}$

Filtration time, t_f.

For const P. filtration

$$t_f = \left(\frac{B}{2\Delta P}\right) V_g^2 + \left(\frac{C}{\Delta P}\right) V_g$$

If the opening b/w the bag is too less agglomeration of the particles can take place.

V_g = vol of gas filtration.

For deposited cake thickness of ΔZ.

$\Delta P \rightarrow$ P. drop for ΔZ bed.

(For overall capacity of Bag filter → Capture velocity (Check fugitive emission)

If resistance for filter media is negligible.

$$t_f = \left(\frac{B}{2\Delta P}\right) V_a^2.$$

Where, $B = \left(\frac{\mu_a C}{\rho_B k}\right) \cdot \frac{1}{A^2} = \frac{K}{A^2}$.

C = Canning ham ~~coefficien~~ correction factor

ρ_B = Bulk density of filter cake.

k = Permability const.

A = Area of filter (bag) available for gas stream to pass throu

$$t_f = \left(\frac{K}{2\Delta P} \frac{1}{A^2}\right) V_a^2 = k$$

where $k^* = \frac{K}{2\Delta P}$.

Capacity $= \frac{V_a}{\text{Time}}$

Cleaning of Bag

1.) Mechanical Sha
2.) Pulse - Jet Bag
3) Reverse - Jet Ba

Reverse flow

(Maintanence Work is d

→ t_c → time of cl

- We will get the

Max. capacity =

- Overall capacity =

- Optimum Capaci

(for design purpo

+ Arrange a bag in

① Size of the bag

Dia of bag

② Compartments i

may be 1, 2, 4 ... we

can be

maintena

move in through
cloth happens, rupture
would be there
, clogging will
is easy
↳ No clogging
If the spacing b/w
the bag is too less
agglomeration of
particles can
take place)
of ΔZ.
Capture velocity
fugitive emission)
negligible.
factor
for gas

stream to pass through

$$t_f = \left(\frac{K}{2\Delta P}\frac{1}{A^2}\right) V_a^2 = k^* \frac{V_a^2}{A^2},$$

(time during which we are operating bag filter).

where $k^* = \dfrac{k}{2\Delta P}$.

Capacity $= \dfrac{V_a}{\text{Time}}$; $\dfrac{\text{vol of gas filter}}{\text{over time, min}}$

Cleaning of Bag House.

1.) Mechanical Shaking (Not used in large industry)
2.) Pulse - Jet Bag Filter
3) Reverse - Jet Bag Filter.

Reverse flow

(Maintenance work is diff).

t_f & t_c :

→ t_c → time of cleaning.

We will get the max. capacity of bag filter

Max. Capacity $= \dfrac{V_a}{t_f}$.

Overall capacity $= \dfrac{V_a}{t_f + t_c}$.

→ Optimum Capacity, $t_f = t_c$. (If t_c is unknown)

(for design purpose).

+ Arrange a bag in bag house:

① Size of the bag. (< 3 to 4 m)

Dia of bag → 40 to 50 cm.

② Compartments in bag house. needed (since some bags can be corroded or chocked)

1, 3, 4 are working
2 can be sent to maintenance work.

①	②
③	④

Guidlines for Bag filter

Bag filter Area (m^2)	No of Compartment
1 - 200	1-2
201 - 600	2-4
601 - 1000	5-7
1001 - 1600	8-10
1601 - 2200	11-13
2201 - 3000	14-16
3001 - 4100	17-20
> 4100	> 20.

widely used / for cement & any large industries

→ Max available P - 150 cm of water column

→ Desirable P - 100 cm " " " (80-90%)

→ When cake is formed over filter & it is not possible to remove, so @ early stage remove the bag.

→ (Vol flow rate change is not seen in this case since ID fan is running)

* It can be seen in control panel (by control rings)

1) High press drop (If entire

2) If entire bag is choked there will be rupture. identified by

1) Drop in press drop (sudden drop in ΔP) → 80-90 % cm of water ah

2) Conc of particulates from the Chimney outlet

* No repairing can be done for a Choked / Ruptured bag → Only Replacing

→ If bag is used for large duration → η ↓s expansion & contraction happens there will be leakage of gases through the bag. So, yearly replacement of bags are reqd.

→ No of bag

Arrange ba

→ For actual

change the

Actual value

→ Press. drop

are connec

(only for

Constant

ΔP =

At t=0,

$t = t_f$,

t_f

* Rupture

→ Choking

→ Sending

* Air

→ Recommen

* We need

of b

A/c R

→ If Al

→ If Al

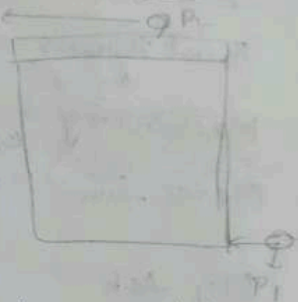
- No of bag ? (use SKI measurements)

Arrange bags in square pitch.

- For actual no of bags, we need to change the arrangement of bags (pitch).

Actual value → N + n.

(n → ΔN)



- Press. transducers / manometers are connected to control pannel (only for bag house).

Constant Rate Filtration

$$\Delta P = BQ_0^2 t + CQ.$$

At $t=0$, $\Delta P = CQ$. $\left(Q = \frac{V}{t}\right)$.

$t = t_f$, $\Delta P = BQ^2 t + CQ$.

t_f.

- Rupture of bags due to
  - → choking
  - → Sending huge quantity of gas.

* Air to cloth Ratio = $\frac{Q}{\text{Total Filtration Area of Bag House}}$

- Recomended value : 1.2 to 2.5 m/min for Pulse-Jet Bag filter

* we need to fix this ratio to get "Surface Area of bag filter".

- A/c Ratios Recomended for cleaning method (ft/min) ↳ in photo.

- If A/c ratio small → Large S.A of bag filter & allowing gas @ small rate
  → the inertial ~~force~~ with which the gas hits is very small.

- If A/c ratio → large ⇒ Rupture ~~of~~ bag takes place.

→ Types of bags used for diff cases

Dust / fume	Shakers	Reverse	Pulse-Jet
Abrasives	2-3		?
Alumina	2.25-3		
Paint Pigments	2		
Machining	3		16
Metal fume	1.5	1.5-1.8	6.9
Fly Ash	2	2.1-2.3	9-10
Chrome	1.5-2.5		9-12.

