IFPRI Project Abstract

Modeling of screw feeder performance

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Project Start Date: 21 October 2019
Abstract Date: 12 May 2022

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 flow variations at the feeder inlet. 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 used a non-local rheological model for slow granular flow, recently developed by us, to study flow in a single screw feeder. When the screw is frictionless and gravity is absent, the model recovers the solution of our earlier, simpler, model. The predictions of the of the wall stress are in good qualitative agreement with experimental data.
- Our experimental feeder setup was used to determine the feed rate of cohesionless glass beads; as predicted by the theory, we find an optimum value of pitch to diameter ratio for maximum feed rate. Our video imaging experiments indicate that the velocity field has a significant rotary component. We have also studied the flow of cohesive powders and find that their throughput is significantly higher than that of cohesionless powders, but fluctuations in the inlet flow are observed.
- We have conducted DEM simulations that couple the inlet hopper with the screw feeder. For short feeders, the fill height decreases with distance from the inlet, but long feeders remain nearly fully filled till close to the exit.

Next Steps:

We will extend our modeling efforts to study the flow when the screw and shaft surfaces are frictional, when there is partial fill, and to study axial variation of perturbations to understand flow variability and control. We plan further experiments and DEM simulations on inclined feeders, and feeders with a decreasing cross section area to promote even flow.