JKTech Specialist Software

JKMultiBal

SMI Technology Transfer

Additional information

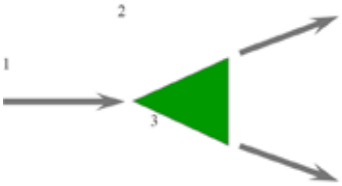
JKMultiBal is a powerful tool for the mass-balancing of comminution and flotation circuits and other areas of mineral processing plants.

JKMultiBal Theory

Mass balancing

Mass balancing is a technique that adjusts data obtained experimentally to form a consistent data set, where the flows of solids and any component (% solids, asssays, size fractions, etc) coming into a node in the circuit equals that coming out. Samples can often be taken to obtain assays and sizing information, however it is generally the flows of material that is difficult to measure experimentally.

The basis of solving the problem of estimating solid flows (using assays) is based on using the process equipment-generated differences in composition of various streams. Consider a process with streams having solid flows s_1, s_2 and s_3 and assays a_1, a_1 and a_3.



ıdicating streams entering and exiting a node

There are two major mass balance equations, which are:

$$s_1 = s_2 + s_3$$

$$a_1 = \frac{s_2 a_2 + s_3 a_3}{s_2 + s_3}$$

The more conventional equation for mass balancing is shown below:

$$s_1 a_1 = s_2 a_2 + s_3 a_3$$

Steady state

JKMultiBal finds a steady-state solution. To improve the quality of the steady state assumption in practice, a series of regular samples are taken and combined to make composite samples, covering a period of time that is long (several hours) compared with circuit fluctuations.

In the absence of the steady state assumption the mass balance constraint cannot be fully utilized and a consistent data set cannot be obtained accurately. This is more a concern when planning for a survey to ensure the operation is as steady as possible.

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Standard deviation

The usual measure of accuracy of a measured variable is the standard deviation. The standard deviation (SD) is defined as:

$$SD = \sqrt{[E(x_i - x)^2]}$$

where xi is a measured value and x is the true mean, and E is the statistical expectation.

Whenever sampling a plant, the mineral processing engineer should be aware of the accuracy of the data as it relates to measured values. This relationship is incorporated into error models used in JKMultiBal.

Repeated sampling

If the inherent accuracy of a particular data measurement is unknown, the standard statistical approach is to take replicate samples (approximately 5 to 10).

Using this approach, once the relationship between data accuracy and measurement is established, it can be incorporated into the error models used for mass balancing. It is not necessary to perform replicate sampling for every single stream and sample.

Normalised variance

Mass balancing takes all selected streams and calculates the smallest set of data adjustments that will make the data consistent. If some (or all) of these streams are measured, the experimental measurements can be compared with the balanced data. The square of the normalized difference (or normalized variance NV) between measured (experimental) data and adjusted (balanced) data is taken as a measure of goodness of fit of the model:

$$NV = \frac{(Measured - Calculated)^2}{SD^2}$$

The square root of the normalized variance is known as the 'Root Mean Square (RMS) error'. A RMS error of value 1 means that all data points were estimated with errors similar to the measured standard deviations of the experimental data points. Obviously the more RMS error varies from one, the more error is associated with fitting the data.

JKMultiBal

The size-by-assay balancing algorithm within JKMultiBal was developed to enable this higher-level understanding of mineral processing circuits. When applied to flotation circuits, the various algorithms present in JKMultiBal allow missing flows to be calculated, as well as generating a consistent data set for further analysis, such as model fitting etc.

Future work includes importing mineralogical data, including liberation and mineral associations, and enabling size-by-liberation mass balancing to be performed. This will allow plant metallurgists, researchers and consultants alike to further investigate various plant issues and identify opportunities for improvement.

JKTech Services

- Consulting (comminution, flotation, mineralogy, mining & geometallurgy)
- Process Mineralogy and In-House Instrument Analysis
- Specialist Software (JKSimMet, JKSimFloat, JKMultiBal, JKSimBlast)
- Specialist Equipment (ore breakage characterisation, flotation characterisation)
- Metallurgical Laboratory Services
- SMI Knowledge Transfer

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JKTech's range of technologies is supported by the ongoing research activities of the Sustainable Minerals Institute at The University of Queensland.