Challenges in the Scale-Up of Dry Fine Milling Processes

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Dry fine milling plays an important role in many processes for processing solid bulk materials. Since the requirements regarding the particle size distribution of powders are increasing not only in terms of fineness but also with regard to the steepness of the distributions and top cut, classification often forms an essential part of these process steps – either in mill-classifier circuits or in classifier mills where a dynamic classifier is integrated into the mill. Therefore, both the efficient generation of fine particles inside the mill part and efficient classification are important for the production of fine powders with a defined top cut.

Using the fluidized bed opposed jet mill as an example, the scale-up procedure for a mill with an integrated classifier is presented. The desired fineness forms the basis for selecting the classifier type and the maximum size. The specific energy consumption determined in the tests for producing the desired fineness forms the basis for the design of the nozzles and grinding pressure, and thus the achievable throughput. Operating conditions often have a significant influence on the required specific energy consumption.

Initial studies of comminution processes are often carried out on a laboratory or pilot scale. During these tests, achievable particle sizes, specific energy consumption, media consumption and other parameters are determined, which then form the basis for scaling up to production scale. For many applications, there is sufficient empirical data to ensure a safe scale-up. However, there are also some topics that are currently not sufficiently understood and continue to lead to problems. These include:

- Finest achievable fineness and the influence of the material properties

- Occurrence or avoidance of wear

- Occurrence or avoidance of material deposits

There are still uncertainties when scaling up mills. For example, there is a lower limit to the achievable fineness. Initially, this phenomenon was attributed to the reversal of the flow through the deflector wheel, which occurs above a certain value of the ratio between radial and circumferential gas velocity (figure 1). However, it turned out that this lower limit is material-dependent, which could also indicate that the comminution limit was reached with the prevailing stresses. In our view, this is an important starting point for further research.

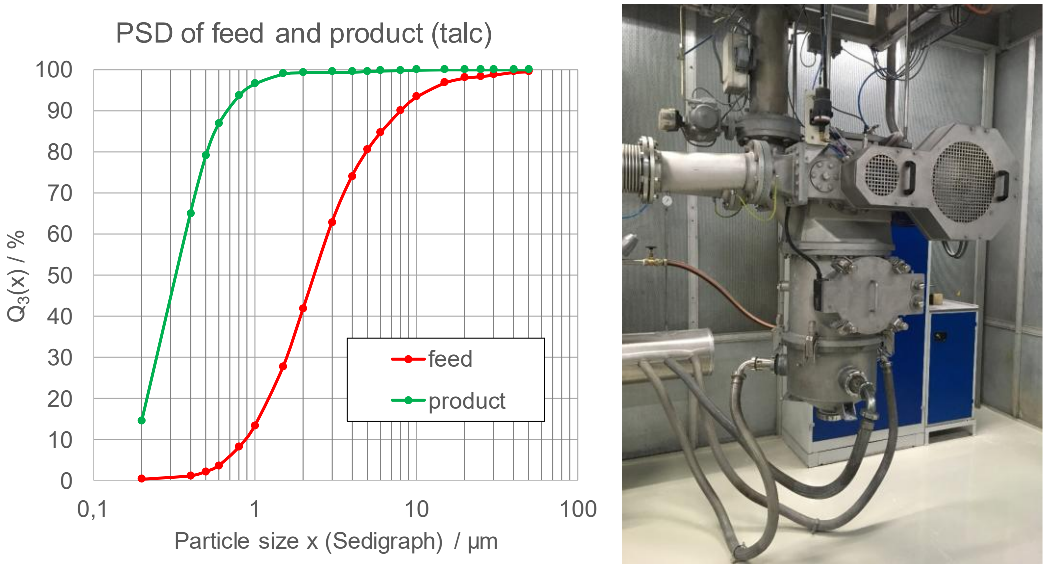

Figure 1: Image of the 400 TTD fluidized jet mill at the test center of HOSOKAWA ALPINE AG and particle size distributions of feed material and product of a test with talc [1]

The wear of system components, such as the deflector wheel, housing, or nozzles, is also not yet fully understood. Our own investigations have shown that operating conditions often have a significant influence on wear. It is often difficult to find materials that are both wear-resistant and yet meet the design requirements of high-speed rotors. There is still a great deal of development to be done in this area as well.

Reference:

Sander, S. and Droop, D. Current trends in air classification of fine powders, 16th European Symposium on Comminution & Classification (ESCC 2019), 2-4 September 2019, Leeds, UK