Container blending for cleaner, faster batch mixing

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Spillage and dusting, long blending times, labor-intensive vessel cleanup for product changeovers.... Sound familiar? They may if you use a conventional batch blender to mix your dry bulk solids. One simple way to eliminate these and other inherent shortcomings with batch blending is to move your blending process right into your rigid intermediate bulk containers. This article explains how you can use container blending to minimize batch-blending headaches common in chemical, pharmaceutical, food, and other bulk solids applications.

Using a conventional batch blender requires a lot of material handling. You must dispense each dry ingredient into the blender vessel and then discharge the finished blend to a container for shipping or storage. These handling steps not only can slow down your blending operation but create air-quality hazards and place extra labor and housekeeping demands on your workers. Batch blender problems can also affect your product quality. One way to eliminate these headaches is to switch to container blending.

In this form of blending, a rigid intermediate bulk container (RIBC) already filled with dry ingredients is placed in a container blender, typically a stand-alone pedestal-supported cradle, as shown in Figure 1. The container can be a typical side-door unit, which has straight walls, or a hopper container, which has an integral hopper with angled walls below a straight-walled upper section (Figure 1). The cradle holds and rotates the container to mix the ingredients, turning the container itself into a blender vessel and handily eliminating the material handling steps required with a conventional batch blender.

In a typical container-blending operation, an operator fills the container with dry ingredients in the correct proportions and then loads it onto the container blender’s cradle or moves it to storage or a staging area for later blending. In most cases, the operator uses a forklift truck to load the container into the cradle; the operator can also use a pallet jack to load it from floor level or, if the container is on casters, can simply wheel it into the unit. Next, the operator selects the blending cycle length on the blender’s control panel and presses the start button. The blender rotates the container for the selected cycle duration and signals the operator at the cycle’s end. The operator removes the container from the cradle by the same method used to load it and moves it to storage or to a container discharge station for further processing or packaging.

The container blender’s cradle can have one or two pedestals (two are shown in Figure 1). Its clamping mechanism can be one of two types: a top-clamping device for a container lifted by a forklift truck, or a bottom-clamping device for a container moved by a pallet jack or for a wheeled container. The bottom-clamping device keeps the container level with the floor during loading and unloading. The cradle’s rotational axis is skewed to provide rotation at multiple angles, thus continuously changing the position of the container’s straight walls throughout each revolution. This action moves the dry ingredients inside the container in a cross-flow, folding action that rapidly homogenizes the batch.

Figure 1

Container blender (double-pedestal type) loaded with hopper-style rigid intermediate bulk container
The container blender can also be integrated into a fully automated system. In this system, the container is automatically retrieved from storage, moved to an automatic filling station, filled with ingredients, moved by a robotic vehicle or a conveyor to the container blender, loaded onto the cradle, blended, unloaded, and transported to storage or a container discharge station.

**Using container blending to solve batch blending problems**

Container blending can solve many common problems in using a conventional batch blender.

**Reducing dusting and spillage.** Multiple material transfers when manually filling and discharging a conventional batch blender vessel can result in dusting and spillage and allow airborne substances to contaminate the material to be blended and the workplace air. In container blending, the container is filled and discharged away from the container blender and contains the material so it can’t contact the blender, minimizing material transfers and reducing dusting and spillage.

**Reducing blend times.** The time required for mixing ingredients in a conventional batch blender can be extensive, because ingredient filling into and product discharge from the vessel are included in the blending cycle. The blending mechanism in many batch blenders also requires a long blending cycle. In container blending, the time for filling and discharging isn’t included in the blending cycle. This allows the container blender to blend more batches, without long delays for filling and discharging, especially since filling for a blend that includes several ingredients typically takes longer than the blending cycle itself. The operator can keep filling containers one after the other and stack them up in a staging area next to the container blender. As soon as one container is blended and removed, the operator can load a new container into the cradle and blend that. This allows containers to be filled over two shifts a day, for instance, while all are mixed in only one shift, saving labor and blending time and energy. The material’s cross-flow action during the container’s rotation also speeds the blending process.

**Reducing blend segregation.** Discharging the blended product from a batch blender vessel and transferring it to subsequent processing or storage can tend to segregate the ingredients in the blend. In container blending, the product remains in the container until the point of use, reducing the risk of segregation after blending.

**Eliminating cross-contamination and vessel cleanup for product changeovers and increasing process flexibility.** Residue that collects in the crevices, seals, or welds inside a conventional batch blender vessel and isn’t completely cleaned out between batches can contaminate future blends. Transferring ingredients into and blended product out of the batch blender vessel can also result in cross-contamination as dust and material contact the blender’s components. Cleaning and sanitizing the vessel between batches is often a time-consuming and costly process. These problems limit the blender’s flexibility for operations requiring blending of many product formulations.

