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Selecting the Optimum On-line Analysis System for Process Control

Application Note 59

Introduction

For any given plant there are several key factors which need to be addressed in selecting the most suitable on-line analysis system configuration for Process Control. These include:

Process Control Requirements
- Elements to be analysed
- Frequency of analysis (assay update time)
- Residence time of upstream process
- Importance of stream in overall control strategy
- Confidence required in assay-based control decisions

Physical Layout of Plant
- Length of slurry lines from primary samplers to analyser unit (MSA)
- Number of pumps required for sample stream transport (MSA)
- Whether or not gravity can be used for transportation of stream

Capital Constraints
- Capital investment
- Economic benefits expected
- Cost of on-going maintenance
- Flexibility of system modules
- Incremental benefits of less essential assays

Technical Capability
- Is GS Omni technology required?
  - o Measurement of light elements
  - o Lack of mineralogical, matrix and particle size effects
- Streams to be measured:
  - o Critical for control of process (usually includes Feed, Final Tail and Concentrate)
  - o Need for understanding of trends within the process (usually includes Rougher Concentrate and Cleaner Tails)
- Elements to be measured in each stream

The trade-offs between multiplexing and dedicated analysers, GS Omni technology versus XRF, and capital and maintenance costs versus benefits can then be worked out and a recommendation can be made for the best system configuration for the particular plant.

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Process Control Requirements

For each process stream, the elements to be analysed and the frequency of analysis need to be specified. The elements to be analysed are determined by the objectives of the process and the particular metallurgical problems which are anticipated from the metallurgical testwork. The frequency of analysis required, often referred to as the assay update time, depends on the following criteria:

- The fluctuation in assays in a given process stream considering the residence times of the processes immediately upstream and the stability of the circuit. A general rule of thumb is that the assay update times of the analysers for the critical streams should be less than half of the retention time of the preceding process stage.

Therefore, in the tailings stream from a scavenger bank of cells with a retention time of 5 minutes, the grade can be expected to vary considerably on a 2/2 minute by 21/2 minute basis so on-line analysis should be made at an interval less than this so that all of the trends in plant performance are monitored. To obtain these sorts of assay update times, requires dedicated analysers or Multi-Stream Analyser (MSA) units with few streams.

- How critical a given stream is in the overall process control strategy. If the critical streams are monitored frequently according to the above criteria, the operators should be able to control the plant to give overall stability and best metallurgical results at minimum cost. The less critical intermediate streams can then be monitored at a lower frequency for the fine tuning of the circuit.

- The degree of confidence required in the assay-based control decisions. Streams that are more critical for control of the plant need to be monitored more frequently than others. Trends in plant performance will then be shown in more detail, giving greater confidence in control decisions.

For example, in a copper concentrator, the main objective would usually be to maximise recovery while producing a particular copper concentrate grade. In addition, testwork may show that recirculating loads tend to build up in the cleaning stages. Thus, concentrate and tailings grades are of critical importance because they monitor recovery as well as concentrate grade.

To fully monitor the recirculating load, it is also necessary to monitor the rougher and scavenger concentrates and cleaner tailing streams. As recirculating loads tend to build up slowly with time, these analyses are not required on a minute-by-minute basis so these streams can be monitored with a lower cost-per-stream Multi-Stream Analyser (refer to Copper Circuit of Figure 1).

Physical Layout of Plant

The physical layout of the plant can influence the selection of the analysis system. For example, when using the Multi-Stream Analysers one tries to minimise the length of the slurry lines from the primary samplers to the analyser. If one stream is a long way from others in the plant, from an on-going maintenance point of view, it would be prudent to use a dedicated analyser for that stream and transport the signals electronically rather than transport small slurry streams over long distances.

To further minimise on-going maintenance, multi-stream analyser unit(s) should be situated to minimise the number of pumps required to transport sampled streams. Ideally, the analyser(s) should be located so that the sub-streams flow under gravity, or the pressure of the main line from which they were taken, to the analyser and then gravity feed back to a convenient point in the process.

If there are large distances in the plant between the streams which are to be measured, it may be prudent to purchase several analysers, instead of one, and spend more capital to ensure that on-going maintenance costs and downtime are minimised.

Capital Constraints / Return on Capital

The economic benefits of having an on-line analysis system coupled to a control system, be it manual or fully automatic, comes from one or more of the following:

- Increase in metal recovery.
- Improvement in concentrate grade and control of impurities.
- Reduction in reagent consumption.
- Decrease in operating costs.
- Improvement in stability of operation.

These benefits have to be weighed against the capital investment of the analysis system and the cost of on-going maintenance including mechanical repairs, electronic repairs, downtime and calibration.

The flexibility of the system with hybrid systems of dedicated analysers for the critical streams and multi-stream analysers for the less critical streams enables the most cost effective analysis system to be selected for each particular plant.

In working out what streams are to be measured, the law of diminishing returns should be considered. The incremental capital cost of measurement of less essential streams and assays should be weighed up against the incremental economic benefits to the plant in each case.

