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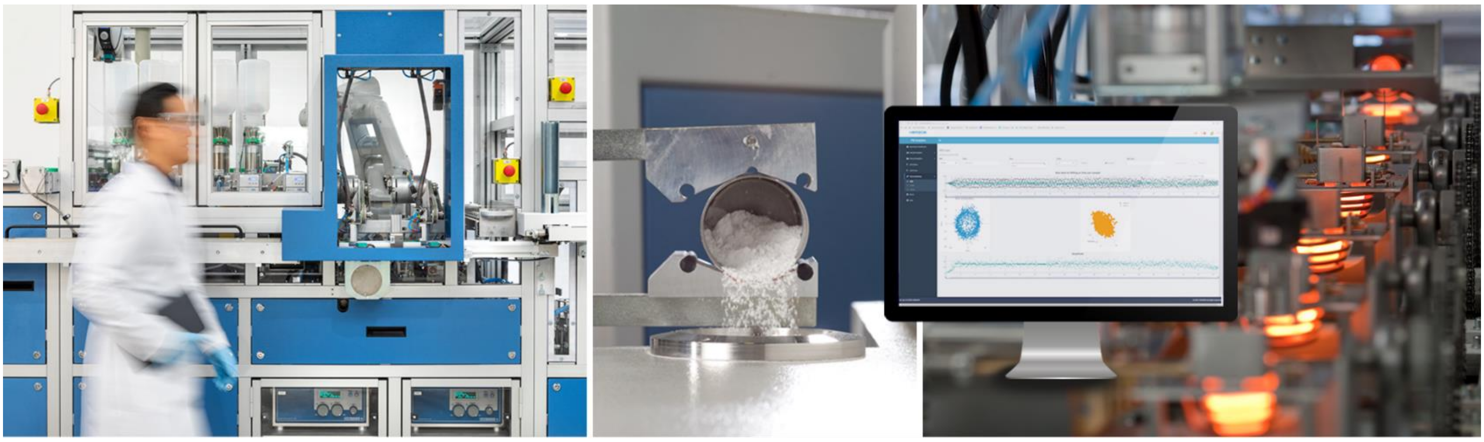
HERZOG



Tool Condition Monitoring of the HP-SST Sieve Tower for Reliable Particle Size Analysis

Abstract

This Application Note describes a sensor-based approach for monitoring the mechanical condition and screening efficiency of the HERZOG HP-SST sieve tower used for particle size analysis of lump iron ore in accordance with ISO 3082 and ISO 4701. A 3D acceleration sensor mounted on the vibration frame records the kinematic behavior of the machine during idle runs, while data acquisition and evaluation are performed via the HP-SST PLC and PrepMaster Analytics. Measurements under reference and intentionally disturbed floor-anchoring conditions reveal characteristic changes in the x/y and x/z acceleration trajectories. These deviations correlate with impaired rotational motion and reduced screening performance, enabling robust tool condition monitoring, early fault detection and predictive maintenance in automated, high-throughput laboratories.

Key words

• Particle size • Iron ore screening • Tool condition monitoring • Sieve tower HP-SST •

Introduction

Particle size analysis of ores is a key step for process control, plant performance and product quality in the mining industry. In the iron ore sector, international standards such as ISO 3082 [1] (sampling and sample preparation of iron ores) and ISO 4701 [2] (determination of size distribution by sieving) provide the framework for representative and traceable particle size measurements. Within this framework, mechanical sieve towers are widely used to determine the particle size distribution of lump iron ore in a reproducible and standardized way.

The HERZOG HP-SST sieve tower (Figure 1) is widely established as a standard solution in the iron ore industry. Integrated into robotic automation systems, it enables fully automatic sample loading, weighing, sieve cleaning and restacking. Plugged apertures are detected automatically and affected sieves are replaced, ensuring a norm-compliant, highly reproducible and largely operator-free screening process, even in high-throughput laboratories.

Screening efficiency strongly depends on the ability of the particles to follow a sufficient throwing parabola on the sieve surface, which requires a stable and well-defined acceleration vector in all three spatial directions.

Figure 1: HP-SST integrated in a robot cell- photo shows HP-SST during unloading of sieves.

Any disturbance of this acceleration pattern can significantly decrease screening performance and thus impact the reliability of the particle size result. In this Application Note, we present a method to monitor the screening efficiency and mechanical condition of the HP-SST using a 3D acceleration sensor.

The sensor-based approach evaluates the kinematic behavior of the machine during idle runs and provides a robust basis for tool condition monitoring, early fault detection and consistent particle size measurements.

Methods

The 3D acceleration sensor is mounted on the top of the vibration frame of the HP-SST. Signal acquisition is performed by the PLC of the HP-SST, while data evaluation is carried out using the PrepMaster Analytics Software Suite. Measurements are taken after completion of the screening cycle and after the HP-SST has been reloaded with a new sieve stack. During the measurement, the sieve tower is operated at the same amplitude as in regular screening operation. The recording time for each measurement is approximately 20 s.

For this Application Note the acceleration measurements were carried out under two operating conditions:

1. **Reference condition** with correct and rigid floor anchoring of the HP-SST.

2. **Fault condition** after slightly loosening the front-left floor fixing screws.

