Part-B answer

4. In the conical region of silo, inclined solids wall offers significant wall stress/resistance stress on the particles during the flow of particles. It dominates very high as the cross sectional area converges. This resistance stress causes the consolidation of particles. Hence, depends upon the outlet diameter, arch may be formed in the conical region of the silo. These effects are not at all observed in the cylindrical region of the silo.

5. $\sigma^1\ (2\pi r)dl\ sin\theta = \ \rho_b\ (\pi r^2)dz\ g$

6. Sudden raise in the energy (pressure) losses at minimum fluidization velocity is to overcome the static friction between particles.

7. Draw Geldart chart. Fluidization – Type A and B. dense phase pneumatic transport – Type A and D.

8. If abrasive particles are stored in silo, funnel flow is recommended to avoid the erosion of silo walls.

Please turn to next page for the solutions of Q 9 and Q10.

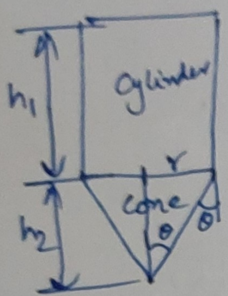
(9)

mass = 1000 tons

density = 3 g/cc = 3000 kg/m³

Volume of powder to be stored $= \frac{10^5}{3000} = \frac{1}{3} \times 10^2$

$= 33.33\ m^3$



Volume of silo $= 33.33\ m^3$

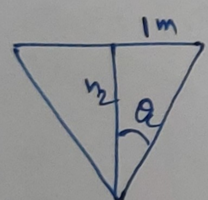
$V_{cylinder} + V_{cone} = 33.33\ m^3$

$\pi r^2 h_1 + \frac{1}{3}\pi r^2 h_2 = 33.33$

dia = 2 m

r = 1 m

$\pi h_1 + \frac{1}{3}\pi h_2 = 33.33$ — (1)



$\theta_c \rightarrow$ cone angle

$\varphi_x = 12^0$

Jenike tester

$\tan \varphi_e = \frac{\text{shear stress}}{\text{normal stress}}$

$= \frac{6.92}{4}$

$\varphi_e = 60^0$

for mass

$\theta_c = 33^0 - 3^0$

$= 30^0$

$\tan \theta_c = r/h_2$

$h_2 = \frac{1}{\tan 30} = \sqrt{3}\ m$

from Eq (1) $\pi h_1 + \frac{1}{3}\pi \times \sqrt{3} = 33.33$

$\Rightarrow h_1 = 10.03\ m$

Silo Height $= h_1 + h_2$

$= 10.03 + \sqrt{3} = 11.76 m$

10) Sol^n:-

Pipe :

$L = 50\ m$

$D = 4\ inch = 0.1016\ m$

$U_f \approx U_s = 15\ ms^{-1}$.

$\Delta P = ?$

K.E << P.E.

Mass flow, $M_p = 200\ kg/min$.

$\rho_p = 2000\ kg/m^3$. , $\epsilon = 0.98$.

$\theta = 90°$.

for pressure drop,

$$\Delta P = F_{fw} L + F_{pw} L + \rho_f L \epsilon g \sin\theta + \rho_p L (1-\epsilon) g \sin\theta. \rightarrow (1)$$

Now,

$$F_{pw} L = 0.057\, G L \sqrt{g/D}.$$

$$G = \frac{M_p}{A} = \frac{200\ kg/min}{\frac{\pi}{4}(0.1016)^2} = \frac{200 \times 4}{\pi (0.1016) \times 60} \frac{kg}{m^2 sec}$$

$$= 411.15$$

$$\therefore F_{pw} L = 0.057 \times 411.15 \times 50 \sqrt{\frac{9.8}{0.1016}} = 11508.304$$

$$F_{fw} L = \frac{2 f_g \rho_f U_f^2 L}{D}, \quad \text{where, } f_g = \text{fanning factor}.$$

$$Re = \frac{\rho v d}{\mu}$$

$\cancel{\mu = 1.8 \times 10}$ $\mu = 10^{-3}\ cP = 10^{-6} \frac{g}{m \cdot s}$.

$$= \frac{1 \times 15 \times 0.1016}{10^{-6}}$$

$$= 1.5 \times 10^6$$

$\therefore$ from diagram, f_g is found to be 0.011.

$$\therefore F_{fw} L = \frac{2 \times 0.011 \times 1 \times (15)^2 \times 50}{0.1016} = 2436.02$$

Now,

$$\rho_f L \epsilon g \sin\theta = 1 \times 50 \times 0.98 \times 9.8 = 480.2$$

$$\rho_p L (1-\epsilon) g \sin\theta = 2000 \times 50 \times 0.02 \times 9.8 = 19600$$

Substituting in eq^n 1, we get.

$$\Delta P = 2436.02 + 11508.304 + 480.2 + 19600$$

$$= 34024.524 \text{ Pa.}$$

$$= 34.024 \text{ KPa}$$

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