Online monitoring of the interaction of balls and slurry with the Sensomag®

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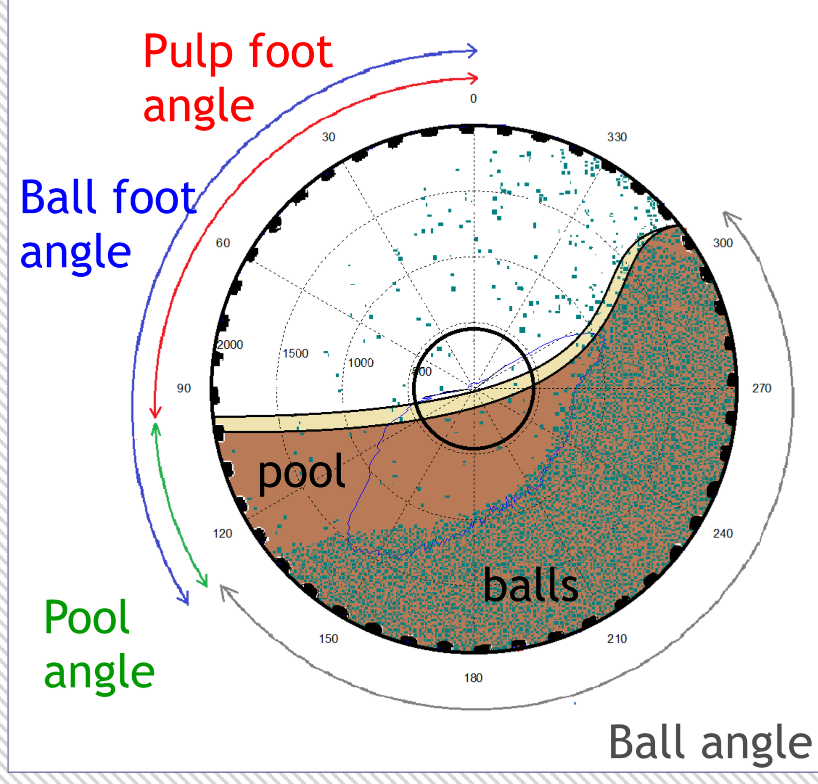
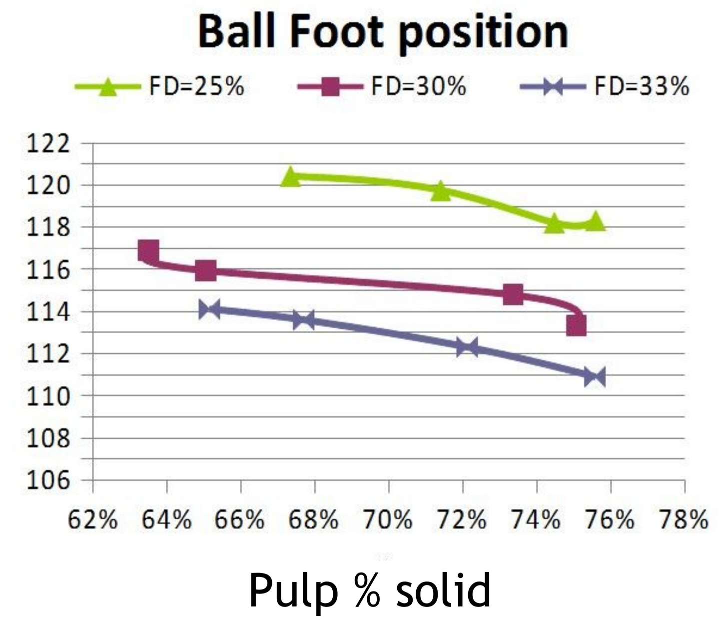
Objectives

Through the online measurement of conductive and inductive signals, Sensomag® continuously records balls and pulp position in an operating ball mill. Several surveys were made on a full scale plant. To study how the % solid of the slurry and the ball filling degree affects the signals and the grinding.

