IFPRI Project Abstract

Development of innovative tools to characterize the drying of wet powders under shear

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Project Objective:

The primary objective of this project is to characterize how shear can affect the state of agglomeration of products undergoing drying. To this end, we are developing different experimental tools that will allow easy implementation and testing of various powders and liquids while controlling the input energy and/or shear rate during the drying process. Some tools will be devoted to low mechanical shear, while others will be dry by airflow under large shear. The use of model granular materials, wetted by the addition of a binding liquid, will be compared to some powder products that often undergo such processing.

Approach:

The approach for this project is through experiments. We develop small-scale (laboratory) tools for studying the drying of wet powders with shear, characterizing the drying process by studying the evolution of the size distributions of agglomerates. The first year of the project focused on an oscillating box experiment, in which the powder and the liquid were introduced before agitating the mixture by providing shear through collisions via oscillations of the box. Following the first annual general meeting and the input of various industrial partners, an alternative approach is being developed where the shear is provided by airflow instead, combining both drying and mechanical shear stresses.

Recent Results:

During the past year, different developments have been explored:

- The development of a setup where the agitation is provided by an extended turbulent vertical airflow led to some first results such as the effect of the input pressure, grains size and total mass of grains on the average aggregate size. However, the amount of shear reached out was only moderate.
- Following discussion with industrial partners, we have developed a new system where the shear obtained is much larger and consists of two opposite turbulent jets close to each other in quasi-2D systems, providing a large shear in a small region. Some first measurements characterizing the flow in such a system and its effect on model wet granular materials have been obtained.

Next Steps:

The first AGM led to re-directing the experimental approach through drying by turbulent air jet, providing more intense and localized shear. The following steps of this project are to:

- Characterize the flow in a general closed system where two collimated jets are colliding, to estimate the maximum shear rate possible in such a geometry. This quantity is likely to play the most significant role in determining agglomerate size distributions. This step will help optimize the size, angle, and position of the nozzles and the bottom geometry of the system.
- Perform experiments with wet glass beads to identify if we could isolate fragmentation processes of cohesive aggregates.
- Perform experiments with calcium carbonate at ambient humidity and temperature to develop a postmortem measurement of the size distribution of aggregates.
- Add a controlled temperature and humidity to the incoming airflow.