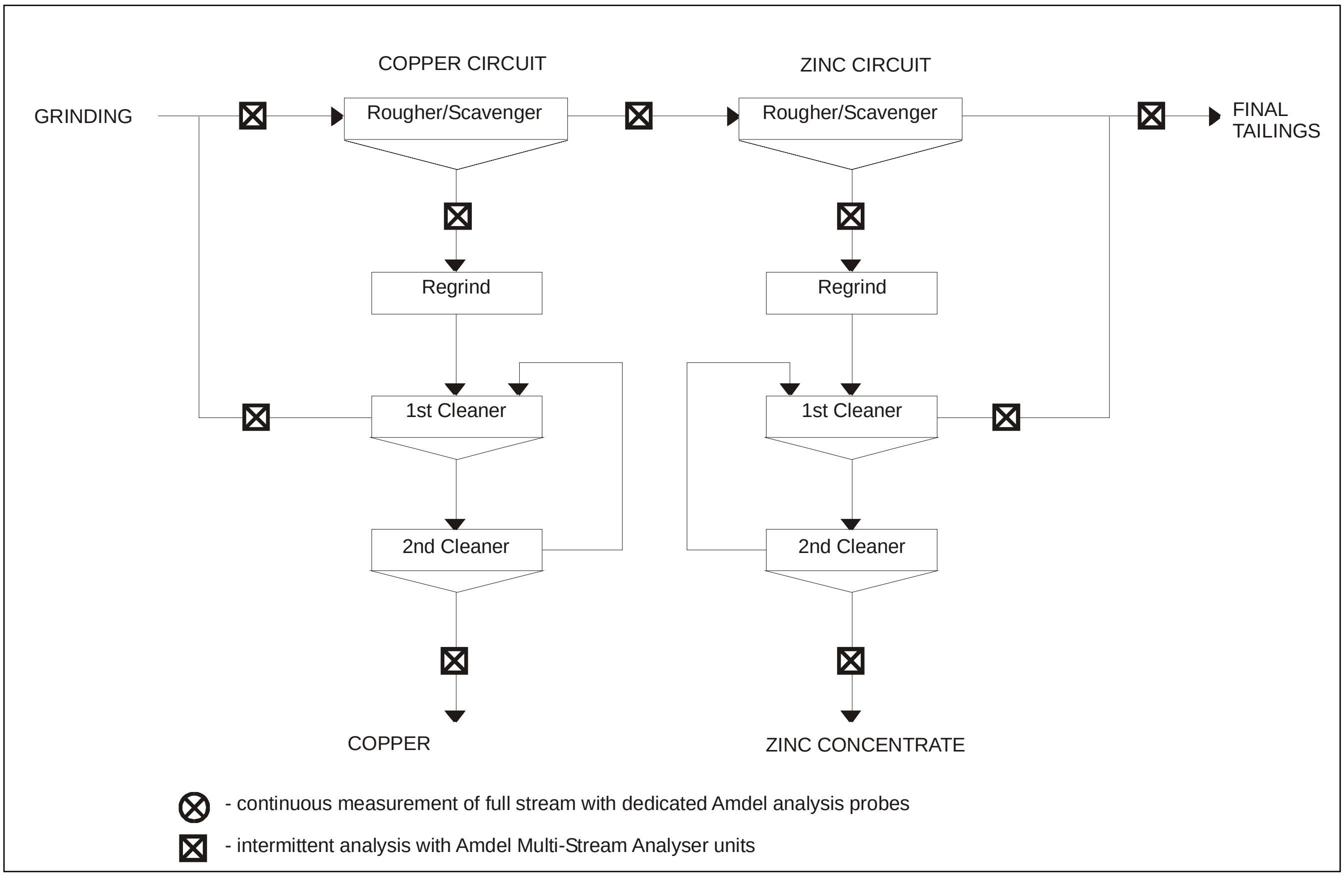

Figure 1: Typical ISA system in a Base Metal Flotation Circuit

Discussion

In specifying an on-line analysis system, the main considerations which impact on the price and technical capability of the system are:

1. Whether or not GS Omni technology is required. Because of the higher cost of the GS Omni technology, this would not normally be considered unless its unique properties (like measurement of light elements, and unaffected by changes in mineralogy, matrix and particle size distribution) are critical to the project.

2. Which streams are to be measured - the streams should be listed into two groups:
   i. those which are critical for control of the process. This will normally include the feed, final tailings and each concentrate stream.
   ii. those which are not critical for control but which will allow a better understanding of trends within the process. These will normally include the rougher concentrate and cleaner tailing streams etc.

3. What elements must be measured in each stream.

Based on this information, the various trade-offs between multiplexing and dedicated analysers, GS Omni versus XRF, capital and maintenance cost etc., can be worked out so that a recommendation can be made for the best system configuration for the particular plant.

For example, in a nickel concentrator, it is essential to control the concentration of talc (or MgO) in the concentrate stream. To be able to control the concentration of talc in the concentrate requires measurement of Ni and talc in each of the feed, rougher concentrate and final concentrate streams so that the appropriate concentration gradients between these can be optimised and the ratio of Ni/talc can be maximised at each stage for minimum reagent usage. It may also be useful to measure Fe and S in the feed stream because this may give an indication of the nickel mineralogy entering the plant. In all other streams, it is only necessary to measure Ni because the information from these streams is used only for monitoring the recovery of Ni. Thus, an GS Omni would be required with multiplexing for the three main streams, and possibly a Multi-Stream Analyser (with XRF technology) for the other streams.

Conclusion

Thermo Scientific's recent developments in on-line slurry analysis now make it possible to select an on-line analysis system which more closely meets the specific needs of a particular plant. The optimum analyser system configuration is often a combination of different types of analysers.