Six Factors to Consider When Designing a High-Speed Powder Filling Line

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For the purposes of this paper, high-speed powder filling refers to applications where the fill rate exceeds 100 containers per minute. High-speed lines operate in a new realm of production and process control and are a lot less forgiving compared with lower-speed powder filling lines. When planning for a profitable high-speed powder filling line, make sure you address the following key factors:

Container Handling

High-speed powder filling systems need continuous-motion rotary filling machines. Infeed timing screws and starwheels accurately control, transport, and position containers in the filling machine (Figure 1). By eliminating the starting, stopping, and positioning of the containers usually associated with slower in-line or rotary indexing filling systems, a continuous-motion rotary filling machine allows more time to fill the container. This translates directly into increased line speeds.

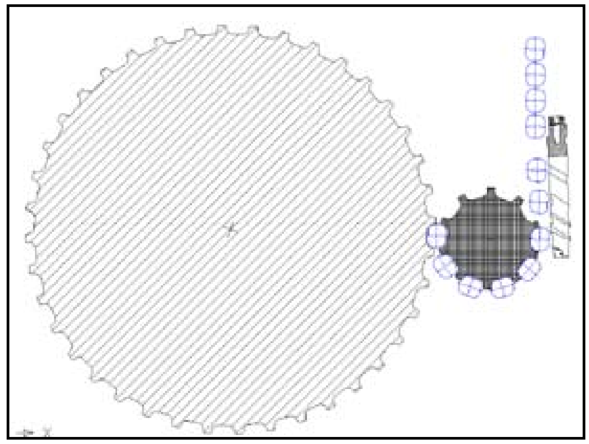

Figure 1

Complex-shaped containers amplify the need for good container handling. Machines that do not lift the container can more easily accommodate tapered containers with bases that exceed neck size. Keeping the container at the same elevation as the conveyor throughout the filling process simplifies container handling, allowing more time for the actual product filling. Again, this translates into increased line speeds.

To achieve a successful high-speed line, the delivery of containers to the filling machine must be uninterrupted. If the queue of empty containers is not continuous, the filling machine may start and stop frequently. This can have a negative effect on production speeds and fill weight accuracy.

Product Flow

There are two basic types of powders: free flowing and non-free flowing. A digital test can quickly and easily determine if a powder is free flow or non-free flow. This test is performed by poking your finger (digit) into the powder and then removing it. If the powder naturally fills in the space where your finger was, then it is considered free flowing. If a void remains in the space where your finger was, then it is considered non-free flowing.

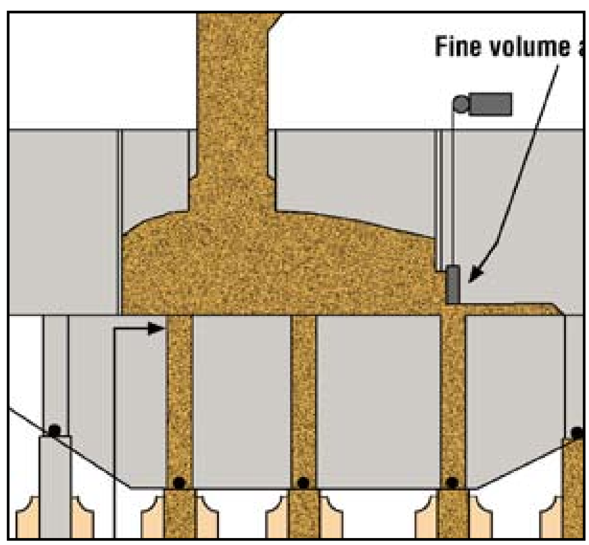

Figure 2

Free-flowing powders are suitable for handling on volumetric flask/cup-type filling machines (Figure 2). These machines use a flask/cup, which is sized volumetrically to deliver the proper target weight of the given product/container. Flask/cup-style filling machines are also an excellent choice for fragile or friable products as there is little to no product degradation with this type of system. The machine can adjust the volume of the flask/cup to compensate for changes in product density.

The auger filler is another common filling system for free-flowing powders (Figure 3). It is volumetric in nature and uses an auger tool (screw) to control the flow of powder. The volume of space between the auger tool's flights and the number of revolutions of the auger tool determines the volume of powder dispensed. By properly sizing the auger tooling and accurately controlling the revolutions of the auger tool, target fill weights can be easily obtained, adjusted, and controlled.

