Going for a Tumble

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Blending prior to compression, tabletting or packaging is a critical process in which many aspects can go wrong both during the blend and after the blend. Until the powder is locked into its final form, your blending step is still at risk of segregation. This article will describe a few of the common problems associated with blending, some typical ingredients and their characteristics, the conformity and repeatability of batch-to-batch operations and the issues with discharging segregation concerns.

Some of the common problems associated with blending are due to poor particle engineering up front. In an ideal process, all the particles would be perfect granules of a similar particle size and similar density. Reality is quite different. Let’s look at an example of how particle size can affect the blend outcome — on a macro scale — imagine if you try and blend sand and tennis balls together. While the blender is running, you achieve what may be an adequate blend. However — when the blender is stopped, the sand will quickly migrate in the void areas between the tennis balls, resulting in segregation of the powders.

Looking at this on a micro-scale, the same thing can occur. Take a batch in which the average size of the particles is sub 10 microns and you attempt to blend it with 500 micron excipients — the same segregation effect will occur, but on a smaller scale. Looking also at bulk density — a large variation in bulk-density can also have adverse affects on the final outcome. Heavy material tends to sink, while light material tends to float.

Another common misconception is that if you blend for a long period of time — you achieve a better blend. Not so. There is an optimal blend time for each batch and

considerable over-blending can actually lead to segregation. Many studies have been done that show a perfect blend at 20 minutes, but larger variations at 40 minutes and then optimal blending again at 60 minutes, followed by a non-optimal blend again at 90 minutes. Factors that cause this can be static buildup on specific particles, particle degradation, over-working the material, etc.

Although blenders are designed for blending all powders to a homogeneous mixture, loading does have an effect on the outcome. Loading of the material should be accomplished in layers with trace quantities “sandwiched” in the middle of the batch. Often the trace material is thrown in last (on top), but the top-most material comes into contact with the vessel walls first, upon startup of the blender. This may yield a portion of the trace ingredient clinging to the walls, while the balance of the excipients are thoroughly mixed. Proper practice is to create a sandwich or layer effect of the material for optimal results.

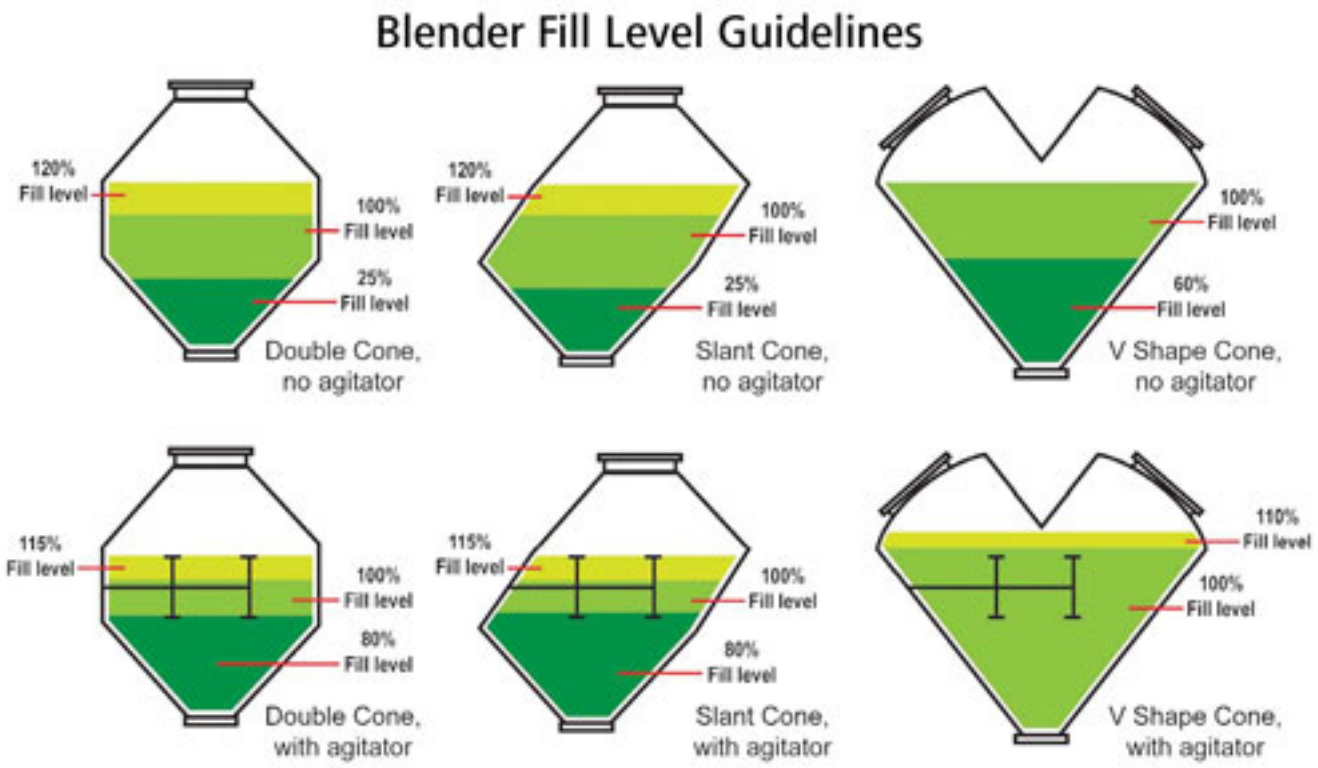
Trace quantities of material also may require additional shear forces to properly blend. Tumble blending is the gentlest type of blending that can be performed, but trace quantities require what is known in the industry as an intensifier or agitator bar for this shear. The agitator bar not only can provide additional shear force, but can also provide a milling functionality to the agglomerates. Tip speed of the agitator blades determine if delumping or milling is performed.