→ Bags are sensitive to Temp

- < 100°C ⟶ Can use. Bag filter
- > 100°C ⟶ Bag filter can be damaged

→ Type of filter media for filter Cloth Material

Cotton → Very sensitive.

- Cotton, Nylon, Glass
- Max temp bag (filter) can withstand ⟹ 280°C

Properties of Bag filter fibre Materials

Fibre	Strength	Max Temp(°C)	Remarks
Cotton	Strong	80	- low Cost. - Not suitable for acidic dust
Nylon	Strong	100	- Easy to clean - Excellent for Abrasive materials.

Polyester	Strong	135	- Easy to clean
Teflon	Medium	260	Expensive.
Glass Fibre	Strong	280	Poor Resistance to abrassion.
Nomex Nyloo	Strong	230	Poor resistance to moisture.

→ If ΔP of bag filter ≥ 150 cm of water column

* Hood & wein shouldn't be ⊥ → (like 120°).

Types

1) Cylindrical / plane / Surface Back filters.

2) Pleated " " "

↳ (More surface compared to plane S.A).

↳ $S.A = 3.5(\pi d L)$

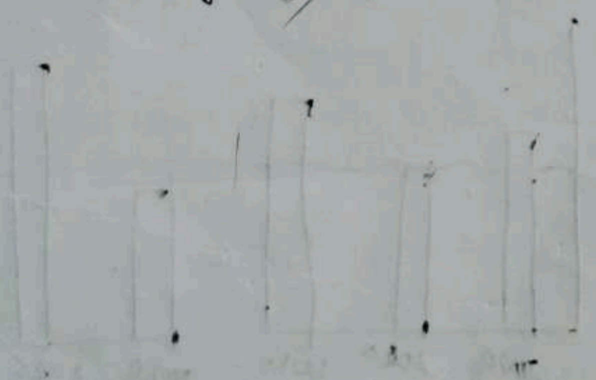
→ One side is completely fixed.

- Inside a cage is provided.. (2 types)

1.) Perforated. cage. (Rubber Gasket Lining is provided - which fitted).

2.) Rods for cage of plain bag.

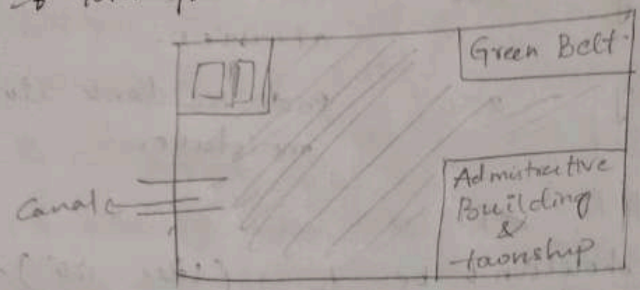
⇒ (If we've less no of bags & more are reqd, we can compensate it by providing pleated bags, but it is not a good)



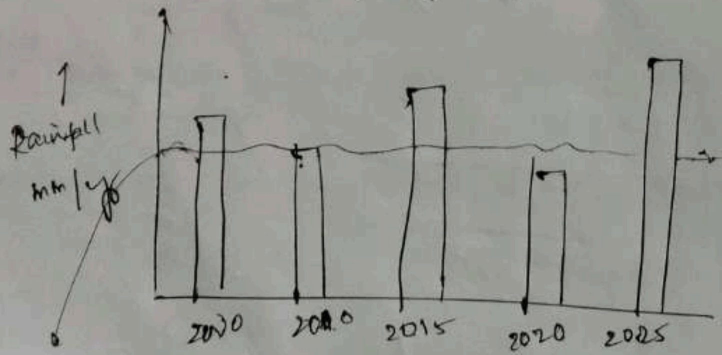
13/10/25 Waste Water

Surface Run-Off Management. ETP

If total plant area has sub-spaces



- Highly conc. pollutant from factr. will be going through Canal.
- ETP can't handle heavy flow of waters in case of rains, floods etc.
- Zero Discharge liq.
- Prevent mixing of drains with surface run off water under any circumstances.
- The effluent going through the drain sl.
- ~~Seggregate~~
- Collect 20yr rainfall data from IMD (Indian metrological Dept.) & find out the avg data (3 month) from the annual date.



$$\text{Avg Rain Fall} = \frac{\sum h_i}{\sum \text{year}}$$

- If area is known (excluding Green belt,)

$$Q = \text{Area} \times h \times \underbrace{\text{Co-efficient}}_{\text{need to be calcd}}$$ (Based on soil type).

If the water ...
water demand ...
water recycled ...
Surface Rain ...

- The water c...
but for TDS ...

Eg: Q = 4000 ...

- If the Su...
then the ...

(Soil) Type...
T1
T2

Depending ...
percolates ...

∴ If the water demand for industry,
water demand = $Q_D - Q_T - Q_S$
water recycled = Q_T.
Surface Rain off water = Q_c.

⇒ → The ~~Q_D~~ water can be stored & gravity settled, filtered but for TDS, COD etc, the water should be treated.

eg: $Q = 4000\ m^3/hr$. ETP = $200\ m^3/hr$
↓
$50\ m^3/hr$ (Sometimes plant won't work @ full scale).

→ If the surface run-off water is not toxic then the water can be used for ETP.

⇒ (Soil) Type. Area.

Type	Area
T_1	A_1
T_2	A_2
⋮	⋮

ΣA_i = Area.
→ calc, Q_s.

Depending on soil characteristics, how much water percolates is found out.

21/10/24

Surface Run-off Calculation

Rational Method: $Q = C \times i \times A$

Q = Peak Rate of Run off, m^3/Day

C = Run-off Co-efficient

i = Avg Intensity of Rain fall, mm/Day

A = Water Shed Area, Acres.

Total rainfall on yearly basis

Yr		Rainfall (mm)
April 2019 – Mar 2020		1969
Ap 2020 – Mar 2021		1920
Ap 2021 – Mar 2022		2287
22	23	1573
23	24	1122
Total		8894
Avg		1779.

eg: i = 1222 mm = 1.222 m

Heavy rainfall can happen 2-3 days / 7 days
↳ low l area (cyclone etc).

→ Find out in that area for how many days the rainfall will happen.

→ Naturally continous heavy rainfall can't happen

→ When raining, consider, for 3 hrs rain, the pollutants will be washed out., Now collect this water & check it.

