



IFPRI Project Abstract

A Systems Engineering Approach to Dry-Milling with Grinding Aid Additives

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Project Objective:

1. Develop a system engineering approach for optimizing and scaling industrial dry fine grinding processes.
 2. Obtain numerical relations about the effect of grinding aid additives and humidity on material behaviour, process aspects and energy requirements.
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Material and Methods:

- ✓ **Material:** Calcinated alumina from Almatix Inc. and Calcium Carbonate from the IMERYS Minéraux Belgique SA.
 - ✓ **Grinding aid additives:** Diethylene glycol (DEG) and Heptanoic acid (HepAc).
 - ❖ **Test equipment (for this report):** Two dynamical air classifiers, the 100MZR in laboratory scale and the ATP-100 in industrial scale, both from Hosokawa Alpine.
 - ❖ **Approach:** The classifiers were operated in passage mode, with samples collect from the feed material and both coarse and fine products outlet for particle size distribution and mass flow rate measurements. Tromp curves were determined for all tests.
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Recent Results:

The first two years of this project focused on mapping which process aspects of batch and continuous ball milling are affected by grinding aid additives and how to implement those impacts into already established population balance models. The current funding period focused then, on the air classification stage and on closed circuit milling, mainly in terms of impacts by the use of additives. This document will deal only with air classification since closed circuit trails are still being conducted.

In order to allow the comparison between two scales of equipment, this study used a non-dimensional ratio between classifiers air volume flow and the wheel tip speed times the wheel open area, called here as process parameter ratio. Figure 1 presents the corrected cut size for the 100MZR as a function the process parameter ratio for different material additives. It is evident that the process cut size is not directly affected by the use of grinding aids. This indicates that, in terms of particle size, plant product quality is determined mainly by the classification stage. Figure 1 also presents the bypass of fine particles to the course

outlet. Interestingly, this process inefficiency was only reduced by the use of grinding aids for mid-range values of the process parameters ratio. The following can be concluded: for coarser cut sizes, the classifier don't require additives for an efficient operation and negligible recirculation of fines are observed. As the cut size reduces, the presence of additive become advantageous to maintain a low bypass. However, for very small cut sizes, near the minimum size achievable by the equipment, the process will be inefficient, with or without additive.

Figure 1 compares also the cutsize and bypass variation with process parameters for the two equipment scales. These results confirm the conclusion mentioned before. Additionally, it is also observed that the intensity of the additive contribution is also related to the equipment design. A take home message is that, additive can improve plant efficiency in certain operation ranges, but the combination of a well-designed classifier allied with additives is the best choice.

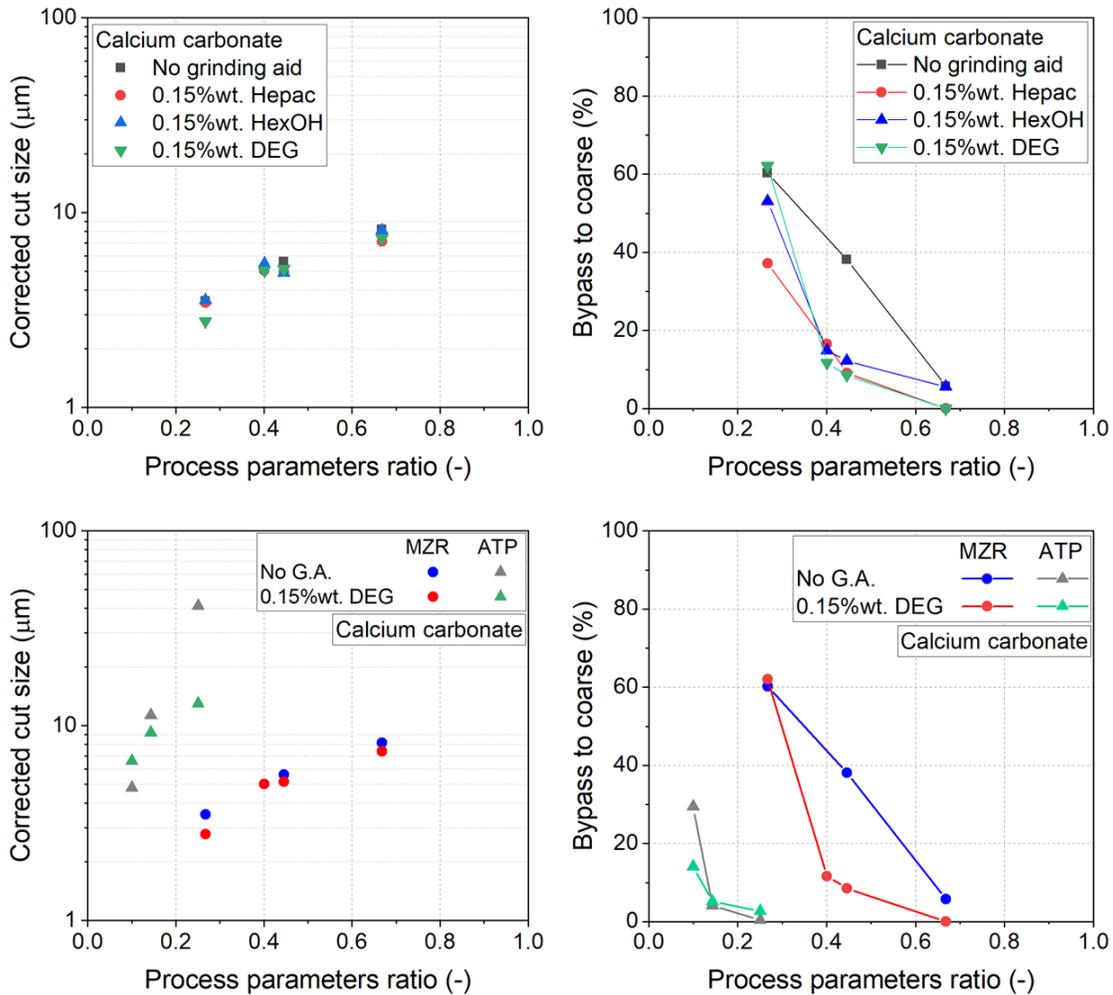


Figure 2: Variation of corrected cut size and bypass of fine particles to coarse outlet with process parameters and different material formulations for the 100MZR (Up) and between scales (below).

Next Steps:

Conclusion of closed circuit trial where the main variables are plant mass feed rate, classifier cut size and additive type. It will be observed mainly plant product size, powder recirculation rate and energy consumption on each unit.

Flowsheet simulation experiments conducted based on population mass balancing. The project finding, in the point of view of additives impacts, will be used to adapt current models from literature. Additionally, it will be proposed a standard material characterization procedure, in the sense of obtaining the parameters required for process simulation.