In some processes, it is common practice to pre-blend, mill and then final blend the powder to its final form. The milling step is actually a de-agglomeration step and the final blend is used for adjustment of the end result. In the cosmetic industry — pigments are often added to the final blend, since the raw material may not be always the same.

During discharge, the process engineers must focus on the methods and handling of the material. Design of the blender shell must focus on mass flow design. Aeration, rat holing, percolation and projection are all different scenarios of segregation that can occur during discharge. To briefly define all these:

1. Aeration is a common problem with dissimilar-sized materials that are present in a blender or hopper. Especially when located near a tablet press where vibrations occur — the small particles settle to the bottom and the large particles migrate upwards.
2. Rat holing occurs when mass flow is not occurring from the discharge area of the blender (hopper). A vertical column of material exits the area above the valve — causing the segregation of the blended powders. Powder near the vessel walls travels slower than material in the center, which can lead to de-blending of the material.
3. Percolation occurs as material exits and forms a natural angle below the valve, based on the angle of repose of the material. What tends to occur is that small particles migrate to the external portions of the material cone and the large particles are left in the center.
4. Projection happens if material is transported off a belt or feeder, and allowed to cascade in a trajectory plane. There is always a risk that the

heavier/larger particles project further. This, of course, is a segregation issue. The severity depends on the difference in densities and the particle size.



Sampling of a Blend

Critical to any blending process is the method of sampling, which includes location, quantity of samples and volume of samples. In a typical double-cone blender, at a minimum, the areas around the trunnions, the front and back of the center-bands, and the top and the bottom of the mass must be sampled. Since tumble blending is a repeatable process — if you load in the same fashion with the same material, blend for the identical amount of time at the identical speed, your blending outcome will be identical each time.

Finally, in addition to the selection of a blender, you must also consider the cleaning of the equipment. Typically, cleaning is the last facet that is thought about after a process is developed. It actually should be considered up front, which will seriously aid in the selection of the proper blender. All tumble blenders are basically large tanks that rotate, meaning they are easy to clean. Even with an agitator bar in place — the lack of long shafts, paddles, mixing arms or complex baffles enables easy and fast turnover between batches.

Each of the topics discussed above can be a very detailed conversation. Blending must be looked at not only for the actual blending aspect, but with the upstream and downstream process layout in mind.

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