Particle-capturing performance of South African non-corrosive samplers

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Particle-capturing performance of South African non-corrosive samplers

- Sample the respirable fraction of dust
- Different samplers used world-wide
- Pilot study during 2007/2008 revealed that D50 values were scattered between 2 and 42 µm
- Samplers have an effect on the analysis results of silica
- Project to access the particle-capturing performance of some South African samplers (also known as cyclones)
Particle-capturing performance of South African non-corrosive samplers

Objectives:

• To compare the performance of two locally manufactured samplers with one another under laboratory controlled conditions

• Not to discredit manufacturers or suppliers

• To illustrate the need for standardisation of samplers within the South African mining industry
Particle-capturing performance of South African non-corrosive samplers

Methodology:

• New samplers from different suppliers (4 \( \mu \text{m} \) cut-point)

• Laboratory tests:
  
  - Physical properties
  
  - Aerodynamic properties
  
  - Particle size distribution with standard dusts: polydisperse particle standard (1 – 10 \( \mu \text{m} \)), Arizona dust (3 – 30 \( \mu \text{m} \)) and platinum mine ore dust (< 100 \( \mu \text{m} \))
Physical properties of the samplers

Samplers used in the study:

- Samplers obtained from three suppliers: two local and one international
- Locally supplied samplers will be referred to as X-Samplers and Y-Samplers
- Aluminium sampler was used as the control
Physical properties of the samplers

- X-Samplers: cone shaped top
- Y-Samplers: flat top => differences in outlet shape could affect the dust distribution on the filter
- Differences in barrel length
- Area of inlet apertures were different between the samplers types => different air velocities through the aperture
- Although there were differences between each type of sampler, physical properties were consistent within a group
Physical properties of the samplers

Burrs are visible in outlet (right) and inlet (below) – poor finishing
Physical properties of the samplers

Inside of Y-Sampler (right)

Rough inside of X-Sampler (below)
Visible differences between dust distributions
Aerodynamic properties of the samplers

• Pressure loss through X-Samplers showed poor consistency
• Pressure loss through Y-Samplers showed good consistency
• Air velocities compared well between the X- and Y-Samplers
Particle size distribution of sampled dust

• Particle size distribution of sampled filters was analysed using the laser light scattering technique

• Light scattered by particle into detector depends on particle size, shape and refractive index

• D50 = 50% of the sample has a particle size below this value

D90 = 90% of the sample has a particle size below this value
Particle size distribution of sampled dust

- Respirable dust is defined as particulate passing through a cyclone with an efficiency that will allow:
  - 100% of 0 μm Aerodynamic Equivalent Diameter (AED);
  - 50% of 4 μm AED;
  - 30% of 5 μm AED; and
  - 1% of 10 μm AED.
Particle size distribution of sampled dust

Polydisperse Particle standard (1 - 10 micron)

Respirable Particle Mass (%) vs. Particle size distribution (μm) for Aluminium, X-Samplers, and Y-Samplers.
Particle size distribution of sampled dust

ARIZONA TEST DUST (3 - 30 micron)

Particle size distribution (μm)
Respirable Particle Mass (%)
Y-Samplers X-Samplers Aluminium
Particle size distribution of sampled dust

Platinum mine ore dust (< 100μm)
Particle size distribution of sampled filters taken in three platinum mines

Supplier X: D50 & D90 of actual underground sampling

Particle size distribution (μm)

Frequency

Particle size distribution (μm)

D50 D90
Particle size distribution of sampled filters taken in three platinum mines

Supplier Y: D50 & D90 of actual underground sampling

Particle size distribution (μm)

Frequency

Particle size distribution (μm)

D50
D90
Particle size distribution of sampled filters taken in three platinum mines

PSA results according to mine

MINE A

MINE B

MINE C

Particle size (µm)

Dust concentration (mg/m³)

X-Samplers  Y-Samplers  X-Samplers  Y-Samplers  X-Samplers  Y-Samplers

Avg D50  Avg D90  Avg Dust
Particle size distribution of sampled dust

- Particle larger than 10 μm were deposited on the filters => larger XRD response
- Different performance with different standard dusts
- Different performance with dust from different mines within the same commodity
Conclusions & Recommendations

- Samplers within the South African mining industry needs to be standardised to ensure reliable, consistent and comparable results.
- Quality assurance protocol for manufactured samplers.
Future research

• ISO SC2 Workgroup 7: Silica measurements
• Two new work items: X-ray diffraction method
• Effects of samplers
• Internationally used samplers – laboratory tested and compared
• Both X- and Y-Samplers were submitted for this study
Future research

- CSIR Centre of Mining Innovation to continue research on these and other samplers used in the SA mining industry
- The effect on XRD Response due to varying performance of national samplers
- Collaboration with users of samplers
- Collaboration with manufacturers of samplers to ensure consistent and comparable performance
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