Lecture 12: Exercise on mineral processing

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Problems 1 to 7

A floatation plant treats feed whose grade is 0.8% Cu. The plant produces concentrate and tailings. The copper grade of concentrate is 26% and that of tailings is 0.16%. Calculate:

a) Cu recovery in concentrate
b) Fraction of feed in concentrate
c) Enrichment ratio

Let $\mathrm{M_F} = \text{mass of feed}, \mathrm{M_C} = \text{mass of concentrate}$ and $\mathrm{M_T}$ is mass of tailing, f, c and t are Cu grade in feed, concentrate and tailing respectively.

Material balance

$$\mathrm{M_F} = \mathrm{M_C} + \mathrm{M_T} \qquad (1)$$

$$\mathrm{M_F} \times \mathrm{f} = \mathrm{M_C} \times \mathrm{c} + \mathrm{t} \times \mathrm{M_T} \qquad (2)$$

By 1 and 2 we get

$$\frac{\mathrm{M_F}}{\mathrm{M_C}} = \frac{\mathrm{c}-\mathrm{t}}{\mathrm{f}-\mathrm{t}} \qquad (3)$$

$$\text{plant recovery} = \frac{\mathrm{M_C} \times \mathrm{c}}{\mathrm{M_F} \times \mathrm{f}} \times 100 \qquad (4)$$

By 3 and 4 we get.

$$\frac{\mathrm{M_F}}{\mathrm{M_C}} = \frac{\mathrm{c(f}-\mathrm{t)}}{\mathrm{f)c}-\mathrm{t)}} \times 100 \qquad (5)$$

Plant recovery is copper recovery and by equation 5 it is 82.73% Ans.

Fraction of feed in concentrate $= \frac{\mathrm{M_C}}{\mathrm{M_F}} = \frac{\mathrm{f}-\mathrm{t}}{\mathrm{c}-\mathrm{t}} = 0.0286$ Ans

$$\text{Enrichment ratio} = \frac{\mathrm{c}}{\mathrm{f}} = 28.9$$

Problem 2

In the circuit shown below, the dry solids of density $300\mathrm{Kg/m^3}$ are fed at the rate of 25 tons/hr. The feed to the cyclone contains 36% solids by weight. It is found that 250 μm size in the rod mill discharge, ball mill discharge and cyclone feed is $27\%, 5\%$, and 14% respectively. Determine the volumetric flow rate of feed (solid+ water) to the cyclone.

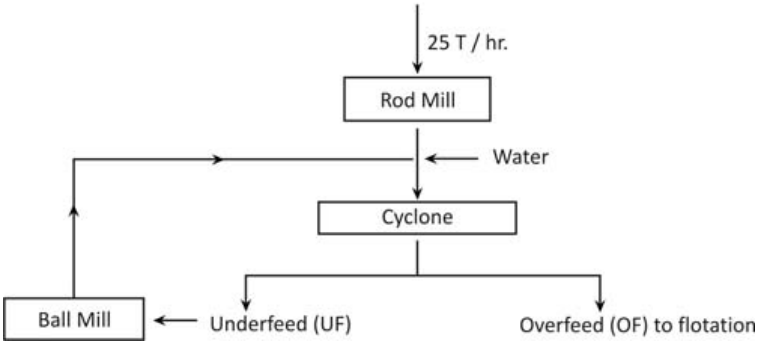

Figure12.1: Flow sheet showing flow of materials

Solution: material balance

$\text{cyclone feed}(C_F) = \text{Ball mill feed}(B) + \text{Rod mill feed}\ (R)$

$C_F = B + 25$ (1)

Performing balance on 250 μm size

$C_F \times 14 = 5B + 25 \times 27$ (2)

Solving equation 1 and 2 we get $C_F = 61.1$ tons/hr.

Volumetric flow rate of feed (dry) to cyclone $= 20.36 \frac{m^3}{hr}$ Ans

Volumetric flow rate of water $\frac{64}{36} \times \frac{61.1}{1} = 108.6\ \frac{m^3}{hr.}$ Ans

Note $\frac{64}{36}$ is dilution ratio. Density of water $1 \text{ton}/m^3$

Problem3

A hydro cyclone produces two products i.e. underflow and overflow from the feed. The overflow is treated further for concentration of valuable mineral; whereas underflow is recirculated. In a hydro cyclone a slurry of density $1140\ \text{Kg}/m^3$ is fed for separation. It produces underflow of slurry density $1290\ \text{Kg}/m^3$ and overflow of slurry density $1030\ \text{Kg}/m^3$. Determine mass flow rate of feed to cyclone, when 3 liter sample of underflow takes 4s. Density of dry solid is $3000\ \text{Kg}/m^3$. Calculate % solids in feed, underflow and overflow by the following equation

Solution

$\%\ \text{solids} = \frac{100 \times \rho_s(\rho_m - 1000)}{\rho_m(\rho_m - 1000)}$ equation 6 of lecture 11

$\%$ solids in feed $= 18.42\%$

$\%$ solids in underflow $= 33.72\%$

$\%$ solids in overflow $= 4.37\%$

Dilution ratio of feed, under flow and overflow can be calculated by equation 10 of lecture11. These dilution ratios arc 4.42, 1.97 and 21.97 respectively.

