Numerical on bag filter

Q- A bag house is to be constructed using bags of 0.25 m diameter and 6 m long. It is to receive 15 m^3/s of air. Assuming the filtration rate of 2.2 m/min. Determine the no bags required in the bag house.

Ans:-Total filtration area required= gas flow rate /filtration rate= 15x60 $m^3/min/2.2\ m/min$= 409.1 m2

Area of one bag = pi*D*H= 3.14*0.25*6 =4.71 m^2

No of bags required in bag house= 409.1/4.71 =86.8 that is 87 bags

Numerical on ESP

Efficiency of ESP (η) = $1 - \exp(-Aw/Q)$

η = 0 to 1

A = Collector plate area in m^2

w = particulate velocity

Q = Gas flow in m^3/sec

Compute the plate area of ESP handling a flow of 3600 m^3/min. If the particulate velocity is taken as 0.15 m/s, and efficiency of ESP as 99 %

$$(\eta) = 1 - \exp(-Aw/Q)$$

$$0.99 = 1 - \exp(0.15*A/3600/60)$$

A = Area of plate =1842.1 m^2

Numerical Solid waste Management

- Compute the landfill area requirement for 20 years of a city with population of 10 lakh. (*Given: MSW generation = 500 gm per capita per day; MSW density = 500 kg/m3).*
- Solution: total time = 20 year= 20x365 day

Total population = 10 lakh

MSW generation = 500 gm per capita per day;= 0.5 kg

Thus total mass of MSW generation in year by 10 lakh peoples = 0.5kg/daypx10,00000px20x365day=3650000000kg = 36.5×10^{8}kg

Given MSW Density = Mass/volume = 500kg/m^3 (1)

Putting earlier calculated mass in equation 1

$$36.5\ \times10^{8}\ \text{kg/volume} = 500\text{kg/m}^3$$

$$\text{Volume of landfill required} = 36.5\ \times10^{8}\ \text{kg}/500\text{kgm}^{-3} = 73{,}00000\ \text{m}^3$$

Assume height of land fill is 10 m

Thus area of land fill = total volume of land fill/ height= 73,00000 m^3/ 10m = 73,0000 m^2

Since in a land fill total land requirement = land required to dump solid waste+ same amount of land required to construct road for vehicle movement

Thus total land requirement = 73,0000x2 = 1,460,000 m^2

Problems

1. The sound power generated from a moving tractor is 0.001 watt. What is the Sound Power Level?

Ans-

As we know, $Lw=10\log_{10}(w/w_0)$

$=10\log(0.001/10^{-12})$

$=90$ dB

2. If a sound source has a pressure of 2000μp at 10m distance. Configure the sound pressure level in dB?

- Sound Intensity in watt/m².
- Sound Power in watt. (w?/Lw)

Ans-

As we know, $Lp(dB)=10\log_{10}(P/P_r)^2$

$=10\log(2000/20)^2$

$=40dB$

ii. As we know, $I=P^2/\ell e$

$=(2000\text{x}10^{-6})^2/(1.185\text{x}340m/s)$

$=9.9\text{x}10^{-9}$ watt/m².

iii. Given, r=10m

Here measured sound power is not given.

So, I= $W/4\pi r^2$

$I = w/4\pi r^2$

$\Rightarrow$ $9.9 \times 10^{-9} = W/4 \times 3.14 \times 100$
$\Rightarrow$ $W = 1.24 \times 10^{-5}$ watt
So, $L_w = 10\log_{10}(w/w_0)$
=>$L_w = 10\log((1.24 \times 10^{-5})/10^{-12})$
=>Lw=71 DB

3. Determine the sound power level by combining 5 sound levels i.e., 61 dB, 54 dB, 73 dB, 67 dB and 45dB?

Ans. $Lw_a = 10\log_{10}(Wa/W_0)$
=>$Wa = Wo \times 10^{Lwa/10}$
=>$Wa = Wo \times 10^{61/10}$

Here, Lw_a=61dB, Lw_b=54dB, Lw_c=73dB, Lw_d=67dB and Lw_d=45dB

So, $Wb = Wo \times 10^{54/10}$ $Wc = Wo \times 10^{73/10}$ $Wd = Wo \times 10^{67/10}$ $We = Wo \times 10^{\frac{45}{10}}$
W=Wa+Wb+Wc+Wd+We
$= Wo(10^{6.1}+10^{5.4}+10^{7.3}+10^{6.7}+10^{4.5})$
Resultant Sound Power $Lw = 10[\log Wo(10^{6.1}+10^{5.4}+10^{7.3}+10^{6.7}+10^{4.5})/Wo]$
=>Lw=74.23dB

Equivalent Continues Noise Level

'Equivalent continues noise level(L_{Aeq})' of that steady sound which over the same interval of time contains the same total energy as the fluctuating sound.

$$LAeq=10\log_{10}(\frac{1}{T}\sum_{i=1}^{n}10^{0.1li}\times t_i)$$

Where, T=total time of Operation.
Li=Noise Level of the ith Sample.
ti=fraction of total time.
n=number of sample.

Problem

1.If an Industrial fan generates a noise level of 65 dB(A) for 10 minutes out of every hour. Compute the LAeq, if the background level is 55dB(A)?

Ans−$LAeq=10\log_{10}(\frac{1}{T}\sum_{i=1}^{n} 10^{0.1li} \times t_i)$

Here, T=60,L1=65 dB(A) and L2=55dB(A) t1=10, t2=50

So, $LAeq=10log\ [\frac{1}{60}(10^{0.1\times 65} \times 10) + (10^{0.1\times 55} \times 50)$

= 59dB(A)

Calculate the population equivalent of a city, given average sewage 75×10^5 lit/day and average BOD_5 as 300 mg/L. Assume BOD loading 50 gm/capita/day.

Population equivalent = total BOD of wastewater/ BOD value per capita perday

Total BOD = 75×10^5 lit/day x 300mg/L = 22500×10^5 mg/day = 2250kg/day
(Since 10^6 mg = 1kg)

Given BOD loading = 50 gm/capita/day= 0.05 kg/capita/day

Thus Population equivalent PE = 2250kg/day/ 0.05kg/capita/day = 45000 person

Example 7.3 Determine the daily requirement of water treatment chemicals in kg for a water treatme plant (WTP) handling a flow of $500\ m^3/hour$. Dosage requirement from jar test for 1 litre as :

5 ml of 10 gm/L alum solution

2.2 ml of 5 gm/L lime solution

1 ml of 1 gm/L polyelectrolyte solution

2 ml of 5 gm/L chlorine solution

Solution. Alum solution strength 10 gm/L
5 ml contains 50 mg

$\therefore$ Alum dosage is 50 mg/L. Similarly lime dosage is $2.2 \times 5 = 11\ mg/L$

Polyelectrolyte dosage $1 \times 1 = 1\ mg/L$. Chlorine dosage $2 \times 5 = 10\ mg/L$

$\therefore$ Daily requirement of alum.

$$\frac{500 \times 1000 \times 24 \times 50}{10^6} = 600\ kg$$

Daily lime requirement

$$\frac{500 \times 1000 \times 24 \times 11}{10^6} = 132\ kg$$

Polyelectrolyte daily requirement

$$\frac{500 \times 1000 \times 24 \times 1}{10^6} = 12\ kg$$

Daily chlorine requirement

$$\frac{500 \times 1000 \times 24 \times 10}{10^6} = 120\ kg$$

To prevent the formation of dichloramine, ammonia should be dosed in the ratio. $Cl_2 : NH_3 \simeq 4:1$

$\therefore$ Ammonia requirement $120 \times 0.25 = 30\ kg/day$