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Ask Joe! Column

The Art of Blending and Blender Selection - A Few Basics

Guest article by Clark A. Beebe, Technical Services Manager, Gemco

Powder “blending” or ;mixing; (the terms are often used interchangeably) is still an art. It has not yet arrived at the stage of science in that it is a totally predictable process. There are so many factors involved that the study of them individually and then in combination is still on-going.

Among the properties that affect the outcome are particle size, shape and density along with other attributes such as the tendency to agglomerate, absorb moisture or develop a static charge. Because of all this complexity, the common approach to blending powders is to take a macro rather than a micro-approach.

(Photo above is a laboratory blender. Any blender chosen should be able to work easily to meet all the various competing processes, production needs and solve more problems than it creates.)

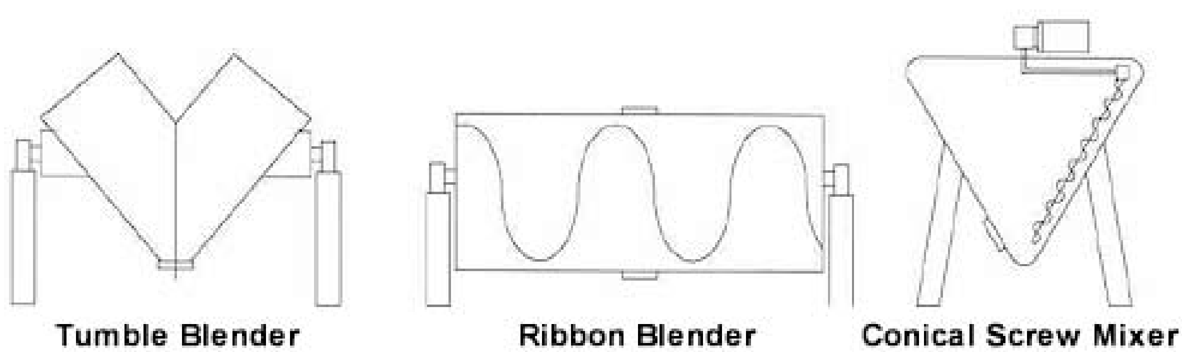
What is a Good Blend?

The first question to ask is, “What is a good blend?” The user must define what is an acceptable precision in the final blend. Once an acceptable blend is defined, then the process must be sampled and analyzed to ensure that the goal is met. If you are making boxes of cake mix that are sold in one pound boxes and the user further mixes during preparation, the blend is not that critical.

Even if the flour or sugar is off by five or ten percent from what is optimal, it won’t really matter. In this case the sample size for analysis would be the one pound unit of sale. If on the other hand, the process involves stamping small gears from powdered metal, the mixture at the base of each tooth must have the correct properties or they will break in operation. In this case the sample size would be much smaller than the part to represent the smallest critical section of the part itself.

What Type of Blender is Best?

The next question is, “What type of blender is best?” The answer is, of course, the one that achieves the desired blend for the lowest overall or unit cost. Which one that will be depends upon many things: the production throughput required; the required precision of the blend; the material handling requirements; cleaning and cross-contamination issues; documentation requirements [and costs]; any liquid addition requirements and their precision; etc. Each application will have unique issues that drive the selection.



There are three basic types of powder blenders commonly used today: diffusion, convection and pneumatic.

Pneumatic Blenders

Pneumatic blenders typically use air flow or pulses injected at the bottoms or sides of a hopper or bin to carry materials from lower in the batch further up with the rising air. Pneumatic blenders or blend adapters can be used on all sizes of batches form laboratory to entire silos.

They are best used for non-critical blends where particle sizes and densities are similar among all the components of the mix so that fines are not carried to the top by the air. If the fines contain most of one ingredient, or if there are significant differences in size or density of the particles, then pneumatic blenders are not the correct choice.

Convection Blenders

Convection blenders use mechanical means to reorient particles relative to one another in order to achieve a blend. Typical designs include ribbon, plow paddle and conical orbiting screw mixers. There are many variations on this theme with dual screws or ribbons, side auxiliary choppers, etc. if liquid must be added to the point where the mixture starts to become a paste or mass rather than still free flowing, this can be an effective design.

Advantages typically include cost, fixed load and discharge points and limited space requirements. They typically provide final blend variations of about plus or minus ten percent and often have issues of some thin layers near the shell where the powders are not touched and do not mix.

