IFPRI Project Abstract

Modeling of screw feeder performance

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Project Objective:

The main objective of the project is to develop a theoretical understanding and predictive model for screw feeder performance. The model should predict the dependence of feeder performance on powder properties and feeder geometry, and consider complicating factors such as feed rate variations. The model predictions should be tested against experiments on diverse powders.

Approach:

A continuum mechanical model for slow granular flow will be applied to screw feeders. An experimental setup will be constructed to measure the mean flow rate, and the detailed velocity and stress fields to test the predictions of the model. DEM simulations will be used to validate and refine the theoretical studies and guide experimental measurements.

Recent Results:

- We have posed the equations of motion in helical coordinates, as they are most appropriate for flow in a screw feeder. The solution for frictionless screw in the absence of gravity was obtained using the non-local rheological model developed by us. The prediction of the of the wall stress is in qualitative agreement with experimental data.
- We had earlier determined the mean feed rate using our experimental feeder setup. Over the last year, we focused attention on the feed rate fluctuations. We showed that one cause of the fluctuations is the variation of the free surface slope at the exit. We have shown that placing the exit slot at the top of the end cap significantly reduces the fluctuations. Thus, feed rate fluctuations can be reduced by appropriate exit design.
- We have conducted DEM simulations that couple the inlet hopper with the screw feeder, to understand the effect of cohesion on inconsistent flow from the inlet hopper. While at an early stage, the study suggests that agglomeration is a key cause of variability.

Next Steps:

We will extend our modeling efforts to study the flow when the screw and shaft surfaces are frictional and when there is partial fill. We plan to extend the non-local model to cohesive powders, where we will account for agglomeration. We plan study feed rate variability arising from inconsistent flow into the feeder from the inlet hopper by experiments and DEM simulations.