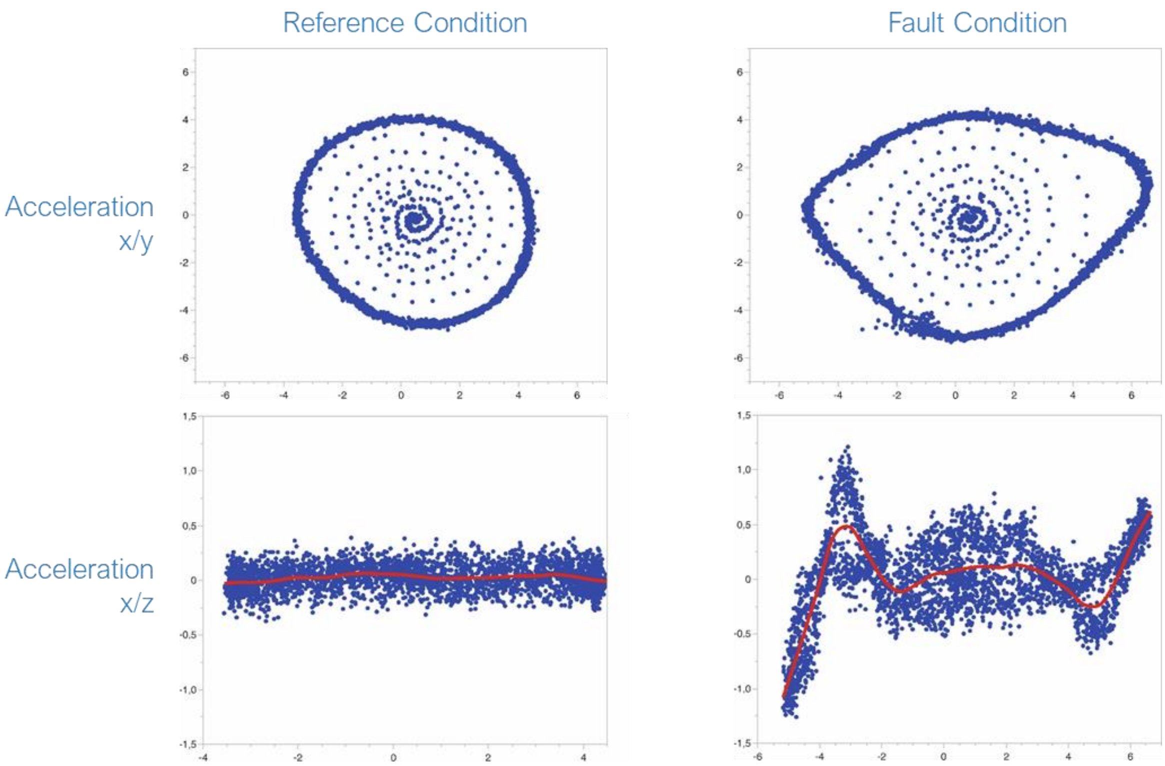


Figure 2: Acceleration patterns in the x– and y–directions (upper row) and x– and z–directions (lower row). The normal reference condition is shown on the left, the fault condition after screw loosening on the right.

Results

Under reference conditions the x/y acceleration plot shows an almost circular trajectory, indicating a uniform rotational motion. The x/z plot forms a narrow band with only minor deviations in the z direction above and below the centerline (Figure 2, left).

After loosening the floor fixation, the x/y plot shows a pronounced deformation with significant broadening in the x direction; the curve clearly deviates from the ideal circular shape. In the x/z plot an increased amplitude in z direction is observed. The deviations in z direction are particularly pronounced at the maximum x values (Figure 2, right).

Discussion

The results demonstrate that 3D acceleration measurement is a simple yet very powerful method for assessing the mechanical condition of the HP-SST sieve tower. Deviations of the measured x/y and x/z trajectories from the reference pattern provide a clear indication of faulty rotational motion and can be directly linked to changes in screening performance [3, 4].

From a process perspective, any disturbance of the ideal acceleration pattern reduces screening efficiency in several ways. Uneven or reduced acceleration in one spatial direction impairs the throwing parabola of the particles [3, 4, 5]. Instead of being lifted and projected across the sieve surface, particles tend to slide or roll, which decreases bed loosening and limits the probability that near-cut particles reach and pass the apertures within the available time.

Disturbed motion also causes local variations in bed depth and residence time, creating stagnant and over-excited zones on the sieve deck. This non-uniform separation deteriorates cut sharpness, shifts the effective cut size and increases the measurement uncertainty of the particle size distribution.

In addition, insufficient three-dimensional motion promotes plugged apertures and agglomeration of fines, so that fine material is systematically retained and the fines content is underestimated unless screening times are significantly increased.

These effects directly impact the analytical result: disturbed acceleration leads to biased and less reproducible particle size distributions, which in ISO-based QA/QC environments translates into higher test uncertainty and reduced confidence in trend data for process control. While the presented example focuses on a loosened floor anchoring, similar changes in the acceleration signature can arise from wear or defects in the eccentric unit, misalignment of the drive, bearing damage or unbalanced rotating parts.

Continuous monitoring of the HP-SST is implemented via PrepMaster Analytics. Using the integrated Tool Condition Monitoring (TCM) dashboard, dedicated idle runs are triggered at regular intervals and the acceleration data are evaluated by statistical process control (SPC) methods and, optionally, AI agents trained on sensor-based TCM data. This enables early detection of mechanical anomalies, supports predictive maintenance and helps to secure consistently high screening efficiency and reliable particle size measurements in automated, high-throughput laboratories.

References

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