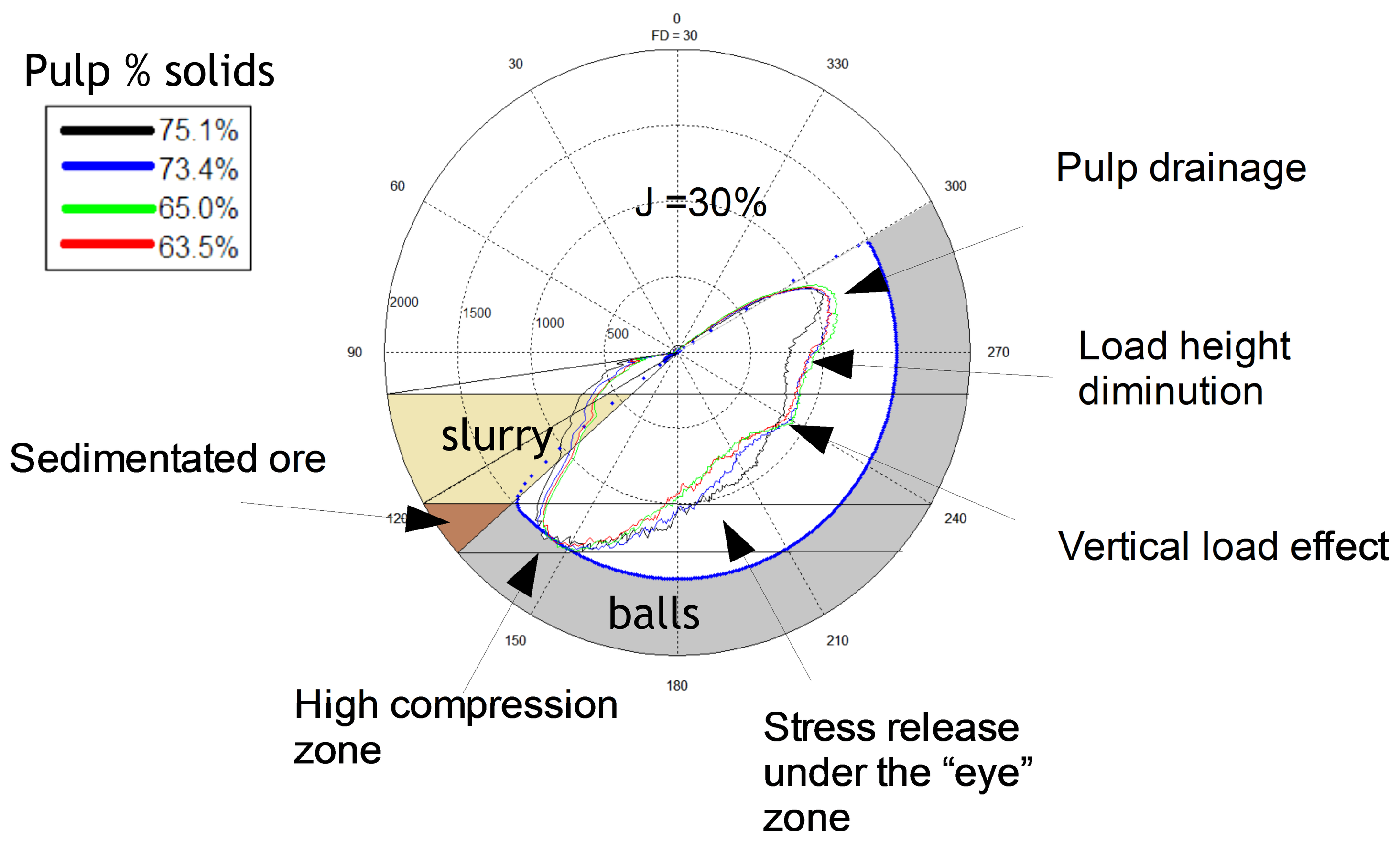
Angles analysis

Angles are measured counter-clockwise from the vertical. Conductive signal indicates the limits of the pulp. Inductive signal indicates the limits of the ball load. All the angles seems to be strongly correlated to the % solids and the ball filling degree (FD).





