Quiz-I Solutions

Sol^n-1

Size Range (um)	Avg. Particle dia. ($\bar{D}_{pi}$)(um)	Mass (g)	Mass fraction (x_i)	($x_i/\bar{D}_{pi}$)
−704 + 352	$= \frac{704+352}{2} = 528$	25	$= \frac{25}{250} = 0.10$	1.8939×10^{-4}
−352 + 176	264	37.5	0.15	5.6818×10^{-4}
−176 + 88	132	62.5	0.25	18.939×10^{-4}
−88 + 44	66	75	0.30	45.454×10^{-4}
−44 + 0 (Pan)	22	50	0.20	90.909×10^{-4}
		$\Sigma m = 250g$	$\Sigma x_i = 1$	$\left(\Sigma \frac{x_i}{\bar{D}_{pi}}\right) = 162.878$

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Volume Surface mean Diameter, $\bar{D}_s$,

$$\bar{D}_s = \frac{1}{\sum_{i=1}^{n} \left(\frac{x_i}{\bar{D}_{pi}}\right)}$$

$$= \frac{1}{162.878 \times 10^{-4}}$$

$$\boxed{\bar{D}_s = 61.3955\, \mu m}$$ Ans. 2

Sol^n-2

Size Range (µm)	Avg. diameter ($\bar{D}_{pi}$) (µm)	No. of particles (n)	Mass, (m), kg $= \rho_p \cdot V_p \cdot n$ $= \rho_p \cdot (\frac{\pi}{6} \bar{D}_{p_i}^3) \cdot n$	Mass fraction (x_i)	$\left(\frac{x_i}{\bar{D}_{pi}}\right) \times 10^{-6}$
0-2	$= \frac{0+2}{2} = 1$	2000	2.77×10^{-12}	0.011	0.011
2-4	3	600	22.5×10^{-12}	0.090	0.030
4-8	6	140	41.93×10^{-12}	0.168	0.028
8-12	10	40	55.47×10^{-12}	0.222	0.022
12-16	14	15	57.08×10^{-12}	0.229	0.016
16-20	18	5	40.44×10^{-12}	0.162	0.009
20-24	22	2	29.53×10^{-12}	0.118	0.005
			$\Sigma m = 249.72 \times 10^{-12}$		$\Sigma\left(\frac{x_i}{\bar{D}_{pi}}\right) = 0.121 \times 10^{6}$

2

Volume surface mean diameter,

$$\bar{D}_S = \frac{1}{\sum_{i=1}^{n}\left(\frac{x_i}{\bar{D}_{pi}}\right)} = \frac{1}{0.121 \times 10^6}$$

$$\boxed{\bar{D}_S = 8.264 \times 10^{-6}\ m = 8.264\ \mu m}$$ 1

Surface area of sphere $S_p = (\pi \cdot D_S^2) = \pi \cdot (8.264 \times 10^{-6})^2$

$$\boxed{S_p = 214.44 \times 10^{-12}\ m^2}$$

Volume of sphere, $V_p = \frac{\pi}{6} \cdot \bar{D}_S^3 = \frac{\pi}{6} \cdot (8.264 \times 10^{-6})^2$

$$\boxed{V_p = 295.36 \times 10^{-18}\ m^3}$$ 1

Specific surface area, $A_w = \frac{S_p}{V_p} = \frac{214.44 \times 10^{-12}}{295.36 \times 10^{-18}}$

$$\boxed{A_w = 0.726 \times 10^6\ m^2/m^3}$$ Ans.

1

Soln 3

Volume of spherical bead $= \underbrace{\frac{\pi}{6}(D_p)^3_{sphere}}_{\text{Vol}^m \text{ of sphere}} - \underbrace{\frac{\pi}{4} D^2_{p_{cylinder}} L_{cylinder}}_{\text{Volume of cylinder drilled}}$

$$V_p = \frac{\pi}{6}\left(\frac{1}{4}\right)^3 - \frac{\pi}{4}\left(\frac{1}{16}\right)^2\left(\frac{1}{4}\right)$$

$$\boxed{V_p = 0.00741 \text{ inch}^3} \text{ — (1)}$$

Surface area of spherical bead = ~~(Surface area of sphere)~~ − ~~(Surface area of cylinder)~~

$$S_p = \frac{\pi}{4}\left(\frac{1}{4}\right)^2 - \left[2\left(\frac{\pi}{4}\right)\left(\frac{1}{16}\right)^2\right] + \left[\frac{\pi}{4}\left(\frac{1}{16}\right)\left(\frac{1}{4}\right)\right]$$

$$S_p = 0.196 - (0.0061) + (0.0491)$$

$$\boxed{S_p = 0.239 \text{ inch}^2} \text{ — (2)}$$

Volume of equivalent sphere ≡ Volume of spherical bead

$$\frac{\pi}{6} D_p^3 = 0.00741$$

$$\boxed{D_p = 0.2418 \text{ inch}} \text{ — (1)}$$

sphericity, $\phi_s = \frac{6V_p}{S_p D_p} = \frac{6 \times 0.00741}{0.239 \times 0.2418}$

$$\boxed{\phi_s = 0.769} \text{ — Ans. (1)}$$

Sol^n-4

Mesh No.	Fraction of Mass in feed (x_F)	Fraction of Mass retained in Oversize (x_D)	Fraction of Mass retained in undersize (x_B)	Cumulative mass fraction: feed (x_F')	Oversize (x_D')	undersize (x_B')
4	0.0107	0.018	0	0.0107	0.018	0
6	0.0235	0.033	0	0.0342	0.051	0
8	0.0672	0.088	0	0.1014	0.139	0
10	0.0864	0.112	0	0.1878	0.251	0
14	0.1087	0.142	0	0.2965	0.393	0
20	0.1759	0.229	0	0.4724	0.622	0
28	0.1397	0.182	0	0.6121	0.804	0
35	0.1077	0.104	0.1195	0.7198	0.908	0.1195
48	0.1013	0.065	0.2198	0.8211	0.973	0.3393
65	0.0746	0.025	0.2391	0.8957	0.998	0.5784
100	0.0501	0.002	0.1877	0.9458	1	0.7661
150	0.033	0	0.1427	0.9788	1	0.9088
200	0.0212	0	0.0912	1	1	1

for 48-mesh screen,

$$x_F = 0.8211, \quad x_D = 0.973, \quad x_B = 0.3393$$

Overall screen efficiency/effectiveness (%)

$$E = \frac{(x_F - x_B)(x_D - x_F)(x_D)(1 - x_B)}{(x_D - x_B)^2 (1 - x_F)(x_F)} \times 100$$

$$= \frac{(0.8211 - 0.3393)(0.973 - 0.8211)(0.973)(1 - 0.3393)}{(0.973 - 0.3393)^2 (1 - 0.8211)(0.8211)} \times 100$$

$$\boxed{E = 79.76\ \%}$$ Ans.

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