INTRODUCTION TO SAMPLING FOR MINERAL PROCESSING

Part 4 in a series “Metallurgical Samplers”
1 - Introduction to course and sampling
- Course objectives
- Course introduction
- Objectives for sampling

2 - Sampling Basics
- Some definitions
- 3D/2D/1D Sampling
- Delimitations / Extraction
- Rebounding / Cutter Speed and geometry

3 - Sampling Errors
- Delimitations / Extraction
- Bridging / Cutter issues / Multiple cutters
- Back pressure

4 - Metallurgical Samplers
- Belt Samplers / Crushers
- Linear Samplers and enclosures
- Rotary Vezin / Arcual Samplers
- Secondary / Tertiary Samplers

5 - Process Control Samplers
- Launder / Pressure / Poppet sampler
- Analyzers (XRF or particle)

6 - Effects on Mass Balancing
- Some aspect of the AMIRA code
- Detrimental effects and metallurgist responsibility
- Sampling errors in launder / pressure sampler
- Mass balance effects

7 - Effects on Recovery and NSR
- OSA and sampler errors
- Grade and Recovery targets
- Recovery - Error propagation
- Net Smelter Return - Error propagation (loss of revenues)
Objectives of Metallurgical Samplers

• Metallurgical Samplers
  – Used for metallurgical reconciliation
  – Requires samples that represent actual metal grades
  – Should be probabilistic
  – Composite samples for laboratory analysis
  – Can be used for process control
Metallurgical Reconciliation

- Mine to Mill Reconciliation – comparing the mine reports to the tonnes, grade and metal processed by the mill
- Mill to Sales Reconciliation – which matches the mill metal production reports to the sales results in a specific period of time.
- Metallurgical Balance: Metal grade in Plant Feed = Final Concentrate + Final Tailings.
- Permits defining a budget for what the company will produce = funds to be received
Sampling - Golden Rule

• The “golden rule” states that for correct sampling “all parts of the material being sampled must have an equal probability of being collected and becoming part of the final sample for analysis” (Gy)
Sampling System

- For a representative sample:
  - The total stream should be sampled
  - The sample cutter should intersect the sample at right angles to the flow
  - The sample cutter should travel through the stream at a linear and constant speed (speed deviations < max +/- 5%).

- Composed of the sampling implement and the sampling protocol
- Sampling systems must be flexible enough to permit adjusting the number of increments collected for each sampling lot
Precision

• The magnitude in terms of random variations between replicate measurements (Ex.: +/- 1 kg)
• The degree to which repeated measurements under unchanged conditions show the same results
• Error or variance between two or more measurements
• In sampling, precision is based largely on the heterogeneity of the ore coupled with the number of increments collected
Precision
Central Limit Theorem

- Definition for sampling:
  - The variance of the mean of n increments is n times smaller than the variance of a single increment

\[ \sigma^2_m = \sigma^2_i / n \]

- \( \sigma^2_m \) = variance of mean
- \( \sigma^2_i \) = variance between increments
- \( n \) = number increments
Central Limit Theorem

• Number of primary increments is the most important parameter in a sampling regime
• Variance in results tend to cancel each other out and the results tend to cluster around a central value
• The more increments that are taken the more precise the result
• There is an interleaving sampling test which can be performed to determine sampling variance
Cross Stream Sweep Sampler
ARM48 Sampler
Proper Cutter Orientation
Cross Stream Sweep Sampler
Multi-Stage Sampling Tower
Cross Stream Sampler - Slurry

- Electric Drive System - Model LDLE (Pneumatic Drive Available - Model LDLP)
  - Ensures uniform cutter velocity through the material stream
  - Non-reversing motors last longer

- Vapor Seal
  - Minimizes vapor and dust from entering drive area through underside of sampler

- Cutters and Cutter Caps
  - Designed to suit each application
  - Ensures correct increment delimitation and extraction

- Rubber Seal
  - Eliminates sample contamination

- Inspection Door
  - Easy removal
  - Full access for inspection and maintenance
  - Provides protection from dust and moisture

- Low Profile Integrated Cutter Enclosure (ICE™)

- Process In

- Process Out

- Process Connection Inlet
  - Easily adaptable
  - Flanged pipe or launder
  - Vertical or side feeding
  - Feed entrance ensures representative samples

- Inspection Doors
  - Convenient location for cutter adjustment and maintenance

- Rubber Lined Inner Surface
  - Prevents wear
  - Special lining materials are available

- Process Connection Outlet
  - Easily adaptable
  - Open, flat, and transition bottoms available
  - Simplified plant design and installation requirements

- Sample Outlet
  - Feed to secondary sampler or sample pump for analyzer feed
  - Flow controlled to specific rate

- Drip Rings
  - Eliminates sample contamination into sample launder

- Sample Launder
  - No splashing
  - No accretion
  - Sample integrity preserved

- Inspection Door for Sample Launder

- Artists Concept
Turnkey Flotation Feed Sampling System
Rubber Lined Enclosure
Cross Stream Sampler - Slurry

- Top Mounted Inspection Doors in Three Pieces
- Rotating Sample Cutter
  - Independent cutting
  - Axial openings with minimum 15% cutter opening
  - 1 to 4 cutters available
- Extra Large Inspection Doors
  - Convenient for cutter maintenance
  - Hinged with latches for easy access
- Cutter Cap Technology
  - Latest improvements
  - Easily replaceable one-piece cap is always installed correctly
- Rubber Lined Inner Surface
  - Natural rubber and neoprene material
  - Other special lining materials available on request
- Multiple Installation Configurations
  - Can be open bottom for mounting on pump box
- Transition Connection
  - Pipe flange also available

- Patented Pneumatic Drive
  - Ensures uniform cutter velocity through the material stream
  - Follows accepted rules, eliminating sampling bias
- Sample Cutter
  - Easily replaceable
  - Cutter blades, available in various materials
  - Field adjustable
- Primary Flow In
- Inspection Doors
  - Convenient location for cutter adjustment
  - Large, hinged, easily accessible
- Rubber Lined Inner Surface
  - Prevents wear
  - Special lining materials are available
- Sample Out
MILL DISCHARGE SAMPLER
PRIMARY - MODEL 1330 w/ ICE® SECONDARY - MODEL 4810 VEZIN
TERTIARY - MODEL 4510 VEZIN

MODEL 4810

MODEL 4510
Moving Inlet Sampler
Moving Inlet Sampler

Model 1850 with Swirl Tank
Light Duty, Low Profile
For more information you can always contact us at:
www.heathandsherwood64.com