8/4/22.

TUTORIAL-1

Problem-1:- Hindered settling.
Glass spherical particles.
$D_p = 1.554 \times 10^{-4}$ m

Slurry contains 60 wt% ~~solids~~ solids.
$\rho_s = 2467$ kg/m^3, $\rho_w = 998$ kg/m^3, $\mu = 1.005 \times 10^{-3}$ Pa s.
Find hindered settling velocity.

Ans:- ~~0.4~~ $\epsilon \neq 0.4$ (we need to find volume%)

$$U_t = \frac{g D_p^2 (\rho_p - \rho)}{18 \mu} = \frac{9.81 \times (1.554 \times 10^{-4})^2 (2467 - 998)}{18 \times 1.005 \times 10^{-3}}$$

$$\Rightarrow U_t = 0.019 \text{ ms}^{-1}$$

Total weight = 100 kg
Solid wt = 60 kg, liquid wt = 40 kg

$\epsilon =$ ~~998~~ 998 / 40 / 2467 / 60 $=$ 998 / 40 $\times$ 60 / 2467 $=$

$$\epsilon = \frac{\frac{40}{998}}{\frac{40}{998} + \frac{60}{2467}} = 0.62$$

correct eq^n were used.

$$\psi_p = \frac{1}{10^{1.82(1-\epsilon)}} = 0.205$$

$$\Rightarrow U_s = \epsilon^2 \psi_p U_t = (0.622)^2 \times 0.205 \times (0.019)$$

$$\Rightarrow U_s = 1.526 \times 10^{-3} \text{ ms}^{-1}$$

~~ρ_p~~ $\rho_m = \epsilon \rho + (1 - \epsilon) \rho_p = 0.622 \times 998 + (1 - 0.622) \times 2467$

$$\Rightarrow \rho_m = 1553.282 \text{ kg/m}^3$$

$\mu_m = \frac{\mu}{\psi_p} = 4.9 \times 10^{-3}$ $\quad Re_{p,s} = \frac{D_p U_s \rho_m}{\mu_m \epsilon} = 0.12 < 1$ → Stokes regime (correct solving.)

Problem-2:- Specific gravity of solid = 4
CCl_4 is the fluid. (specific gravity = 1.594)
$D_p = 0.1\,mm$, volume fraction of particles in CCl_4 = 0.2
$\mu = 1.03\times10^{-3}\,Pa.s$
Find the settling velocity.

A:- $\epsilon = 1-0.2 = 0.8$, $\psi_p = \frac{1}{10^{1.82(1-\epsilon)}} = 0.4327$

We don't know the regime.
We need to find k value.

$$k = D_p\left(\frac{g\rho(\rho_p-\rho)}{\mu^2}\right)^{\frac{1}{3}}$$

$$\Rightarrow k = 0.1\times10^{-3}\left(\frac{9.81\times1594\,(4000-1594)}{(1.03\times10^{-3})^2}\right)^{\frac{1}{3}}$$

$\Rightarrow k = 3.28 > 2.6$ and $68.9 > 3.28$
↳ intermediate regime.

$$\Rightarrow U_t = \sqrt{\frac{4}{3}\frac{g(\rho_p-\rho)D_p}{C_D\rho}} = \frac{0.0444}{\sqrt{C_D}}$$ ← or relation.
↳ $f(Re)$ ↑ using C_D from Re vs C_D plot

We need to assume Re_p, the find U_t and cross-check Re.

$$C_D = \frac{24}{Re_p}\left(1+0.173\,Re_p^{0.657}\right)$$

Let $Re_{p_{assume}} = 2$. $\Rightarrow C_D = 15.273$ $\Rightarrow U_t = 0.0113$

$\Rightarrow Re_{p_{true}} = \frac{U_t \rho D_p}{\mu} = 1.76$

As $Re_{p_{assume}} \neq Re_{p_{true}}$, assume $Re_{p_{assume}} = 1.8$

$C_D = 16.73$ $\Rightarrow U_t = 0.0108$ $\Rightarrow Re_{p_{true}} = 1.68$

$\rightarrow C_D = 18.534$

Finally, $Re_p = 1.60$, $U_t = 0.0103\ ms^{-1}$, $U_s = 0.0028\ ms^{-1}$
$= \epsilon^{2.4} U_t$

$1.6 = Re_{p_{assume}} = Re_{p_{true}} = 1.596$