Design of Bag Filter for the Control of Dust Emissions for a Cement Plant

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Abstract: **Air pollution from industries generates dust emissions in the form of particulate matter either by way of fugitive or channelized or steady state particularly from cement industries through different stacks or dumping yards and loading or unloading areas. The major and significant particulate emissions are from stacks attached to kiln. These emissions are being controlled by installing either Electrostatic Precipitators but such a devise is very sensitive in terms of power breakdown, voltage fluctuations, improper ratio of fuel to raw material in the kiln feed etc. resulting in high emissions. In the state of Rajasthan where predominantly cement industries are in existence, the bag houses have been installed successfully to replace Electrostatic Precipitators to overcome the said bottlenecks. The author has designed the Bag Filter for a 100 tonne per day Vertical Shaft Kiln technology based cement plant in Rajasthan on the basis of actual field data monitored which is of great significance.**

The monitoring emissions were carried out during different operating conditions and periods and average and designed parameters are reflected as under :

- Volume of gas =2500Nm3/hr=6.94 m/s
- Temperature (max) = 100 C
- SPM concentration (max) = 2000 mg/Nm3
- Density of particle = 1500 kg/m3

Following are assumed for the purposes of design

- **Length of bag filter = 3 meter**
- **Dia of bag filter = 0.15 meter**
- **Velocity of gas in Bag =0.1 m/s**
- **C= Cunningham Correction Factor**
- **D=particle size of 1 micron to be removed**
- **c= Packing Density**
  $= \frac{\prod d^2 x\ Lf}{4}$
  =0.053
- **V= Ө/Af (1-c)**
  = 6.94/ 0.1 x (1-0.053)
  = 73.28 m2
- **Area of single bag = ∏d x Lf**
  3.14 x 0.15 x 3
  = 1.41 m2
- **No. of bag required = 73.28/1.41**
  =51.97
- **Say provide 7 x 8 = 56**
- **Ku = Kuwabara constant**
  $= C - \frac{3}{4}\ C^2/4 - \frac{1}{2}\ln c$
- **η = Efficiency of bag filter**
  $= 0.6396\ (1\text{-}c/\ kuD^2\ V\square^{1/3}\ x\ (KTC/d\mu)^{2/3}$

Where,

- **c= Packing Density = 0.053**
- **Ku = Kuwabara Constant = 0.77**

- **D= diameter of bag =0.15 m**
- **V= Velocity inside bag = 0.1 m/s**
- **d=Particle size =1 micron**
- **μ = Viscosity of gas = 1.5 X 10^{-4}**
- **K= Boltzmanns constant = 1.02 X 10^{-15}**
- **C = Cunningham Correction Factor =1.42**
- **T = Temparature of gases in Kelvin**

Therefore

- **η = 99.8 % = Efficiency of bag filter**
- **Inlet concentration = 2000 mg/Nm^3**
- **After bag filter = 2000 x 0.002**

  = 4 mg/Nm^3

Which is much below the standards of 250 mg/Nm^3 or even stringent standard of 150 mg/Nm^3 of spm?

- **Pressure drop**
- **ΔP = pressure drop in N/m^3**
- **= (K1 + K2 Cma) V**
- **= (K1 + K2 Cma) ϴ/Af**

Where

- **Cma= mass area concentration in kg/m2**
- **K1= constatn in N/ m^3 = 20000**
- **K2 = Constant s^{-1} = 3000**
- **ϴ =Volume of gases in m^3/s**

And

- **Cma= $\frac{QCmvx\ t}{Af}$**
- **t= time interval of cleaning of bags in second**

Where Cmv = Concentration in Kg/m^3

Here, assume interval of cleaning of bags = 3 hours

- **At the biggning of start , t = 0**
- **Hence Cma = 0**
- **Thus ΔP = $\frac{K1 \times Q}{Af}$**

$$= \frac{20000 \times 6.94}{56 \times 1.41}$$

= 1757 N/m^2

- **t= time interval of cleaning of bags in second**

Where Cmv = Concentration in Kg/m^3

Conclusions:

The design of Bag Filter in the present paper would demonstrate efficiency to the extent of 99.8 percent and as such would be able to meet the prescribed emission standards under all operating conditions of the kiln and can employed in cement industries with cost effectiveness

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