Design Space for Loss-in-Weight Feeders

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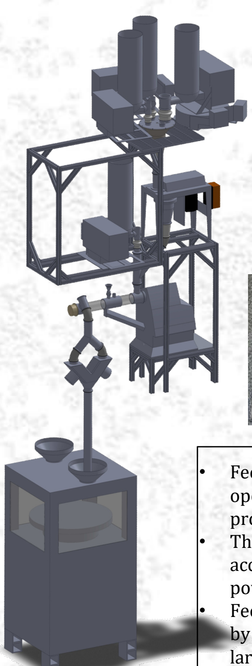
PURPOSE

In continuous manufacturing, loss-in-weight feeders play a vital role in controlling content uniformity. If, in a brief period of time, the feed rate of one ingredient changes with respect to the others, the change in concentration of the process stream can propagate throughout the system. Understanding how the feeder and the material behave is vital. Powder properties, such as density and cohesion, can cause large variability in the flow rate of ingredients fed from powder feeders. Also, one needs to understand the operational ranges of the feeder, i.e. percent motor power which coincides. Knowing an ideal range of operation and correlating powder properties to process performance, can lead to determining the design space of the feeder and faster optimization times, which would also save money and material. In this work, a K-Tron KT-20 pharmaceutical loss-in-weight feeder has been evaluated with four common screw types (coarse auger, fine auger, coarse concave, fine concave), various pharmaceutical powders (Avicel, Lactose Monohydrate, Magnesium Stearate, Acetaminophen, Metformin granules, etc.), and multiple feed rates.



K-Tron KT20 Pharma Feeder

Fine Concave (FC), Coarse Concave (CC), Fine Auger (FA), Coarse Auger (CA)

- Feeders are typically the first "unit operation" of any powder handling process
- The ability to sufficiently feed a powder accurately can make or break a potential powder formulation
- Feeding performance (evaluated mainly by setpoint deviation and variance) can largely effect the performance of subsequent unit operations

METHOD

FEEDER CHARACTERIZATION

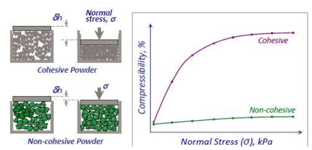
Once the feeder is assembled, the screw is selected, and the hopper is filled with the desired material, the next step is to calibrated the set up. Calibration provides the feed factor (FF) for a specific screw and material combination. A desired set point is then chosen and material is fed onto a catch-scale. The mass vs. time of the catch scale is then averaged, and a relative standard deviation (RSD) and relative deviation from the mean (RDM) are calculated. Lower values for RSD and DM are desired, related to a more accurate feeder, for a given set point.

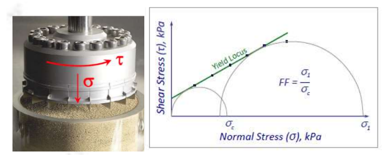
MATERIAL CHARACTERIZATION

***Freeman FT4 Powder Rheometer*: A multifaceted tool used to measure flow and bulk powder properties in the dynamic, static, transitional, confined, and unconfined states.**

Compressibility: *Change in density/porosity of a powder bed with an increasing normal*

Shear cell: *Compression and shearing forces are applied to a static powder bed in a annular shear cell*



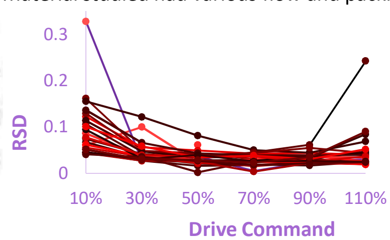


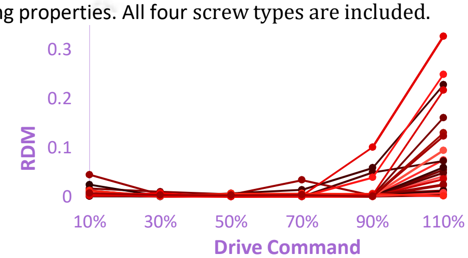
***Tapped Density*: increased bulk density attained after mechanically tapping a container containing the powder sample.**

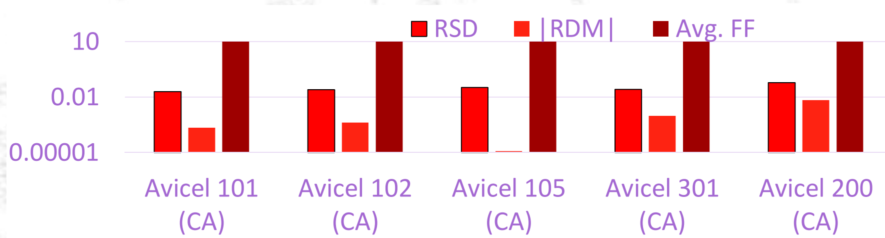
***Particle Size Analysis*: Powder is aerated and sized using laser diffraction Spectroscopy**

RESULTS

Material studied had various flow and packing properties. All four screw types are included.

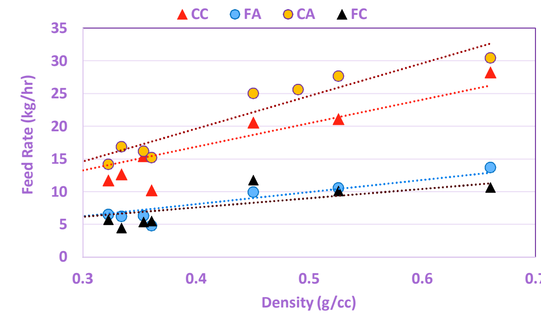






RESULTS

	D50 (μm)	cBD	Tapped Density	Hausner Ratio	FFc 3kPa	Feed Factor
MgSt	12	0.200	0.230	1.15	4.43	5.65
Avicel PH-105	19	0.354	0.545	1.54	2.31	16.22
Powder APAP	24	0.205	0.492	2.40	2.60	10.7
AcDiSol	45	0.490	0.681	1.39	9.26	25.63
Avicel PH-301	60	0.451	0.574	1.27	6.48	25.04
Avicel PH-101	66	0.323	0.461	1.43	5.53	14.2
Lactose 310	78	0.660	0.920	1.39	>10	30.47
Avicel PH-102	122	0.334	0.462	1.38	8.41	16.9
Prosolv HD90	135	0.526	0.625	1.19	>10	27.7
Avicel PH-200	210	0.361	0.417	1.16	>10	15.26



CONCLUSION

Based on experimental results, the ideal range of operation of the K-Tron feeder is between 30 and 80% of drive command. Material comprehensibility, via tapping or normal stress, plays a significant role on feeder performance. The initial feed factor can change at by a large amount based on screw fill volume and density of the material entering the screw. Material tapped density plays a more significant role, than aerated bulk density and particle size when determining the optimal range of feed rates and the maximum rate.

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