→ After 3hrs, we will get clean water after surface run-out.

→ This water can be diverted to river.

Scenario - II.

→ For 2-3hrs.

empty space

Water is

Mitigation

① Pond sizing

→ the reaked

helps to det

↳ this ensures

overflow &

② The PPL

↳ poly pr

→ Segregation

Ensure tha

don't mix

physical

these drain

of storm

→ Effluent

→ Effluent -

m³/Day

fall, mm/Day

es.

fall (mm)

?89

120

287

3

2

94

79.

days | 7days

days the rain-fall

happen

hrs rain,

out.,

& it.

water, after

river.

Scenario - II.

→ For 2-3hrs, no water should go out, empty space is known, @ which rate the water is taken out.

Mitigation Measures

① Pond Sizing Based on Peak poly Discharge

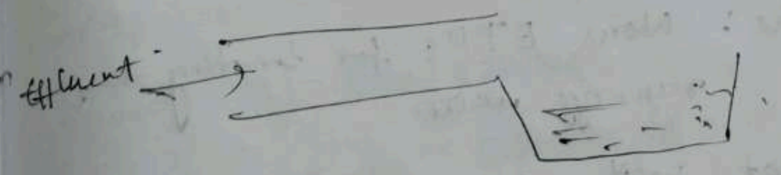
→ The recorded peak discharge during monsoon months helps to determine the reqd vol of ponds / reservoir.

↳ This ensures adequate storage capacity to prevent overflow & efficiently manage collected runoff.

2 The PPL need.
↳ poly propylene (continous layer)

* Segregation of ~~Effluent & Storm Water~~ Drain.

Ensure that effluent drains inside the plant don't mix with storm water drains. Implement physical barriers or blocks @ the junctions where these drains meet to prevent contamination of storm water with industrial effluents.



→ Effluent → 1 to 2 inch over surface run-off water.

→ Quality Assurance of Collected water :

Regularly monitor & ensure that the water collected from storm drains & the ponds is not contaminated & remains suitable for industrial processes. Implement measures to divert contaminated water

→ the rain water (2m) mixes with surface run-off water & gets contaminated.

→ So we do pH test.

pH > 9 → less conc.

pH < 2, 3, 4 → Highly ~~contami~~ conc.

→ Monitoring of Settling Ponds

There should be a contaminated well abt 1 - 2 km from plant to monitor measure contamination for over 20 m depth.

→ * (Write from Photo),

→ Not desirable : New ETPs for treating surface run-off water,

try to treat with current ETPs.

→ As per CPBS, all industries reqd to maintain ZLDs, for this Surface run-off parameter is Imp parameter.

1.) An old bag ...
is to be ...
at 120°C ...
has 20 ba...
Cleaning ...
45 min. f...
following

t = 6 = ...

when, t = tim...

Determine, ...
& overall ...
given con...

For overall ...
cleaning ...
No of bag...
Area of ...
→ Total su...
availa...

For max c...

C_f (t_f = t...

→ Given

=)

No co,

Bag Filter

1) An old bag filter from a discontinued process is to be utilized for a const press filtration at 120.7 cm of water column. The bag house has 20 bags. of 7432.24 cm^2 each. Cleaning time of bag house is determined as 45 min. for the given ~~vessel~~ pressure filtration, the following expressions can be used.

$$t = 674.82 \, V_G^2.$$

where, t = time, min, V_G = vol. of gas filter per unit area., m^3/cm^2.

Determine, the max. capacity of the bag house & overall capacity of bag house under the given conditions.

For overall capacity, time taken should be cleaning time + filtration time.

No of bags given = 20.

Area of each Bag = 7432.24 cm^2.

Total surface area of bags available = 20×7432.24

$= 148644.8 \, cm^2$

$= 148644.8 \cdot 10^{-6} m^2$

For max capacity = $\dfrac{V_G \times A}{t_f + \cancel{t_c} \to 0}$ $\dfrac{V_G \times A}{t} \to$ Max capacity

$(t_f = t_c) = 45$ min. m^3/cm^2

Given $t_f = 674.82 \, V_G^2$. $\dfrac{m^3}{cm^2}$.

$\Rightarrow$ 45 min = $674.82 \, V_G^2$

$V_G = 0.2582 \, \dfrac{m^3}{cm^2}$

Now, Max capacity = $\dfrac{0.2582 \, m^3/cm^2 \times 148644.8 \times cm^2}{45 \text{ min}}$

$= 853 \, \dfrac{m^3}{min}$. $= 14.21668 \, \dfrac{m^3}{hr}$

Overall Capacity. $\frac{V_{G1}}{t_f+t_c} \times A$. capacity = m^3/hr

eqn $\Delta P = 12.7$ cm. of water coloumn. $\underline{t_f = t_c}$

$\cancel{t_f = \left(\frac{1}{2\,\Delta P} - \frac{1}{A^2}\right) V_G^2}$

$\Rightarrow = \frac{V_{G1}}{t_f + t_c} \times A$

$= \frac{0.2582}{90} \times 148644.8\ cm^2$

$= 426.4454\ \frac{m^3}{min} = 7.1074\ m^3/hr$

Q) A bag filter is operating @ const rate ~~an~~ at optimum cycle. the filtration eqn. is given as

$V_G^2 = 2.623 \times 10^6 \times t \times P^{0.65}$

P = cm of H_2O.

V_G = m^3 of gas filtered.

t = time of filtration, min.

The filtration time is 45 min & cleaning time is 8 min. The max allowable press is 10.16 cm of water column. Calc.

a) Max overall capacity of bag house

b) It is necessary to ↑ the capacity of bag house, it has been suggested that an additional unit, identical to the present One be installed.

Both bag filters would work from the same ID fan which have ample capacity & the filtration to be carried out ~~through~~ to same max. pressure as at ~~pressure~~. present

The time reqd to ~~shakes~~ clean 2 bag houses is estimated at 4 min.

