International Fine Particle Research Institute

Review Brief

In-line Characterization of Bulk Properties of Static and Quasi-static Powders

Dry bulk solids are uniquely difficult to characterize for process and product control. Static piles of powder represent a particular blind spot for traditional industrial instrumentation. Because static systems lack the dynamic shear forces of active flow, they are highly prone to hidden, localized consolidation, moisture-driven agglomeration, and asymmetric stress distributions, which can lead to catastrophic silo failures or sudden flushing.

IFPRI wishes to commission a critical review of methods for *in-line* characterization of the bulk properties of bulk solids and an evaluation of the suitability of such methods to detect troublesome storage and handling phenomena such as consolidation, agglomeration, flushing, segregation, and attrition. The review should focus on static or quasi-static powders, such as those in storage bins, hoppers, and silos. The review should consider:

- Non-invasive spatial imaging: process tomographies such as electrical capacitance or electrical resistance imaging
- Mechanical, acoustic, and stress-based sensors, such as silo wall hoop stress monitors and in-line drag force sensors, including soft sensors utilizing physical or correlative models
- Active sensors in which the powder is perturbed locally and its properties are inferred from the response to the perturbation

The review should include discussion of the breadth of application of existing in-line measurement and a high-level discussion of the difficulty and expense of implementing them.

In scope: characterization of powders ranging in diameter from millimeters to microns; single- and multi-component powders; humidity sensitive or insensitive materials. Application of artificial intelligence methods in passive and active sensors.

Out of scope: off-line or at-line approaches (except for calibration/validation of in-line measurements).