Mass flow rate of underflow $= \mathrm{F} \times \rho_u \times$ %solid in UF

Where is volumetric flow rate $= \frac{3}{1000} \times \frac{3600}{4}\ \mathrm{m}^3/\mathrm{hr}.$

Mass flow rate of underflow $= 1172\ \mathrm{kg/hr}.$

Water balance on the cyclone gives $\mathrm{M_F} = 1336\ \mathrm{kg/hr}$ Ans.

Problem 4:

Analyze the following circuit and determine unknowns

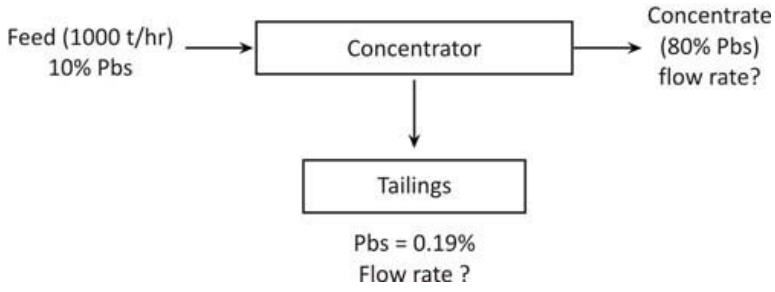

Figure 12.2Flow sheet for materials flow

Solution:

Apply material balance and get the answer

Flow rate of concentrate $123\ \mathrm{t/hr}$ and tailing $877\ \mathrm{t/hr}.$

Problem5: Do yourself

In a hydro cyclone a slurry containing 30% solid is fed for separation of course and fines. The underflow has 50% solids and the overflow has 15% solids. If the feed enters at 20 tons$/$hr in the hydro cyclone, calculate the tonnage of solid$/$hr in underflow. **Answer $\mathbf{14.3\ T/hr}$**

Problem6: Do yourself

A plant treats 210 tonnes of material in a shift of metal grade 40% and tailing has metal grade 0.2%. Calculate mass of concentrate and tailing. **Answer $\mathbf{12\ and\ 198\ T/hr}$**

Problem7

A floatation circuit consists of rougher-cleaner circuit to concentrate PbS

The grade of PbS in feed is 15% and is delivered qt 1200t$/$h. The grade of cleaner tailing is 20%. The cleaner tailings are recycled to rougher and circulating load is 0.25 (recycle/ fresh feed). The recovery and grade in the concentrate is 98% and 89% respectively. Calculate the flow rates and grade of the respective streams.

Solution

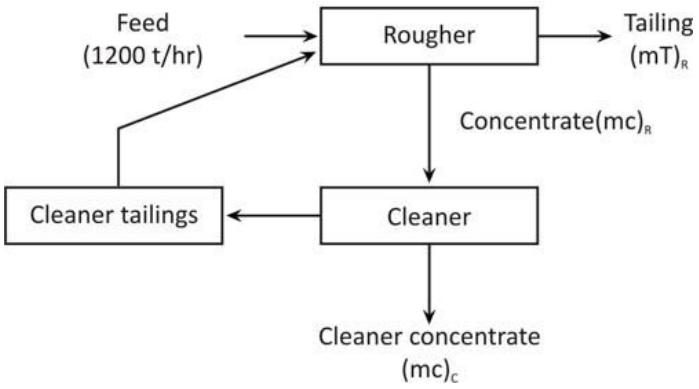

Figure12.3: Floatation circuit to show arrangement of rougher and cleaner along with inputs and outputs.

Solution:

Material balance at steady state of rougher

$$1200 + 300 = (\mathrm{m_T})_\mathrm{R} + (\mathrm{m_C})_\mathrm{R} \qquad (1)$$

Cleaner total mass balance

$(m_C)_R = (m_C)_C + 300$ (2)

$(m_T)_R$ is mass of rougher tailing in t/hr, $(m_C)_R$ is mass of rougher concentrate, $(m_C)_C$ mass of cleaner concentrate.

Rougher PbS balance

$1200 \times 0.15 + 300 \times 0.2 = (m_T)_R\, t_R + (m_C)_R C_R$ (3)

t_R and C_R is PbS grade in rougher tailing and cleaner concentrate respectively.

Cleaner PbS balance

$(m_C)_R c_R = (m_C)_C C_C + 300 \times 0.2$ (4)

C_C is PbS grade in cleaner concentrate

$$\text{Recovery} = \frac{\text{mass of PbS in cleaner concentrate}}{\text{mass of PbS in fresh feed}} \times 100$$

$$= \frac{(m_C)_C \times 0.89}{1200 \times 0.15} \times 100$$

$\therefore (m_C)_C = 198.6\,\text{Tons/hr.}$

$(m_C)_R = 498.6\,\text{Tons/hr.}$

$(m_T)_R = 1001.4\,\text{Tons/hr.}$

By equations 3 and 4 we can determine

$$\left.\begin{matrix}\textbf{Grade of rougher concentrate} = \mathbf{47.5}\ \% \\ \textbf{Grade of rougher tailings} = \mathbf{0.316}\ \%\end{matrix}\right\} \textbf{Answer}.$$