What is the % Increase in the overall capacity that could be attained by

adopting this

a) Max. Capacity

eqn $t_f = 45$ min

given, $V_{G1}^2 = 2.$

$= 2.6$

$V_G = 23$

a) ⇒ Max capacit

Overall capacit

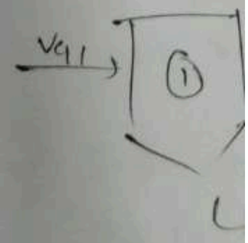
b) Now, t_c

Overall

For 2 bag

Q ov

⇒ Now,



m^3/hr

given as

time

10.16 cm

bag

an

present

same

through

same

present

2 bag

overall

adopting this suggestion, $\frac{Q_2 - Q_1}{Q_1}$.

a) Max. capacity $= \frac{V_G}{t_f}$.

given $t_f = 45$ min, $t_c = 8$ min; $\Delta P = 10.16$ cm

~~given~~, $V_G^2 = 2.623 \times 10^6 \times t_f \times P^{0.65}$

$= 2.623 \times 10^6 \times 45 \times (10.16)^{0.65}$

$V_G = 23{,}080.534\ m^3$.

a) → Max capacity $= \frac{23080.534}{45+0} = 512.9\ m^3$ of gas filtered/min.

$= 30,774\ \frac{m^3}{hr} = \cancel{8.548}\ \frac{m^3}{hr}$.

Overall capacity $= \frac{23080.534\ m^3}{45+8} = 435.4617\ m^3/min$

$= \cancel{7.258}\ m^3/hr$.

$= 26{,}128.902$

b) Now, $t_c = 4$ min.

$Q_{overall} = \frac{23080.534\ m^3}{45+4} = \cancel{471.0313}\ \frac{m^3}{min}$

$= \cancel{7.8505}\ 28261.8783\ \frac{m^3}{\cancel{hr}}$.

For 2 ~~bags~~:

$Q_{overall} = 2 \times \cancel{7.8505}\ 28261.87\ (2 \times V_G)$.

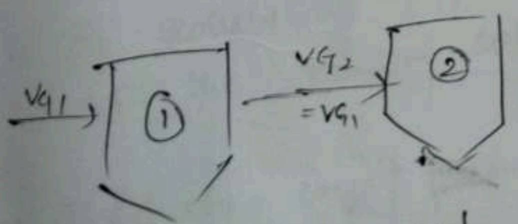
$= \cancel{15.7010}\ m^3/\cancel{hr}$

56523.756.

→ Now, % ↑ in Overall Capacity $= \frac{\cancel{15.7010 - 7.258}\ 56523.756 - 26128.902}{\cancel{7.258}\ 26128.902}$

$= 1.1632 \Rightarrow \underline{100\%}$

identical capacity.



total vol of gas $= 2 \times V_G$.

A bag house is to be constructed, using bags of 30 cm in diameter & 6m long, ~~the bag~~ the gas enters the bag house at 36,000 m^3/hr & the filter in velocity has been determined as 2m/min. Calc. No of bags reqd for a continous operation of bag house.

Filtration velocity : the velocity of gas passing through the filter media

$\Rightarrow$ ~~v_f = 36,000 m^3/hr~~

$v_f = 2 m/min$

$\Rightarrow Q = 36000\ m^3/hr$

$\rightarrow A = \frac{Q}{v_f} = \frac{36000\ m^3/hr}{\frac{2m}{min} \times \frac{60\ min}{hr}} = 300\ m^2$

$\rightarrow$ Area of each bag = $\pi D L$

$= \pi \times 30 \times 10^{-2}\ m \times 6m$

$=$ ~~0.5654~~ 5.6548

$\Rightarrow$ No of bags reqd $= \frac{300 m^2}{5.6548} = 53.05$

≈ 54 bags

24/10/25 Wet Scrubbers

Control of partic

$\rightarrow$ Use only for bo particulates bec

$\rightarrow$ only particulate matter

Method to Con

1.) Adsorbe.

2.) Absorption. (we

3.) Condensation

4.) Combustion

Sp. S.A of adsorbed $= \frac{m^2}{g\ of\ ads}$

$\therefore$ Parameter w

1.) Solvent s

2.) Length of

$\rightarrow SO_2 + H_2O$

Solv

$\rightarrow$ If solubili use the

$\rightarrow$ Distribution by

If you a

CO_2 is

$\rightarrow$ Here pf

21/10/25 Wet Scrubbers

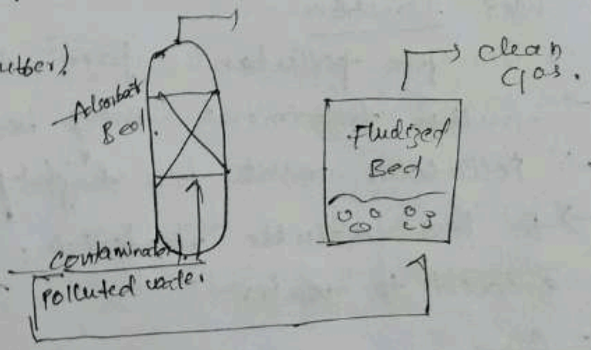
Control of particulate & Gaseous pollutants)

→ Use only for both pollutants (not only for particulates becoz of low efficiency).

→ only particulate matter → Gravity settler, ESP, Bag house, cyclones.

Method to Control gaseous pollutants

1) Adsorber.
2) Absorption. (wet-scrubber)
3) Condensation
4.) combustion.



Sp. S.A of adsorbed $= \frac{m^2}{g \text{ of adsorbent}}$

∴ Parameter in design

1) Solvent selection
2.) Length of bed. (depending on fluidized bed) (l)

→ $SO_2 + H_2O$ → Compound. (s) Solid phase.
(H_2O ↓ Solvent.)

→ If solubility of gas is very low then, we can't use the normal solvent.

→ Distribution coeff / partial coeff, can be changed by

If you add some quantity of alkaline material CO_2 is removed.

→ Here pH plays a very imp role.

→ From gas ⟶ liq, the vol is very huge for gas phase, the vol ↓s.

→ If solid is formed, it can be precipitated out. so we can do normal land filling.

Condensation (-50 to -100 °C).

→ Chilling plant is reqd. in industries.

Combustion

→ Volatile comps / co. present in product, they are combusted in boiler.

Wet Scrubbers

→ Transfer pollutants from air to water

→ further treatment may be necessary

→ Pollutants must be highly soluble in water

→ For less soluble materials, a chemical (alkaline / acid) may be added to water

- ~~SO3~~

* Pollutants → SO_x, NO_x, VOCs, HAPs, CO

→ these are treated by

VOC methods.

→ Thermal incineration

→ Catalytic "

-

-

-

Adv /

→ Handle flammable & explosive dust

- Gas absorption & dust collection

- Handle mists

- Cooling of hot gases

→

Disadv.

