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Ask Joe! Column

The Bulk Solids Pump: A new feeder for free-flowing materials

Guest article by Everett Von Frank, K-Tron

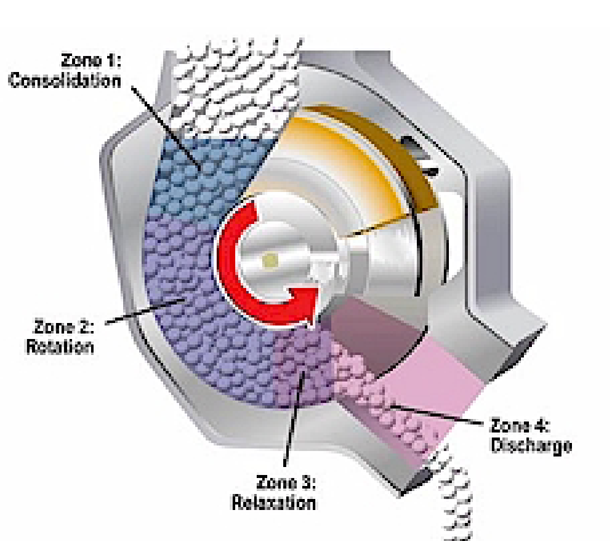
Introduction

Increasingly demanding performance requirements in hi-tech sectors of the plastics, food, pharmaceutical and other industries have brought traditional screw feeding technologies under critical scrutiny. Concerns such as second-to-second repeatability, full range linearity, simplicity and cleanability have risen in importance in recent years. In an effort to address these and other concerns, a new design approach to feeding has been developed.

The Bulk Solids Pump

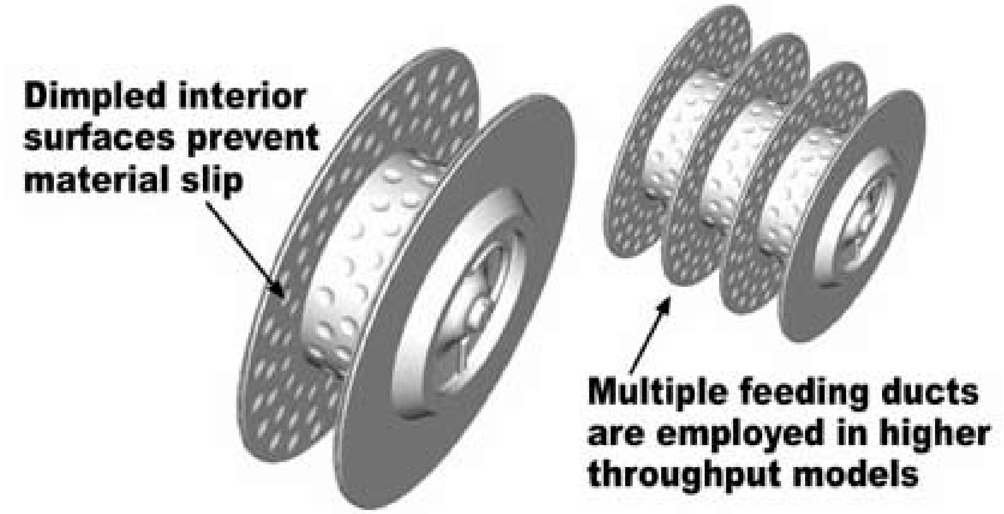
Known originally as Posimetric® feeding, this patented technology was first applied in the late 1970s to feed oil shale and coal into large-scale crushing equipment. It has now been adapted for process industry application, and has been introduced as the Bulk Solids Pump™ (BSP) by the K Tron Feeder Group of Pitman, NJ. The new feeder does not use the usual screws/augers, belts, pockets or vibratory trays to convey the material. It employs innovative positive-displacement action to feed pelletized, granular, flaked or other free-flowing materials with consistently high accuracy, uniform discharge and gentle handling in a true linear volumetric fashion.

The BSP employs one or more specially designed vertical rotating spools which create feeding ducts. Incoming material is captured in the duct and rotated to discharge. While within the duct the material 'locks up' and acts as a solid mass. Approaching discharge, inter-particle forces relax and discharge occurs by cascade at the material's natural angle of repose. The smoothness of material flow from the BSP is evident to even the untrained eye compared to the pulsing flow from a rotary valve or screw feeder. This smooth, even flow results in significantly improved accuracy levels, especially at short sample durations.



As illustrated in Figure 1, the BSP principle is best explained as consisting of four zones: consolidation, rotation, relaxation and discharge. In Zone 1 material enters the feeder and consolidates as particles settle and come into contact with one another and the sides of the duct. At the end of Zone 1 the material is fully constrained by the duct, and inter-particle and surface contact forces produce the lock-up condition. In Zone 2 the material rotates as a solid mass. As the material moves past the 6 o'clock position Zone 3 marks the approach to unconstrained discharge where inter-particle forces fall, the material relaxes and regains its natural flowability. Discharge occurs in Zone 4 where duct rotation causes the material to cascade from the feeder.

