Scaleup of Tumble-Blending Equipment

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Processes utilizing tumble-blending technology are reliably scalable, but initially, the process engineer must understand the mechanics of the blender. First is the shape of the vessel, with the double cone, slant cone and V shape being the most recognized. Second is the size of the vessel and third is the speed of the vessel. Tumble blenders are proportional. From the smallest to the largest, the energy input for each kilo of blended powder is the same.

These vessel shapes were chosen because they have actually been tested to achieve a repeatable blend pattern with most powders. Powder has to travel in a consistent and repeated path to mix. Chaos is bad for blending. If powder particles travel in random patterns, then there is a high probability that they won't make it to the end point at the same time. If particles travel in a repeated path, they will make it to the end point on time.

NASCAR races start with all of the cars in a tight order. They do not leave the track, but travel at different speeds and with different driving skills. After 200 laps, the same cars are rearranged into a new order. This is what a blender must do.

The vessel size-to-load ratio is critical to proper blending. Over- or under-filling can change the blender's efficiency. Every manufacturer can supply information on load levels for their machine.

Nothing happens until something moves. Powder requires some mechanical force to make it move. Something has to push the powder, so the particles can disperse into the total batch. Powder does not get and hold momentum, so the mechanical means of pushing the powder is critically important to achieving a blend. Tumble blenders create either a cascading action, like a wave rolling onto a beach, or a splitting/combining action in the V shape.

Predicting scale-up time in a tumble blender is based on mechanical and materials engineering. Tumble blenders move material in a repeatable pattern. They also move the entire batch in a consistent rhythm. These two factors force the powder to blend. The manufacturer of the blender sets the blender speed carefully to achieve maximum particle mobility to maintain material movement.

A tumble blender is also proportional from the lab blender size to the largest production size. Mechanically, no efficiency is lost in the blender. So no matter what size the blender is, the entire batch will move in each revolution.

A simple rule of thumb used by industry is to count vessel revolutions. The number of revolutions required to complete a blend in one size blender is constant in other size blenders. Your blender manufacturer has a chart that correlates size to size to show the scale-up factor for simple tumble blending. Tumble blenders are efficient, so 2 minutes in a 3-cubic-foot blender may only scale up to 10 minutes in a 150-cubic-foot blender.

There are two ways to determine if you have achieved a specified deviation level. They are analytical and sensory. Analytical tests are chemical or physical. Using a sampling methodology, samples can be lab tested for adherence to specifications. Colors can be matched to a spectrometer. Metal powders can be pressed or fired in a furnace, and then have individual parts tested for flaws. Sensory tests are human determination to a specification. Smell can check for aroma additions. Touch can sense lubricity, or sight can tell major batch consistency changes.

When scaling up a process with an agitator bar, special attention must be given to the speed of the assembly and the blade design. Calculations for the energy input of each type of assembly can be performed. The agitator has four uses during a blend cycle. They are:

1. De-lumping packed material.
2. Dispersing minute additives, like colors or active pharmaceutical ingredients.
3. Uniform particle sizing.
4. Liquid addition or particle coating.

The agitator bar is driven at variable speeds and has disc assemblies with T-shaped blades mounted around its outer diameter. The basic blade configuration is a flat-faced T to give the maximum amount of surface area to product ratio. The bar speed has been determined to input the correct amount of energy to accomplish the job at hand. Time plays an important part in using the agitator. The agitator run time and speed is scaled up proportionally with the blend time. More adjustment will be necessary with the agitator time since the blades may vary.

Basic Questions

What happens if I overfill my blender?

Nothing mixes until it moves. When you overfill the blender, there is less void space for powder to move into. The powder acts like cars in a traffic jam. The powder at the bottom has to wait longer to move and then mix. You will change the efficiency of your blender for the worse. The time required to mix will increase with overfilling. Each of the three shapes has a different ability to handle overloading.

What happens if I under-fill my blender?

You will change the efficiency of the blender for the better. Mixing time will usually decrease slightly. Tumble blender sizes are designed to operate at near peak efficiency. Peak efficiency is reached within a 5 percent load level drop, so no more time will be saved. Particle characteristics play a major role in under filling. Particle shape, size or lubricity could make a batch slide on the walls of the blender rather than blend. If the load moves in a complete mass, it is sliding, it is not mixing.

How does loading affect my final blend? What is layered loading?

The double- and slant-cone shapes are not sensitive to order of loading. Their mass movement of material keeps the whole load together and moving. Loading a V-shape blender correctly is an important factor in blend quality. The configuration of the legs split the batch in half every revolution. Therefore, layering ingredients allows material to be split equally from the beginning of the batch. If loading in a V shape is not consistent, blend efficiency will be affected. It is recommended to load V blenders from the valve, so material naturally splits into the legs equally when it hits the crotch of the vessel internally.

For more information, please visit www.okgemco.com *[1].*

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[1] http://www.okgemco.com/