**CHEM-E6145 Unit Operations in Mineral Processing**

**HSC-SIM: Assignment 3 3.03.2023**

**Kinetic flotation circuit model**

**Name:**

**Student number:**

**The purpose of this assignment is to find out how different process design and operation parameters affect flotation process.**

**Parameters that will be tested are:**

* Air flow rate to the cells
* Froth thickness in the cells
* Amount of the cells
* Ore feed rate

**Process description:**

The Flotation feed is Cu-Mo ore from hydrocyclone, which is floated selectively to produce Mo concentrate.

The Flotation circuit consists of one *Conditioner* tank followed by *Flotation bank with three cells*. The flotation cell tails will be treated in a separate process (not included in the Assignment).

**Feed:**

* Dry solids feed rate is 450 t/h
  + Feed solids percentage is 35%
* Minerals in the Cu-Mo ore (stoichiometric)
  + Molybdenite (MoS2): 7.3 % of the feed
  + Chalcopyrite (CuFeS2): 42.8 % of the feed
  + The rest of the feed is quartz (SiO2)
* 5 particle size classes:
* 0-20 µm, 20-37 µm, 37-74 µm, 74-120 µm, 120-270 µm
* Size distribution
* Rosin-Rammler passing size P80: 78 µm
  + The mineral composition of the particles stays the same through size classes

**Chart, diagram

Description automatically generated**

**Conditioner**

**Model Parameters**

* + Use the Three component flotation model equation.
  + Parameters of the three-component Flotation model based on continuous plant sampling data

*Flotation rate constants*

*Mass proportion of fast, slow and non floating particles.*

**Molybdenite:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size, µm** | **Fast** | **Slow** | **Non** | **Fast kin.** | **Slow kin.** |
| **0-20** | 0.6 | 0.3 | 0.1 | 0.245 | 0.0245 |
| **20-37** | 0.6 | 0.3 | 0.1 | 0.2695 | 0.02695 |
| **37-74** | 0.6 | 0.3 | 0.1 | 0.24255 | 0.024255 |
| **74-120** | 0.6 | 0.3 | 0.1 | 0.218295 | 0.0218295 |
| **120-270** | 0.6 | 0.3 | 0.1 | 0.1964655 | 0.01964655 |

**Chalcopyrite:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size, µm** | **Fast** | **Slow** | **Non** | **Fast kin.** | **Slow kin.** |
| **0-20** | 0.4 | 0.4 | 0.2 | 0.155 | 0.0155 |
| **20-37** | 0.4 | 0.4 | 0.2 | 0.1705 | 0.01705 |
| **37-74** | 0.4 | 0.4 | 0.2 | 0.15345 | 0.015345 |
| **74-120** | 0.4 | 0.4 | 0.2 | 0.138105 | 0.0138105 |
| **120-270** | 0.4 | 0.4 | 0.2 | 0.1242945 | 0.01242945 |

**Quartz:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Size, µm** | **Fast** | **Slow** | **Non** | **Fast kin.** | **Slow kin.** |
| **0-20** | 0.1 | 0.2 | 0.7 | 0.04 | 0.004 |
| **20-37** | 0.1 | 0.2 | 0.7 | 0.044 | 0.0044 |
| **37-74** | 0.1 | 0.2 | 0.7 | 0.0396 | 0.00396 |
| **74-120** | 0.1 | 0.2 | 0.7 | 0.03564 | 0.003564 |
| **120-270** | 0.1 | 0.2 | 0.7 | 0.032076 | 0.0032076 |

**Flotation Bank Model Parameters**

**Flotation Bank**

* Number of cells in row: 3
* *One Flotation Cell unit model can do calculations for a bank of cells*

**Residence Time**

* Flotation Equation: Continuous
* *Kinetic parameters from continuous plant sampling data*
* Residence time calculation: Feed Volumetric
* *Feed rate of each cell is used for calculation of its residence time*

**Cell Dimensions:**

* Use the initial values

**Gas Hold-Up:**

* Use the initial values

**Froth Volume:**

* Froth Volume Calculation: Based on Froth Thickness
  + *Used for Cell Effective volume calculation*
* Froth thickness: 250 mm

**Froth Recovery:**

* Froth Recovery: Function of Froth Depth
  + *Method to calculate froth recovery*

**Entrainment:**

* Use the initial settings

**Air Flow:**

* Air Flow rate: 8 m3/min

**Water Recovery:**

* Water Recovery: Concentrate Target
* Concentrate Solids: 25 %
* Target with launder water: on

**Sb Scaling:**

* Enable “Sb in Use” and set the Nominal Sb to 30

*- Sb = The bubble surface area*

*- to obtain mineral floatabilities from kinetic rate factors*

**Dynamic Parameters, Carry Rate, Warnings, Valve Selection:**

* Use the initial settings

**In the flowsheet**

* Add a launder water stream to the flotation cell
* Set the water flow rate to 2 t/h per cell.

**Effect of flotation air rate**

* Simulate the Flotation circuit by using different air flow rate and Fill the following table for the concentrate:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Air Flow rate (m3/min)** | **Total solids (t/h)** | **Mo grade (wt-%)** | **Mo recovery (rec-%)** | **Cu grade (wt-%)** | **Cu recovery (rec-%)** |
| **8** |  |  |  |  |  |
| **12** |  |  |  |  |  |
| **16** |  |  |  |  |  |
| **20** |  |  |  |  |  |

**What changes did you notice in the results?**

**Why did these changes take place?**

**Effect of froth thickness**

* Set the air flow rate to 18 m3/min
* Simulate the Flotation circuit by using different Froth thickness and Fill the following table for the concentrate:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Froth thickness (mm)** | **Total solids (t/h)** | **Mo grade (wt-%)** | **Mo recovery (rec-%)** | **Cu grade (wt-%)** | **Cu recovery (rec-%)** |
| **50** |  |  |  |  |  |
| **150** |  |  |  |  |  |
| **250** |  |  |  |  |  |
| **350** |  |  |  |  |  |

**What changes did you notice in the results?**

**Why did these changes take place?**

**Compare the effect of Froth thickness on Mo- and Cu-grade. Are there any differences between them ? If so, what is the reason for this ?**

**Number of flotation cells:**

* Set the froth thickness to 250 mm
* Simulate the Flotation circuit by using different amount of Cells and Fill the following table for the concentrate:
* Remember to adjust the water flow rate accordingly (2t/h per cell).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cells in Row** | **Total solids (t/h)** | **Mo grade (wt-%)** | **Mo recovery (rec-%)** | **Cu grade (wt-%)** | **Cu recovery (rec-%)** |
| **2** |  |  |  |  |  |
| **3** |  |  |  |  |  |
| **4** |  |  |  |  |  |

**What changes did you notice in the results?**

**Why did these changes take place?**

**Effect of ore feed rate**

**Increase the ore feed rate from 450 t/h to 500 t/h by keeping the feed solids percentage of 35%.**

**How does this affect Mo-grade and Mo-recovery compared to previous case (froth thickness 250 mm, 4 Cells in row)?**

**What is the reason for this?**

* **When you have completed the tasks, upload the Simulation file as a zip-file and Results as a word-file to your own Dropbox (Assignment 3)** **latest on Thursday March 10th at 16:00.**