→ High corro

→ Liq waste

Wet Coll

→ Spray –

→ Packed

→ Bubble

→ Ventur

→ Cycloni

→ Miscel

1.) It is

iron- or

The ga

the rat

velocit

Determi

such

20 cm

will

gas

Given,

=1

→ Area

Disadv

→ High corrosion potential } → needs 2° treatment
→ Liq waste stream → } methods.

Wet Collectors

→ Spray towers
→ Packed bed
→ Bubble / plate tower
→ Venturi Scrubber
→ Cyclonic "
→ Miscellaneous ".

MoT operations by trybal.

Bag Filters

1.) It is reqd to remove the dusts from an iron ore grinding cum separation mill. The gases flows from the mill @ 45°C @ the rate 13680 m³/h. The gas filtering velocity is 1.5 m/min. Determine the ~~growth~~ cloth area reqd to process such gas, if the dia of the bags are 20 cm & length ~~[illegible]~~ 5 m, How many bags will be reqd for continous cleaning of the gas from this mill.

Given, $T = 45°C$; $Q = 13680\ m^3/h$. $V_f = 1.5\ m/min$

$D = 20cm$; $L = 5m$
$= 0.2\ m$

$\Rightarrow A = \frac{Q}{V_f} = \frac{13680\ m^3/hr}{1.5 \frac{m}{min} \times 60 \frac{min}{hr}} = 152\ m^2$

→ Area of each bag = $\pi D L + \frac{\pi r^2}{4}$

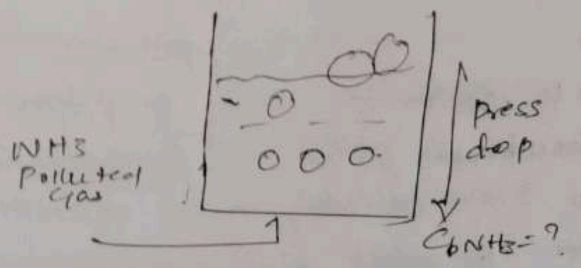
$= \pi \times 0.2m \times 5m +$ 3.1230

$= 3.14159$ 3.2044

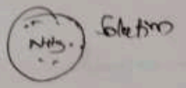
No of bags = $\frac{352}{3.1415}$ = 110.a 112

Wet collectors

28/10/25 Removal = $K_{overall}$ $(C_b - C_i)$



* larger bubbles on top of the surface.



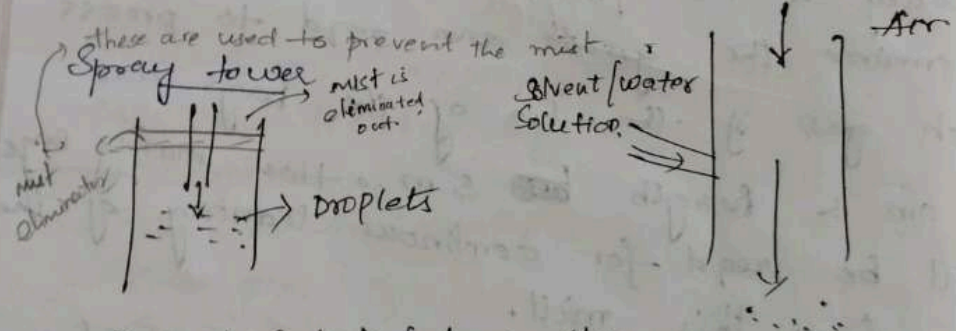
Removal = $k_L a (\Delta C)$

Removal = $K_{overall}$ $(C_b - C_i)$

[Interfacial Area] → a → $\frac{m^2}{m^3}$

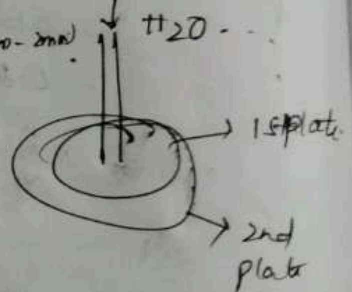
α → depends on packing material based on that a' will ↑.

→ 'a' is very high sometime, becoz. polluted air transfer from bulk phase of gas to the liq phase.



→ Due to inertial force, the ..

→ If the plate distance is less (1mm-2mm) & the top plate is stationary, & bottom plate is rotating @ very high speed 3000 rpm, we get same type of fine droplets.



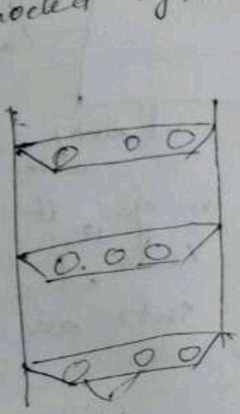
→ 1st plate → CW

2nd plate → ACW.

→ Fine particle matters, choke the mist eliminator

Drawback → Accumulation of the mist.

↳ Choked after 3 months.



nozzles

→ Silicon Carbon material used for nozzles.

→ Stainless steel material have from disadvantages.

→ Atomizers are provided on the top of ato. nozzle.

→ Corrosion inside the nozzles creates the ↓ in η.

→ At top of scrubber there is mist eliminator to remove the mist.

→ High speed liq is contained in the nozzle it will corrode if it's made up of steel.

→ Multi-nozzle atomizer should be placed @ the top of the tower

→ Spray tower is most used in industries

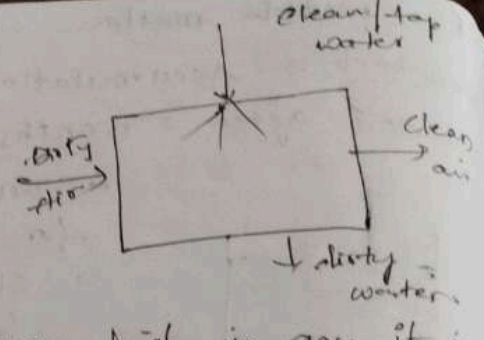
↳ η is very low but press drop is very low i.e. why it is used.