Shape of conductivity curves



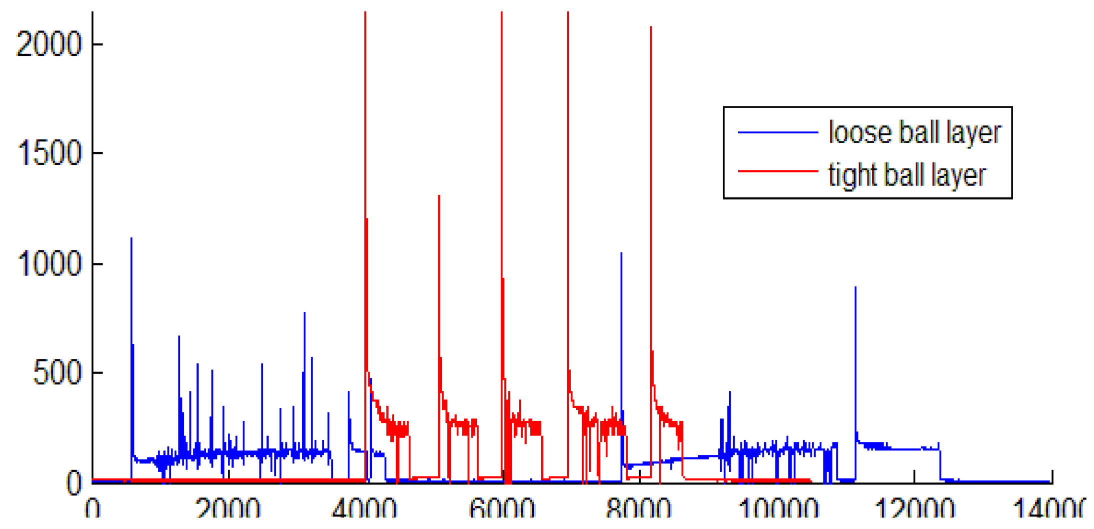
Conductivity measures reveal that balls spacing varies around the ball load. Balls become close in the vicinity of the ball foot where important strains occurs due to balls chute and the lifter entrainment. Then stresses are released thank to the presence of an overhang dead zone, usually called the "eye".

On the upward side of the shell, strains increase again to reach a maximum around 240°, then another decrease is observed. This one is probably related to the fact that the vertical load is maximum. Then the vertical load decreases as the sensor goes up. The last peak is liked to the slurry drainage, as slurry flow out of the balls interspaces, the balls are closer again.

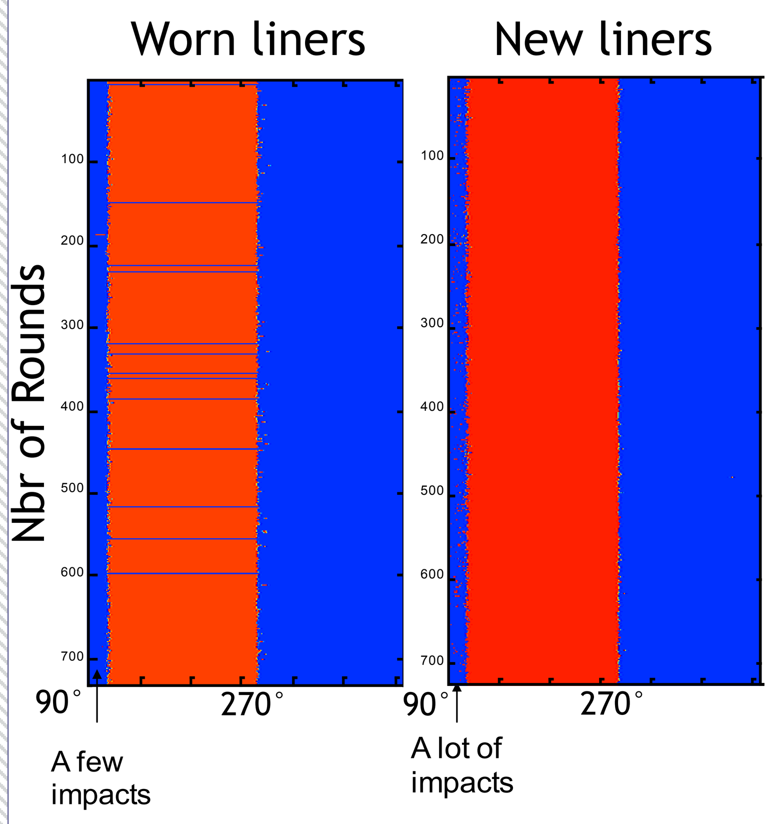
Depending on the % solids of the slurry, the zone corresponding to the « eye » is noticeably more or less marked.