With the container blender, cross-contamination is impossible because the material for one batch contacts only the container’s interior and never contacts the blender. No blender cleanup is required, and the unit can be used immediately for mixing another batch. Because it never contacts the material, the container blender can also handle any number of product formulations.

**Reducing manual steps.** Most batch blenders require more manual filling, discharging, and cleanout steps than a container blender and are less likely to be integrated into a fully automated process line. The container blender doesn’t require manual handling steps and is easy to integrate into a fully automated system in which the container is automatically filled, blended, and transported to storage or a discharge station.

**Tips for successful container blending**

The first step in achieving successful container blending is to make sure that your ingredients are right for this process. Some difficult-to-mix ingredients are better suited to processing in a conventional batch blender with an agitator. With some exceptions, ingredients that are suitable for container blending typically have similar specific gravities, particle size distributions, and moisture contents. When these characteristics are similar, the ingredients tend to require shorter blending cycles and produce superior blend results.

Large differences in moisture content, in particular, can lead to serious container-blending problems because the moister ingredients tend to adhere to themselves and form balls during blending. If you must blend high-moisture ingredients with lower moisture ones, you may need to premix all the moist or all the dry ingredients in one container and then add them to the other ingredients in a final mixing step. You can also use a container with an intensifying mechanism, such as an intensifier bar that’s either permanently mounted through the container wall or mounted in the container lid; the latter allows you to simply switch back to using a standard lid when intensifying isn’t necessary.

Next, you need to determine the right container fill level, container configuration, batch size, blending speed, and blending duration to ensure that your container-blending operation achieves consistent, repeatable results.

**Container fill level.** For best results, you should fill the container from 50 to 80 percent of its maximum (called waterfill) capacity. A 65 percent fill volume is ideal, because it allows ample room in the container for the cross-flow blending action to occur without wasting container capacity.
Container configuration. The rectangular container with a 42- by 48-inch base and a side door is most common for container-blending applications. (This container must be tilted on its side for discharge and has a relatively slow discharge rate, limiting the container’s use in some fast-throughput applications.) Ideally, the side-door container should have a height from 1.3 to 2 times the widest base dimension. The width-to-length proportion should be within 25 percent. Other configurations of the rectangular side-door container can be used as long as the container’s width-to-base proportion is still within 25 percent.

The hopper container is also well-suited to container blending. While its width-to-length proportion should be within 25 percent like the rectangular side-door container, the hopper container has different height requirements: the container’s straight upper walls should be a minimum of 0.5 times and a maximum of 2 times the hopper section’s height. The hopper container also should be symmetrical, with a center hopper discharge, for the best blending results.

Even if your container configuration doesn’t quite fit the width-to-base and height proportions listed here, you can probably still achieve good blending results.

Batch size. The typical batch size for container blending ranges from less than 10 cubic feet to more than 80 cubic feet. As long as you choose a container that can handle your intended batch size, the batch size typically won’t affect the blend quality.

Blending speed. The container blender’s blending, or rotational, speed affects both the blend duration and blend quality. How can you determine the speed at which the unit should rotate your container to blend the product? Although the blender supplier can estimate an approximate speed range for your application, it’s better to perform empirical tests with your ingredients to determine which speed is best, based on your container size and configuration and the ingredients’ characteristics.

The supplier can perform these tests using a full- or lab-scale container blender, or you can run them at your plant with a leased or purchased lab-scale blender, as shown in Figure 2. Because the blending action is difficult to see in a closed container, some suppliers offer a quarter-scale lab blender with a transparent container for predicting the full-size unit’s blend speed and blend quality for each product formulation. Buying a lab blender scaled to your full-size unit can be a particularly good idea if you produce several formulations or continually change your formulations.

If you hear a thumping sound every half revolution during the tests, the blending speed is excessive. This sound indicates that the material is becoming airborne and hitting the container’s opposite wall. In contrast, the optimal blending speed creates a continuous wave pattern inside the container that doesn’t produce any thumping sound. Once you’re operating the container blender in your plant, you’ll gain the experience to recognize this flow pattern and know that you’re at the ideal blending speed.

Blending duration. You must determine the ideal blending cycle length to achieve the right blend quality. Again, the best way is empirical testing, in this case by blending a batch in a full-scale container blender and then sampling the product at frequent intervals to measure the blend quality until the blend is fully homogeneous. Blending longer than this isn’t necessary and, in fact, in rare cases can cause ingredients to segregate from the homogeneously blended product. In most container-blending applications, the blend duration is between 4 and 12 minutes.

For further reading
Find more information on blending topics in articles listed under “Mixing and blending” in Powder and Bulk Engineering’s comprehensive article index at www.powderbulk.com and in the December 2004 issue.

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