Lecture 3: Exercise on measurement of quantities.

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Exercise – (I) specific gravity of slurry

Calculate specific gravity of slurry which contains 65% lime. The specific gravity of lime is 2600 kg/m$^3$. Also calculate volume of slurry.

Substituting the values in equation 1 of lecture 2

$$65 = \frac{100 \times 2600 (\rho_m - 100)}{\rho_m (2600 - 100)}$$

By solving $\rho_m =$ specific gravity of slurry = 1667 kg/m$^3$

Volume of slurry in percent $= 65 \times \frac{1667}{2600} = 41.66\%$

Exercise – (II): % solids in slurry

A slurry stream containing quartz is diverted into a 1 liter can. Time taken to fill is 8 seconds. The density of the slurry and quartz is 1400 kg/m$^3$ and 2600 kg/m$^3$ respectively. Calculate (a) percent solids by weight and (b) mass flow rate quartz within slurry.

Substituting the values in equation 1 of lecture 2

$$\% \text{ solid} \ (\% x) = \frac{100 \times \rho_s (\rho_m - 1000)}{\rho_m (\rho_s - 1000)}$$

$$= \frac{100 \times 2650 \times 400}{1400 \times 1600}$$

$$= 45.88\%.$$

Equation 3 of lecture 2

$$M(\text{kg/hr}) = \frac{F \rho_s (\rho_m - 1000)}{(\rho_s - 1000)}$$
\[ F = \frac{3600}{8000} \text{ m}^3/\text{hr}. \]

\[ M = \frac{3600}{8000} \times 1400 \times 0.4588 \]

=289kg/hr.

If the time to fill the can is 7s, rest everything remains the same, calculate mass flow rate of quartz in slurry.

Answer =330 kg/hr

Exercise (III) Mixing of slurry streams

Two slurry streams enter a pump. One stream has flow rate of 5m\(^3\)/hr and contains 40% solids by weight. Other stream has 3.4 m\(^3\)/hr flow rate and contains 55% solids by weight. Density of solid is 3000kg m\(^{-3}\) in both slurry streams. Calculate tonnage of any solids pumped/hr.

To solve the problem, use the following steps.

1. Calculate density of slurry streams \( \rho_{M_1} = 1364 \text{ kg/m}^3 \) and \( \frac{1579}{\text{ kg/m}^3} \)
2. Calculate mass flow rate of slurry \( M_1 = 2728 \) and \( M_2 = 2953 \) kg/hr
3. Add mass flow rate which will give 5.681T/hr.

Exercise (IV) Slurry making

Calculate how many kg of magnetite must be added to 100kg water to make up a slurry with specific gravity \( (\rho_m) = 1.4. \text{ g/cm}^3 \).

Specific gravity of \( \text{Fe}_3\text{O}_4 = 5.2 \text{ g/cm}^3 \)

\[ \text{Wt} \% \text{ solid} = \frac{100 \times 5.2 \times (1.4 - 1)}{14 \times (5.2 - 1)} = \frac{100 \times 5.2 \times 0.4}{14 \times 4.2} = 35.4 \% . \]

\[ \text{Wt} \% \text{ water} = 100 - 35.4 = 64.6 \% \]

\[ \frac{\text{mass of water}}{\text{mass of water}} = \frac{M_m}{M_{H_2O}} = \frac{100\%}{64.6\%} \]

\[ M_m = \frac{100\%}{64.6\%} \times 100 \]

=155kg

Mass of magnetite =155-100 =55kg
Exercise (V) Units

a) Convert 360 mm Hg pressure into (a) N/m² and (b) Lb/ft²
Answer = 47995.2 N/m² and 1002.4 Lb/ft²

b) Calculate the value of universal gas constant into (a) CGS unit and (b) MKS unit.
given
\[ R = 82.0578 \text{ Cm}^3 \text{ atm} \text{ g mole}^{-1} \text{ °C} \]. The problem is solved in lecture 2.

c) Pressure in an evacuated vessel was recorded 1.2 dynes/Cm². Express this value in microns of mercury at 25°C.
Answer 1.596 micron.

Exercise (VI) Quiz question

Two streams of slurry enter a pump. The volumetric flow rate of stream 2 is 0.68 times and density is 1.16 times that of slurry no. 1 respectively, if density of slurry no.1 is 1364 kg/m³. Then mass flow rate (M₁) of slurry stream no.1 is

(A) \( M_1 = 0.72 M_2 \)  (B) \( M_1 = 0.92 M_2 \)  (C) \( M_1 = 1.5 M_2 \)

(D) \( M_1 = 0.8 M_2 \)

\( M_2 \) is mass flow rate of slurry 2

One can derive the following equation expressing mass flow rates in terms volume flow rates and density of slurry

\[
\frac{M_1}{M_2} = \frac{F_1}{F_2} \left( \frac{\rho_{M1} - 1000}{\rho_{M2}} \right)
\]

\( M_1 \) and \( M_2 \) mass flow rate of stream 1 and 2
\( F_1 \) and \( F_2 \) volume flow rate of stream 1 and 2
\( \rho_{M1} \) and \( \rho_{M2} \) density of slurry 1 and 2.

Using above equation: \( F_2 = 0.68 F_1 \) and \( \rho_{M2} = 1.16 \rho_{M1} \).

\( M_1 = 0.92 M_2 \) ‘B’ is correct.