→ Cyclonic Scrubbers : Mostly used,

→ Gas will be entering with high speed + tangentially with water

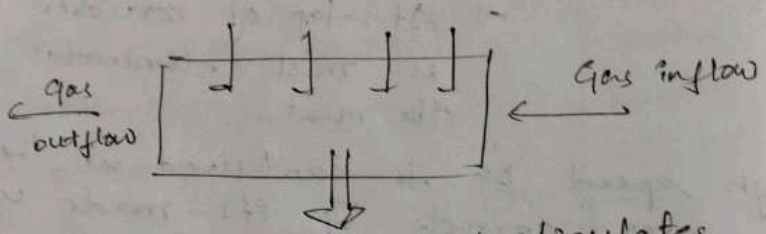
→ Packed Bed Scrubbers : Used to remove other gases, other than polluted gases.

Air Scrubber



→ used where
- ↳ air is wet
- ↳ corrosive
- ↳ hot
- ↳ bag houses can't be used
- ↳ In combo with cyclone.

→ If particle conc is very high in gas, it is advised to send it initially into 1° particulate control devices, then should be sent into air scrubber.

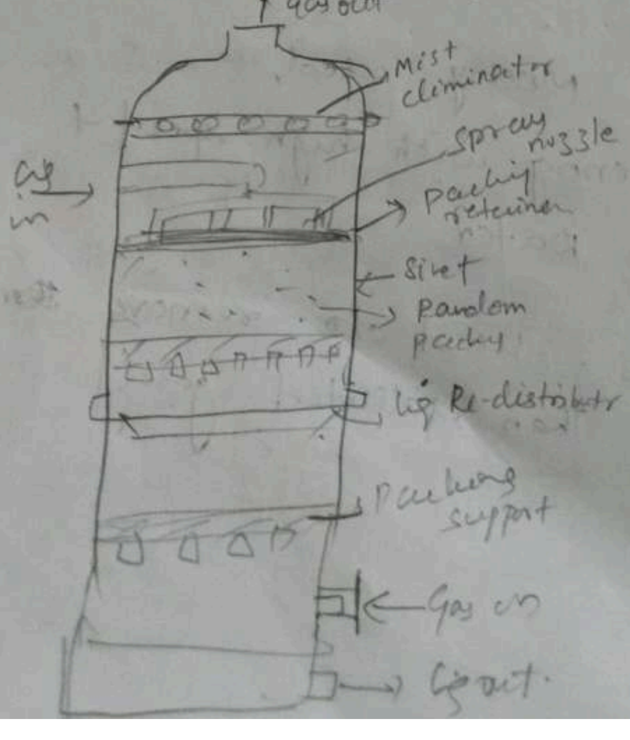


Waste water & particulates.

→ to make very fine droplets, very high flow rate of gas is sent, which needs very high energy for atomization.

Eg: SO_2 & water → sulfurous acid + lime → Calcium sulfite → fertilizer.

Packed tower for Gas Absorption



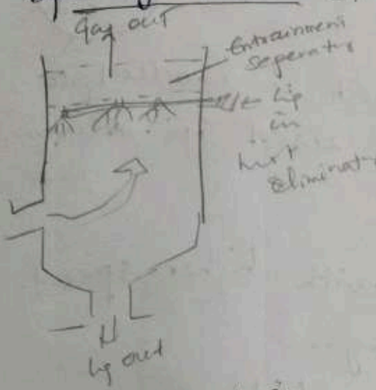
↳ Scrubbing of gas
↳ For designing
- → solubility of gas
- → Temp of gas
- → Inlet conc & outlet conc of gas.
- → Quantity of gas entering packed bed.
- → Consider ambient std condition.

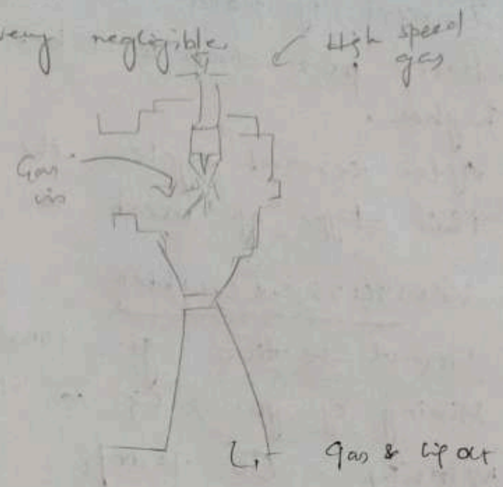
(2) → HETP, height of PC, dia of PC, HTU, NTU

2) Design the packed tower

Spray Tower

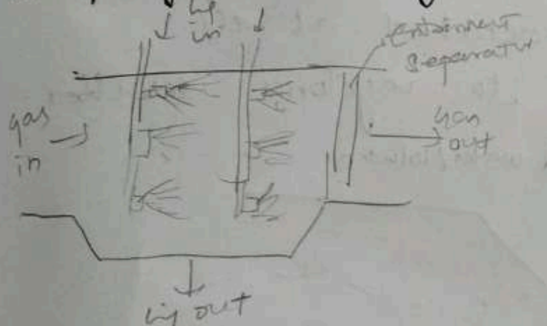
ΔP is very negligible ← High speed gas





Countercurrent spray

- Stage wise atomizers are provided in ejector venturi.
- Spray tower designing, depends on droplet size distribution.



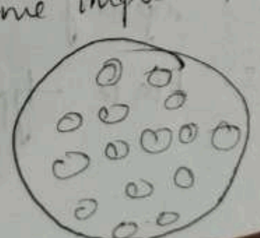
→ No

Cocurrent spray

- If capacity of scrubber is known, velocity should be calc/ decided. ~~flow~~ & L/G should be
- If large vol of water is coming, large droplets are formed. & ~~H₂O~~, the dia of column is designed.

Plate Tower

- Air jet impinges upon tab above each plate hole removal predominately by impaction
- More no of plate more enhancement.
- More no of plate, it will have some impact on the
- When gas comes, it will moves down. & the plate. & velocity will be reduced & the velocity will be ↓ed & residence time will be MT ↑s.



→ Instead of plates we can use mesh screen
→ Here, press drop will be higher. Dia - 75 μm ← 200 mesh screen

→ After several cycles, the mesh is chocked so this type of mesh is not used in industries.

