Chapter 7

1. For a centrifuge of radius 0.07m and rpm 10000, find out centrifugal force developed.

Ans. \( r = 0.07 \text{ m}^2 \)

\[
\omega = \frac{2\pi N}{60}
\]

\[
\frac{F_c}{F_g} = 0.001118 r N^2
\]

\[
= 0.001118 \times 0.07 \times 10^8
\]

\[
= 7826
\]

\( F_c = 7826 F_g \)

2. For a centrifuge of radius 0.05m, and rpm of 12000, find out terminal velocity of a particle of diameter 10 \( \mu \text{m} \) and density 1260 Kg/m\(^3\) in an aqueous solution.

Ans

rpm=12000

\[
\omega = \frac{2\pi N}{60} = \frac{2\pi \times 12000}{60} = 1256 \text{ rad} / \text{s}
\]

\[
\nu = \frac{\omega^2 r d_p^2 \rho}{18 \mu} \left( \rho_p - \rho \right)
\]

\( r = 0.05 \text{ m} \)

\( D_p = 10 \times 10^{-6} \text{ m}; \quad \rho_p = 1260 \text{ kg/m}^3 \)

\[
\nu = \frac{1256^2 \times 0.05 \times 10^{-10}}{18 \times 10^{-3}} (1260 - 1000)
\]
= 0.114 m/s

3. What is physical interpretation of Σ value?

Ans: It is area (in m²) of a gravity settler that has the same sedimentation characteristics as the centrifuge at the same feed rate.

4. We have to design a centrifuge that can handle 5 times flow rate in a prototype centrifuge. If all other dimensions between two centrifuges are same, find the ratio of the length of the centrifuge to be designed and prototype?

Ans

\[
\frac{q_1}{q_2} = \frac{\Sigma_1}{\Sigma_2} = \frac{b_1}{b_2}
\]

\[
5 = \frac{b_1}{b_2}
\]

\[b_1 : b_2 = 5 : 1\]

5. A viscous solution contains with a density \(\rho_p=1500\text{Kg/m}^3\) is to be clarified by centrifugation. Solution density is 1000Kg/m³ and viscosity 20 CP. Centrifuge bowl is with \(r_2=0.02\text{m}\) and \(r_1=0.008\text{m}\) and height, \(b=0.5\text{m}\). Calculate critical diameter of particle in exit stream, if \(N=1000 \text{ rpm}\) and \(q_f=0.05 \text{ m}^3/\text{hr}\).

Ans

\[
N=1000 \text{ rpm}
\]

\[
\omega = \frac{2\pi N}{60} = \frac{2\pi \times 1000}{60} = 104.67 \text{ rad/s}
\]

Bowl volume: \(v = \pi b (r_2^2 - r_1^2)\)
\[ q = 0.05 \text{ m}^3/\text{h} = 1.39 \times 10^{-5} \text{ m}^3/\text{s} \]

\[ 1.39 \times 10^{-5} = \frac{104.67^2 (1500 - 1000) D_{pc}^2 \times 5.27 \times 10^{-4}}{18 \times 20 \times 10^{-3} \ln\left(\frac{2 \times 0.2}{0.02 + 0.008}\right)} \]

\[ = 22.48 \times 10^3 D_{pc}^2 \]

\[ D_{pc} = \sqrt{6.18 \times 10^{-10}} = 2.5 \times 10^{-5} \text{ m} = 25 \mu m \]