IFPRI Project Abstract

Quantitative Prediction of Segregation at Process Scale

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Project Objective:

This project is aimed at identifying critical material and process parameters that control the extent of powder segregation, such that we might develop quantitative models that predict segregation. These predictive models should be valid at full process scale and are to be validated against appropriate experiments.

Approach:

Segregation rate models hold promise for scale-up via continuum-level analysis using device-specific transport equations; however, experimental validation of dynamic models is extremely difficult and typical segregation models are not inherently built with scale-up in mind. Our approach overcomes the experimental limitation by exploiting a novel framework for segregation testing based on introducing a perturbation time-scale that establishes an "equilibrium" between mixing and segregation that is a function of the imposed (known) perturbations. With regard to the scale-up limitation, we have built – and continue to validate – segregation models that are written expressly in dimensionless form with an aim both to connect segregation modeling to flow rheology as well as to enable more transparent scale-up. We are using our experimental segregation validation framework both to benchmark existing segregation rate models as well as to test our new and developing models.

Recent Results:

Our most recent work has focused on archival publication of our previous work on model development and validation, as well as extension of our cohesive model beyond moisture-induced cohesion. As we transitioned the project to the oversight of a new graduation student, a DEM code was developed that can evaluate cohesion based on a more generic, surface energy (or van der Waals) mode. This simulation is being used to test the extensibility of our segregation rate modeling for cohesive materials.

Next Steps:

As the project wraps up, we intend to complete archival publication of all models, and set the stage for device-specific, applied modeling in the near future.