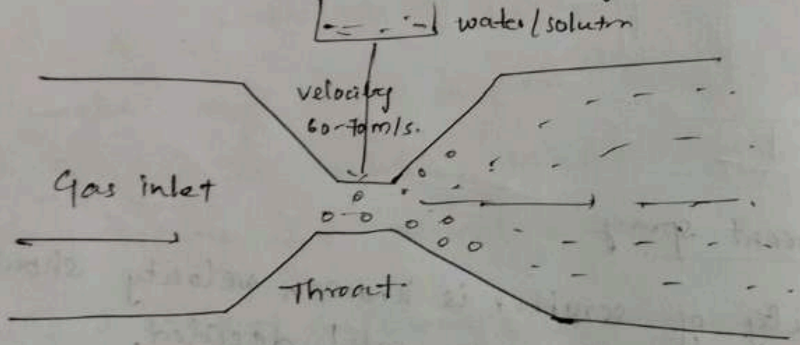
Venturi Scrubber

→ Throat section gas comes with higher speed.
→ Mixing of gas & liq @ through velocity - 60 - 70 m/s (very high)

→ Dust particulate matter come down & settle in tank

→ No maintenence cost associated at all

* It can be connected to cyclonic scrubber.



→ Rotate 90°, it will be vertical & can be fitted in the cylindrical column.

→ Separation of entrained liq is imp for all wet collectors.

→ Types of Scrubber
① Packed Tower
② Spray Tower
③ Plate type Scrubber

② Design features
① Working principle
③ Develope a design problem for yourself

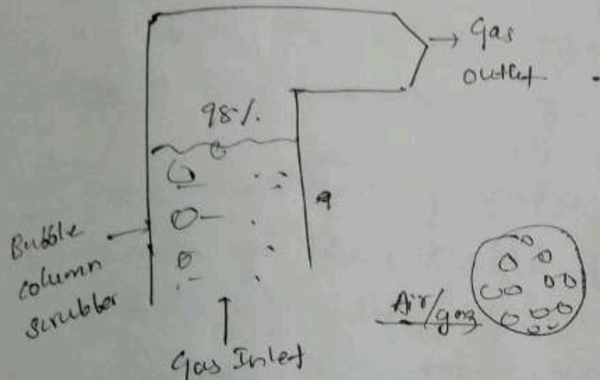
→ Any one of these 3.

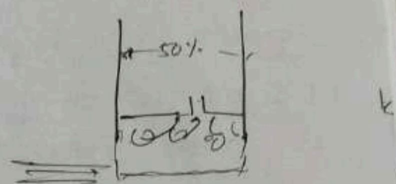
→ Conc of gas.

- How much gas generated by every 1 of 3 tower
- Conc of gas. (ambient std)
- Selection of solvent. Perry's handbook ← Data.
- (12th Nov - Submission)

Bubble Column Separator

- To ↑ η of scrubber we need to ↑ S.A of bubbles.
  ↓
- Breaking of bubble can be done.

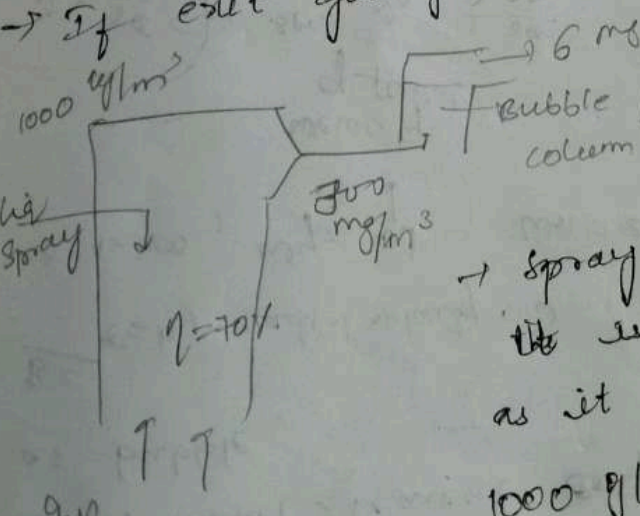




→ 

(60 → @ periphery of bubble)

- In this breaking of bubble process, particulate matter is trapped inside bubbles.
- The further breaking of those bubbles occur & the PM is removed.
- If exit gas of scrubber is passed through.



- Spray tower with 70% η, then is sent to bubble column as it has low vol. requirement.
  1000 g/Nm³ enters spray tower
  6mg/Nm³ goes out from bubble column.

$$\eta_{removal} = \frac{1000-6}{1000} \times 100$$

Q.) A sulphuric acid manufacturing plant emitting SO_2. Exhaust stream of plant contains mainly SO_2 ~~amt~~ (15 % by vol & carrier gas mainly air having emission rate abt 800 kg/m² hr. This is to be scrubbed with ~~a~~ water as a solvent in an absorber to reduce conc of the out going stream to 0.5 % by vol. The equilibrium r/p b/w SO_2 - water syst governed by eqn ~~x~~ = 21.8 y where, x, y are in mole frac (vol%.)

Calc.

a) The minimum amt of water reqd for absorption

b) Conc of SO_2 in out going water to ETP plant if the actual water used is 1.2 times the min water reqd.

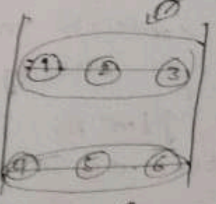
c) Calc the difficulty of this sep. in terms of NTU (No of transfer units) of column

d) Calc the height reqd for the tower if HTU (height transfer unit) for the column is 0.6m.

→ Select solvent, find out dimensions (dia, nozzle dimension

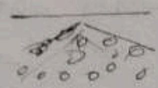
8/11/25

nozzle's inside the scrubber.

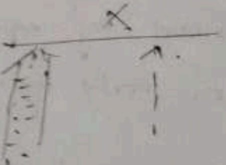


Dr.SO4

- when nozzle is large, huge amt of spray will come out.



gas



- If chocked, we get flow drops of water, there will be no spray.
- Time to time we need to change the nozzle.

Just like pipe flow

- If P drop is huge → Mist eliminator is not working
  - So, we can by-pass the gas & pass water through chimney.

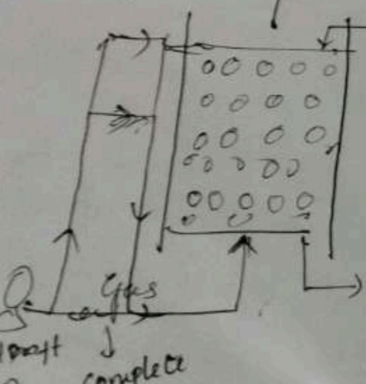
→ Mist eliminator.