Batch tests: influence of ball

A batch sensor is made of electrodes mounted on a bar. This bar is moved along a layer of balls immersed in salted water to simulate the motion of the probe along the ball charge. This experiment shows that the ball layer geometry influence the conductive signal. Experiments also show that the current intensity is linked to the amount of charged particles in the vicinity of the electrodes. If the probe is laid unmoving, the current quickly decreases and soon completely disappears.



Inductive signal

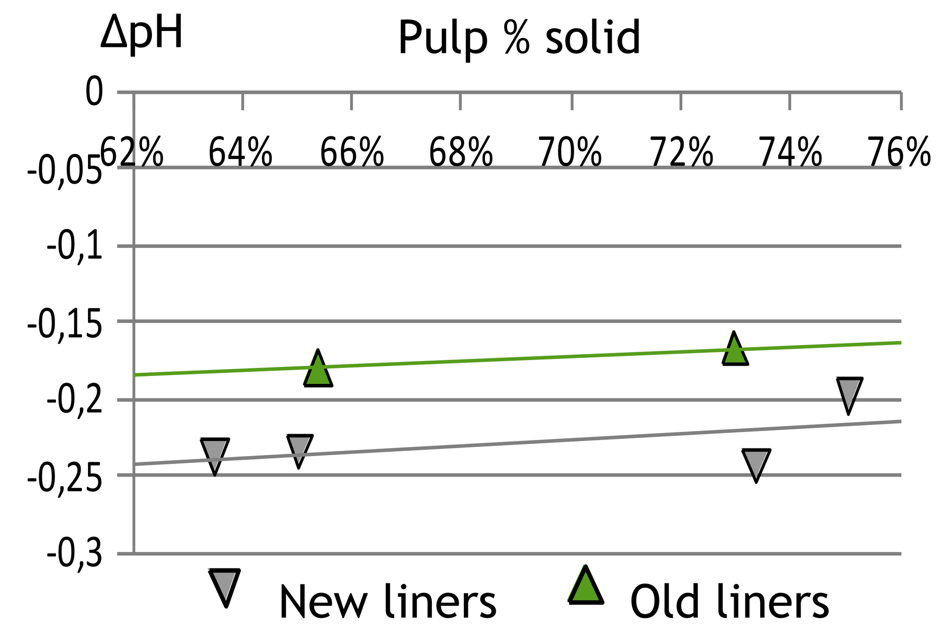


Inductive signal is binary, it equals one (red) when balls pass in front of the probe, zero (blue) the rest of the time.

New liners favour cataract ball chute and reduce impacts on the shell. Consequently, some air bubbles are incorporated in the pulp, which imply:

Modification of slurry rheology: the pulp angle decreases.

Modification of pulp chemistry : the amount of dissolved O_2 in the pulp is reduced so sulphides oxidation is limited and pH decrease (ΔpH) throughout the mill is smaller.



Conclusion

The Sensomag® signals are useful to understand and monitor pulp and balls interactions. More accurate information may be obtained from these signals concerning pulp potential and rheology. Additional survey and data processing is still needed.

Acknowledgments

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