Available filling methods for non-free-flowing powders are more limited. Auger fillers are especially useful for handling non-free-flowing powders. Specially designed auger tooling provides a mechanical means of moving the non-free-flow powder through the system. Non-freeflow auger tooling typically has oversized "flights" (Figure 3) at the top of the tool that pushes the powder down through the auger tool.

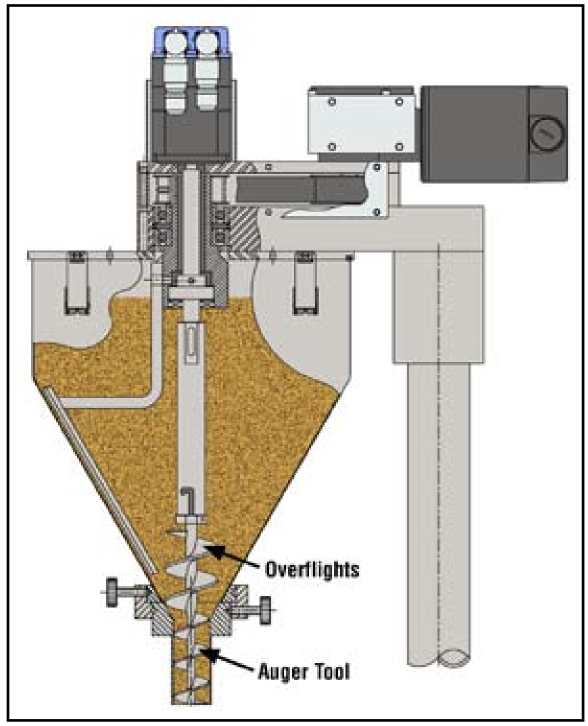

Figure 3

Product Feed
To obtain a reliable high-speed powder filling system, a proper product feed system is imperative. It must be capable of delivering the required amount of product in a consistent manner to maintain throughput of the filling machine.

There are many choices for product feeding including gravity feed hoppers, horizontal and inclined belt conveyors, bucket conveyors, screw feeders (horizontal, inclined, and flexible), vacuum conveyors, and vibratory feeders. The proper choice depends on the type of powder and the accuracy of the feed device. Typically, a level sensor within the filling machine controls the product feed system. Maintaining an accurate and consistent level of product within the filler is important to control the system's fill weight accuracy. The product feeder is a key component.

Product Settling
Powder aeration tends to occur during handling and will increase the volume of a product's given weight. This is illustrated with a simple experiment. Empty a one-pound can of roast and ground coffee into another container, and then try to pour it back into the original can. You will find that it is impossible to get all the coffee back into its original container without including a method for vibrating the container during the filling process.

In high-speed powder filling applications, effective product settling systems are essential to successfully maintain a high level of throughput. Product settling systems can be air-operated or driven through the use of an electric motor. Vibration can be applied to the bottom or the side of the container (Figure 4).


Figure 4

Various container materials respond differently to vibration. Metal and glass containers tend to transmit the vibration more efficiently than plastic or composite containers. The type of product settling system required will also depend on the shape of the container. A typical straight-sided metal can works effectively with a basic vibration system. A plastic container with a built-in handle requires a more exotic product settling system.

Weight Control

High-speed powder filling machines are usually volumetric in nature. This means that the actual target weight of the product being filled is achieved through the use of a known volume and the correlation of the product density to this volume. For instance, if your product had a density of 0.5 grams/cc and you needed to fill 250 grams of product, you would need a volume of 500 cc to achieve your desired fill weight.

Typically, a powder filling machine can maintain a specific volume of product very accurately. The accuracy of the fill weight is dependant on the consistency of the product's density and the ability of the filler to compensate for variations in that density

The degree of change that occurs in product density will influence weight control. Automatic weight control adjustments can be made through the use of external checkweighers (Figure 5) that measure the gross weight of the filled container as well as onboard weight control systems (Figure 6) that can actually measure the net weight of the product. Both types of systems feed actual weight information back to the filler so that adjustments in fill volume can be made to compensate for variations in product density.

Figure 5

Figure 6

Accurate weight control, especially in high-speed applications, minimizes product "giveaway" and helps to ensure a profitable powder-filling line.

Changeovers

Any filling machine must be versatile, allowing changeover from one format to another in a timely fashion. Key attributes include a system that is toolless and incorporates unitized change parts that snap on without the need for adjustments. These attributes help to achieve the "3 No Ts": no tools, no time, and no talent.

Conclusion

Understanding the important factors and selecting a system that addresses each of these factors is the key to successful high-speed powder filling. A well-planned and well-implemented project will provide many years of profitable, high-speed powder filling.

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