Figure 2 shows a more detailed rendering of the feeding duct. Since the BSP's operating principle exploits a material's ability to consolidate uniformly when confined and readily regain flowability when released, the BSP is not designed to handle powders prone to aeration and flooding or other materials that tend to clump or bind. Nonetheless, a quite broad range of free-flowing materials falls between these two extremes.



Note the dimpling of the interior surfaces of the duct and hub. These small depressions are effective in eliminating any possible slip that may occur when handling some materials with characteristic particle forms such as cylindrically shaped plastic pellets that present relatively little contact area with the feeder. Dimpling provides sufficient purchase to assure solid-body rotation of the material. On higher throughput models, not only are the feeding ducts physically larger but multiple ducts are combined coaxially to achieve increased capacity without exceeding the BSP's design max of 30 rpm.

Repeatability Performance

Repeatability, a statistical measure of the variability of feeder discharge at a given setpoint, is traditionally based on 30 one-minute samples and is expressed in terms of +X% of set rate at a 2 Sigma or 95.5% confidence level. However, many of today's critical processes require repeatability measurements not only throughout the feeder's full operating range, but also at sample timescales reflective of the process itself... often only a few seconds.

To document the BSP's performance and compare it with that of a single screw feeder, extensive, carefully controlled tests were conducted at K-Tron's testing facility in Pitman, NJ. Three relatively free-flowing materials (plastic pellets, wax granules, and citric acid granules) were fed on both a model BSP-125 Bulk Solids Pump and single screw model K2MVS60. Automated data collection of catch sample weights enabled sample durations as short as one second to be reliably obtained.

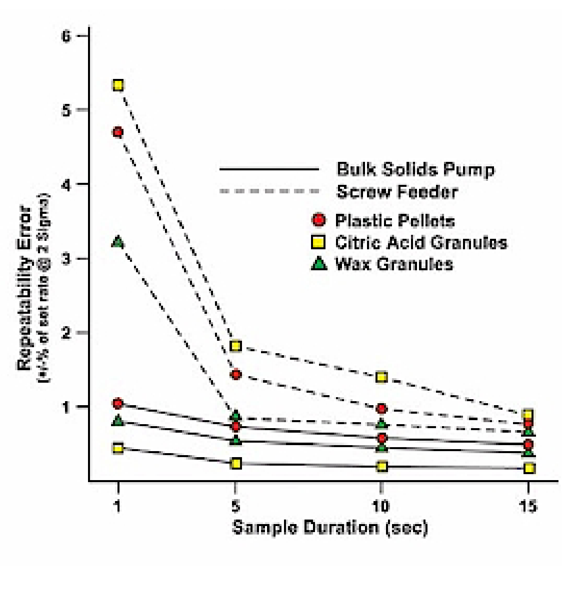


Figure 3 plots repeatability error vs sample duration (1, 5, 10 and 15 seconds) and shows the average repeatability for each of the materials tested. In each case, the BSP's repeatability error was a fraction of that measured for the screw feeder. The exceptional uniformity of the BSP's discharge contrasts sharply with the single screw's discharge pulsation effect, as clearly revealed in the one-second sample duration results. Note that even though the BSP tests resulted in repeatability errors of almost exclusively less than 1%, all tests were conducted with the BSP acting as a speed-controlled volumetric feeder, not as a gravimetric feeder where performance would be further improved.

Linearity Performance

Linearity is a measure of a feeder's ability to deliver an average discharge rate directly proportional to feeder speed, over the feeder's full operating range. In dozens of developmental tests involving comparison of linearity performance on identical materials over identical ranges of rates, the BSP approach averaged a linearity error of +0.1% over its 100:1 turndown range versus the screw/auger's average error of +2.0% over the same turndown.

Cleanability Performance

The BSP's open, obstruction-free design provides little opportunity for material build-up anywhere in the feeding zone. With quick and easy access to the feeding zone, no pockets or screws and only one moving part, the BSP feeder can be cleaned in seconds, making it ideal for applications with frequent material changes. Note that dimpling of the feeder's rotating material contact surfaces conforms to industry standards for sanitary cleanability.

Models and Configurations

Three BSP models are available: the BSP-100 feeds from 2 to 200 dm3/hr (0.07 to 7 ft3/hr), the BSP-125 ranges from 9 to 900 dm3/hr (0.32 to 32 ft3/hr), and the BSP-150 feeds from 45 to 4500 dm3/hr (1.6 to 160 ft3/hr). All units are available in loss-in-weight gravimetric as well as volumetric versions, and are also available as part of the company's multi-ingredient gravimetric blending systems.

Conclusion

The BSP outperforms the single screw feeder on a wide range of relatively free-flowing materials. Tough to handle powders that do not easily flow into a BSP feeder will still require single or twin screw feeders for the best linearity, repeatability and overall accuracy. As demonstrated in carefully conducted laboratory tests, the BSP has proved itself in raising the definition of feeder performance to a new level never before attainable with other, conventional volumetric feeders.

Note: Posimetric® is registered trademark Stamet Corp.

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Welcome to Ask Joe!, a monthly column by our resident materials handling guru, Joe Marinelli of Solids Handling Technologies. Joe addresses the issues that bug you the most. And Joe knows!! Formerly with Jenike & Johanson, Solids Flow and Peabody TecTank, Joe is an expert on materials handling.

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