They are generally used in light density mixes where there is not a very small amount of any individual component. Due to the nature of the motion of a device being pushed through the product to achieve the blend, high density and abrasive products are typically to be avoided due to power consumption and wear/maintenance issues. As thorough cleaning can be quite involved, this aspect should be considered when cross contamination is a major concern. Accurate scale-up predictions are also difficult in this type of machine and should be considered before laboratory work is started.

Diffusion or “Tumble” Blenders

Diffusion blenders blend by placing particles in random motion allowing them to reorient with respect to each other when inter-particular friction is reduced as the result of bed expansion to achieve uniformity. Typically this occurs in a rotating vessel commonly called tumble blending. The “bed expansion” referred to is actually the same mechanism as in a fluid bed unit or pneumatic blender without the air flow. The advantage is that different particle sizes and densities within certain bounds can be accommodated without the separation of smaller particles due to aeration or air flow through the product.

(Photo above is a double cone lab blender with interchangeable vessels)

Tumble blenders typically offer the best blend available of all the types mentioned. They are typically able to achieve one to two percent variations and at times even significantly better than that. When a precise blend is required or some of the individual ingredients in the mix constitute less than five to ten percent of the total, this is the technology that is chosen.

Tumble units are batch type blenders suitable for small to medium sized production requirements. Typical batch sizes run from a liter or less to 8,500 liters (300 cubic feet). Larger units, typically used in the plastics industry, run to 30,000 liters (1,000 cubic feet) or more.

Types of Tumble Blenders

There are three commonly recognized shapes of tumble blenders, the V-shape, double cone and slant cone (Gemco trademark). There is also a significant distinction between symmetrical and asymmetrical designs within the three shapes.

The double cone and V-shape are symmetrical blenders. They present a vertical line of symmetry perpendicular to their axis of rotation. Studies on V-blenders run at Rutgers University have demonstrated that there is no mechanism to move powders of similar size and shape across this line of symmetry therefore care must then be taken to load each side of the blender equally to ensure the desired result. [1]

(Photo above is a 20 cubic foot production v-shape blender with drum loading system and portable design including removable safety gates, drum tray and air skids.)

Asymmetrical blenders are represented by the slant cone or long leg V-shape design where one leg is longer than the other. Asymmetrical blenders superimpose an axial flow of material on the normal material in the direction of rotation. Material is forced across the vertical axis of the unit each half revolution creating a better, faster blend. The slant cone has the advantage that it is available with internal agitator bars, liquid addition and other options not available in other asymmetrical units.

(Photo to the right is a 3 cubic foot slant-cone portable blender with self-contained safety gates.)

Tumble Blender Options

Tumble blenders offer a large array of options and accessories to customize them to the specific process and plant needs. Process enhancements include internal agitator bars to extend minute ingredients, break up unwanted agglomerates and, in certain instances, dissipate static charges. More exotic options such as heating or cooling jackets, interchangeable or split vessel designs, on-line blend end point monitoring, humidity and/or atmosphere control, sampling assemblies and portable designs-even for production sized units-are all available.

Regardless of the type or style of blender chosen, customizing it to smoothly meet plant needs by addressing such issues as material handling and the interface with upstream and downstream product flow, cleaning and product changeover issues, containment and worker exposure, automation, control and monitoring, and industry standards is critical. The blender should be designed with the custom features required to improve work flow, not obstruct it.

(Photo to the left is a 50 cubic foot Porta Hopper blender with quick-change, interchangeable hopper sections for high production and reduced handling operations.)

If drums are commonly used to handle product, one-floor automated drum loading/unloading systems are standard options on most units. Or drum loading systems can be adapted to provide discharge into bins through the use of cover valves, extended supports and special positioning/control systems.

If the unit is to be bulk loaded from above, then an automatic one button positioning system should position the blender for loading and discharge precisely and repeatedly to prevent worker error and speed the process. Perhaps a portable unit, either pilot or production will free up processing areas and allow for multiple purpose suites. If precise positioning is required to match up with an alpha-beta split butterfly valve, specify a positioning accuracy of 1 mm or whatever is required. If feedback of the process is required to tell when a valve is open or prevent rotation if the cover is not in place or if the loading chute is not retracted, state so in the specification.

(Photo to the right is a 30 cubic foot slant cone blender with special, high clearance extended drum with a loading/unloading system and cover valve for discharge into bulk bins and hoppers.)

