Ultrasonic Extinction for Full Concentration, Real Time Particle Size Analysis in the Mining Industry

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Procemin 2011
8th International Mineral Processing Seminar
30 November – 2 December 2011
Sheraton Santiago Hotel & Convention Center, Chile
www.procemin.cl
Ultrasonic Extinction

Addresses limitations with optical or mechanical systems

• Analysis without dilution
• Representative sample
• Complete size distribution
• Simple integration
• Highly robust

• Wide size range
• Wide concentration range
• Solids concentration
• Adaptable duty
• Contamination resistant
Fundamentals

Particle-wave Interactions

- Particle << wave length
  - Entrainment

- Particle >> wave length
  - Scattering

Special case:
- Particle ≈ wave length
  - Resonance

Lambert-Beer’s equation

\[-\ln \left( \frac{I}{I_0} \right)_{f_i} = \Delta l \cdot C_v \cdot \frac{1.5}{x} \cdot K(f_i, x)\]

Extinction Function: Obtained from one time reference analysis
Instrumentation

- **Attenuation spectrum**
  - 31 frequencies
  - Fast scan < 60 sec.
  - High dynamic range (160 dB)

- **Cumulative (Q3) Distribution**

- **Density (q3*) Distribution**

- **Background (Fluid)**

- **Normal (Fluid & Particle)**
Realisation

OPUS specification

❖ Process conditions

➤ Temperature: 0..120 °C (150 °C optional)
➤ Pressure: 0..40 bar
➤ pH-value: 1 - 14
➤ IP65, ATEX II 2G EEx p II T5

❖ Measuring conditions

➤ Suspensions & emulsions
➤ 0.01 µm - 3000 µm
➤ 31 size classes
➤ Volume concentration: 1 to 70 % vol.
Process Adaptation & Scaleability

- Standard OPUS may be adapted to a wide range of process adaptations through addition of adapters
- Adapters user fitted on site
- Allows single OPUS to move from lab to pilot to full scale

- OPUS/FT – Flow-Through Adapter, Ø < DN 25
- OPUS/BP – Bypass-Adapter, Ø DN 25 – 200
- OPUS/AF – Adapter flange, Ø > DN 200
Applications

Copper grinding plant: on-line control of 3 lines

- **product:** copper nickel ore
- **installation:**
  - mill-cyclone stage
  - 3 lines on 1 sensor
  - integrated & automated water flushing
  - 24/7 operation
- **measuring cycle:**
  - 3min/line (incl. cleaning sequence)
Applications
OPUS - Copper grinding plant

• Set-up
Data output

Complete size distribution obtained for each point

Concentration information:
Shows process changes, PSD unaffected
Application B

Fluor spar: on-line & manual

- Set-up
  - Installed in flotation plant
  - OPUS integrated into an automated sampling and sample circulation system using an FT25-Adapter.
  - Measuring station 2 lines alternating + manual
  - Manual sample (10-20 litre) decanted into tank
  - Highly variable concentrations
  - Dilution and stirring to roughly degas
Application
Moderate amounts of bubbles tolerated due to detection at low frequency and correction in main frequency range

System can use different frequency ranges and gap sizes – automatically selected for each sample stream
Droplet size Analysis

- Ultrasonic extinction applied to droplets
- Solvent extraction applications
- Mixer box characterisation
- Optimisation of extraction and separation
- Same instrument for slurries and emulsions
- In situ, real time analysis
- Long probes for depth profiling
Applications - Emulsions

Kerosene in Water

X50% values from 490um to 40um on single instrument setting
Maintenance

- Service intervention
  - By local operator
    - Occasional rough cleaning of sensor
    - (usually after major plant problems)
  - Sympatec service
    - Annual service
    - Remote diagnostics
    - Training of operators, assistance with new products

- Parts usage
  - If flows managed sensor elements can last many years

- Recalibration NOT necessary
  - In event of sensor replacement a simple procedure of checking gap size, automatic alignment of sensor and new background reading
Conclusion

• Full Particle Size distribution (31 classes)
  Detection of coarse and fines when both variable
  No pre-knowledge of distribution required
• Excellent sampling statistics
• Solids concentration analysis independent of PSD
• Robust mechanical design, low maintenance
• Sample dilution not normally required
• Bubbles tolerated, detected and corrected
• Very contamination resistant
• One time configuration
• Transportable for optimisation and scaleup