- If S content is high, (80μg/m³ → SO_2 permissible limit)

Scrubber Nozzles

- Throat position → for longer use, it will be eroded / instead of small droplets; large droplets form.
  ~~mass~~ S.A 'a' is ↓ so M.T ~~area~~ is ↓.

→ Bubble Column



Clean gas

Solute m / Absorbing liq / water

Slurry / waste water

Gas

Forced Draft fan

complete P/L

@ beginning, entire P/L is pool of water, F.D fan need energy to over come the water to pass gas, it'll take huge press ⇒ high P is developed & gas is flowing @ same time, in distributor, at that

pt. there will
happens & a
need to ↓,

Q.) In bubble
get a hug
of equip
- This shou
- At beginn
go with ve
pump of a
will com

@ full c
→ At shut
compresso
- this need
period of

- 2-3 m/s
gas
- Tower
- If veloci
time
gas &
is
- the
is a
- Make Ant
Sparger
- Height ⇒

pt. there will be huge gas going in & rupture happens & accidents may happen in plants. So we need to ↓ press.

Q.) In bubble column, the continuous phase will get a huge thrust of air during starting of equip & all the water will be thrown out. This should be controlled, what will you do.

- At begining, switch ON FD fan, the gas will go with very low flow rate, then switch ON the pump of absorbing liq slowly. The gas & liq will come to contact, & then run the plant @ full capacity. There is a hydrostatic press

→ At shut down, to prevent the chocking, a compressor is used.

→ this need to be done in starting & shut down period of the plant.

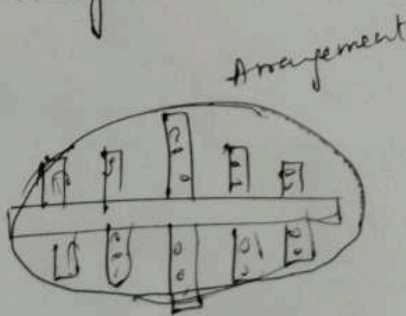
→ 2-3 m/s ⇒ velocity of nozzle

→ Tower gas velocity < Distributor velocity.

→ If velocity of nozzle is ↑ed (30 m/s), the residence time will be ↓ed & the interaction b/w gas & liq is ↓ed so the η of scrubber is ↓ed.

→ The arrangement is such a way that, there is a uniform distribution.

Arrangement



→ Make Antena type of Sparger

→ Height ⇒ More residence time

more ?.

• If more P drop → more load on FD fan.

↑ed

→ Flooding velocity & · Operating velocity
↳ 60 - 70% $V_{flooding}$

· we can calc. equilibrium

Q. A bag house is operated at const gas rate of 30 m³/min, during which 40.8 m³ of gas from a cement kiln operation is processed. The initial & final press drop of unit is 10.16 mm of water column & 101.6 mm of water column resp. If the filter is further operated for 1hr, at the final press, calc. the quantity of additional gas which can be treated by this unit arrangement & conditions.

Q = —— LP & Q

9/11/25

In Designing ... to be in

① A fertilizer ... at 100°C & ... with inlet ... a packed ... industry ... The liq ...

y_{N+1} 3 | ...
x_{N+1} 3 | ...

8/11/25.

In Designing a column, the temp of gas & liq need to be in equilibrium. (same temp)

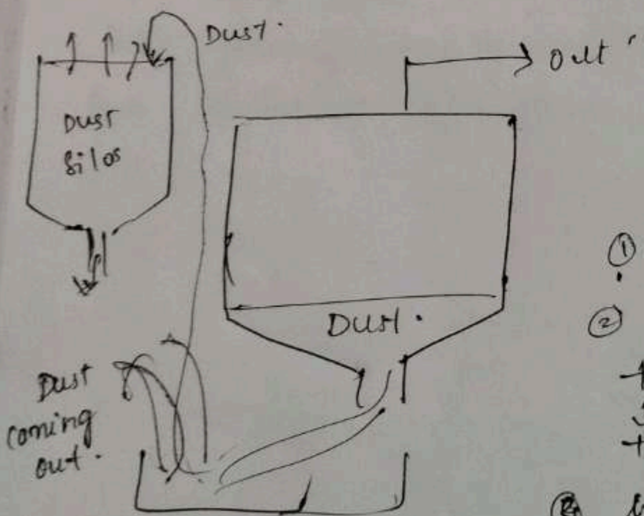
① A fertilizer plant emits. $Q = 2,00,000\ m^3/h$ of gases at $100°C$ & 0.06 atm (gauge press). Containing NH_3 with inlet conc, $700\ kg/m^3$, it is proposed to use a packed tower with water as absorbing. The industry need to bring the NH_3 conc, below, $10\ \mu g/m^3$

The liq equilibrium

y_{NH_3}	0	0.016	0.024
x_{NH_3}	0	0.020	0.031

HTU, NTU,
Height of tower,
dia of column.

2) A bag filter is used to treat 50 m^3/s of the waste gas stream, the bag house to be divided into 8 sections of equal cloth area, so that 1 section can be taken off for shutdown, for cleaning & maintenance & other remaining in working condition. The air to cloth area ratio 9 $m^3/min/m^2$, which provide sufficient surface area for the cleaning of the flue gas. The bags are 25 cm dia & 7 m long. Calc. the no of bags & physical arragment reqd to meet the above purpose.



1	2	3	~~4~~
5	6	7	8

① Dust will come out

② When loading of bag filters, there are large dust silo's, there will be escape of dust.

③ When trucks are loading there will be dust emission.

3) A ~~cold~~ bag filter from a discontinued process is to be utilized for const press filtration @ 120 mm of water, the filter has 40 bags of 6,000 cm^2 each the filtration time is given as 50 min & ~~prefer~~ the filtration eqn, $t_f = 674.85\, V_g^2$

where $V_g \to$ vol of gas filter,

$t \to$ time in min

1.) Calc, overall ~~capacity~~ capacity of the bag filter under given conditions.

2.) Max overall capacity.

3.) If another 3 ~~addit~~ additional identical old bag ~~houses~~ filters are installed to ↑ the capacity, what is the max % increased, in the overall capacity for new arrangment

new arrangment

Assume total cleaning time with new arrangement is 20 min.

1+3 = 4

x m^3/hr +

Total

old capacity = x m^3/hr

New, '' = (3+1) = 4 x m^3/hr