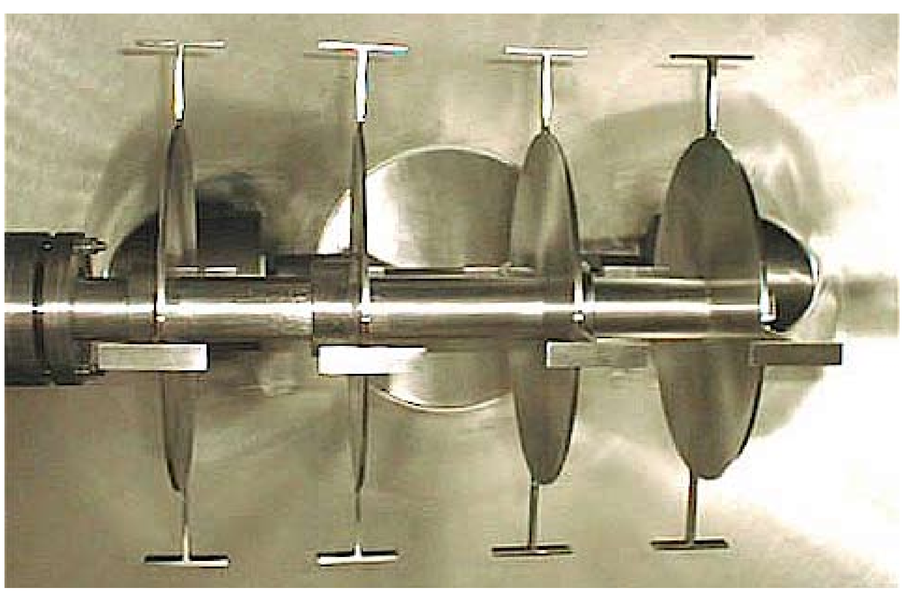
Such items should be designed into the system from the start and not added on later. They often draw the line between a smooth and successful integration of a new unit and one that people have to learn to work around. The blender manufacturer should be able to help in this regard. Ask for suggestions. Tell them more about the plant and the process so that t hey have the background to make appropriate suggestions.

Tumble Blender Selection Criteria

In a nutshell, blender selection depends upon three major criteria.

- The first is the blend required and the quantities/ time frames involved.
- Is the throughput rated in tons per hour?
- Do you have multiple ingredients and a very small unit size that must have the precise percentages of the various components in order to fulfill the expectations of the end user?

First determine the blend requirement and sample size needed for the analysis of achieving that goal.



(Photo above is a large, 4-disc internal agitator bar used for delumping and breaking up agglomerates of minor ingredients and extending minor ingredients.)

The second criterion involved looks inside the blender at the processing of the powders themselves. Any process enhancements in the same unit enhance productivity. If you can delump in the blending step by adding an agitator bar, you may eliminate the need for a milling step afterwards. If you can add only one percent liquid vs. 20 percent, you can reduce the drying required later. The process designer must look beyond what was previously done to what can be done. Every process step eliminated means reduced labor, maintenance, cycle time, worker exposure, floor space requirements, etc.

The third criterion is outside the blender and its interface with the rest of the plant's operation. Determine the best way to load, unload, control and clean the unit. A well designed system will smoothly integrate with the rest of the operations. Worker dissatisfaction with a poorly designed installation will last years after the machine is put into service and affect attitudes as well as output.

Conclusion

Before buying a blender, make sure that the installation will meet as many goals as it can. Talk with maintenance and operations people about current processes and problems. Go beyond the standard answer of "no problems" to make sure that they haven't just learned to live with a poor scenario for loading or discharging or cleaning or whatever. View a new machine as an opportunity to improve the productivity or maintenance or worker satisfaction. Be sure to get the most bang for your buck!

About our author:

Mr. Clark A. Beebe is the Technical Services Manager for Gemco, a leading manufacturer of tumble blenders and dryers. Clark is in charge of engineering, new product design and customer applications.

For more information contact:
Clark A. Beebe
Gemco
301 Smalley Ave.
Middlesex, NJ 08846
Telephone: 800-654-3626 or 732-752-7900
Fax: 732-752-5857
Email: cbeebe@okgemco.com
Web site: http://www.okgemco.com/

[1] AIChE Journal, February 1998, Volume 44, No. 2; Particle Technology and Fluidization; Quantitative Characterization of Mixing of Dry Powders in V-Blenders by Dean Brone, Albert Alexander and F.J. Muzio, Dept. of Chemical and Biochemical Engineering, Rutgers University, Piscataway, NJ 08855.

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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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