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September 2005

A Precise Process

Thorough mixing is critical for pharmaceutical glass maker

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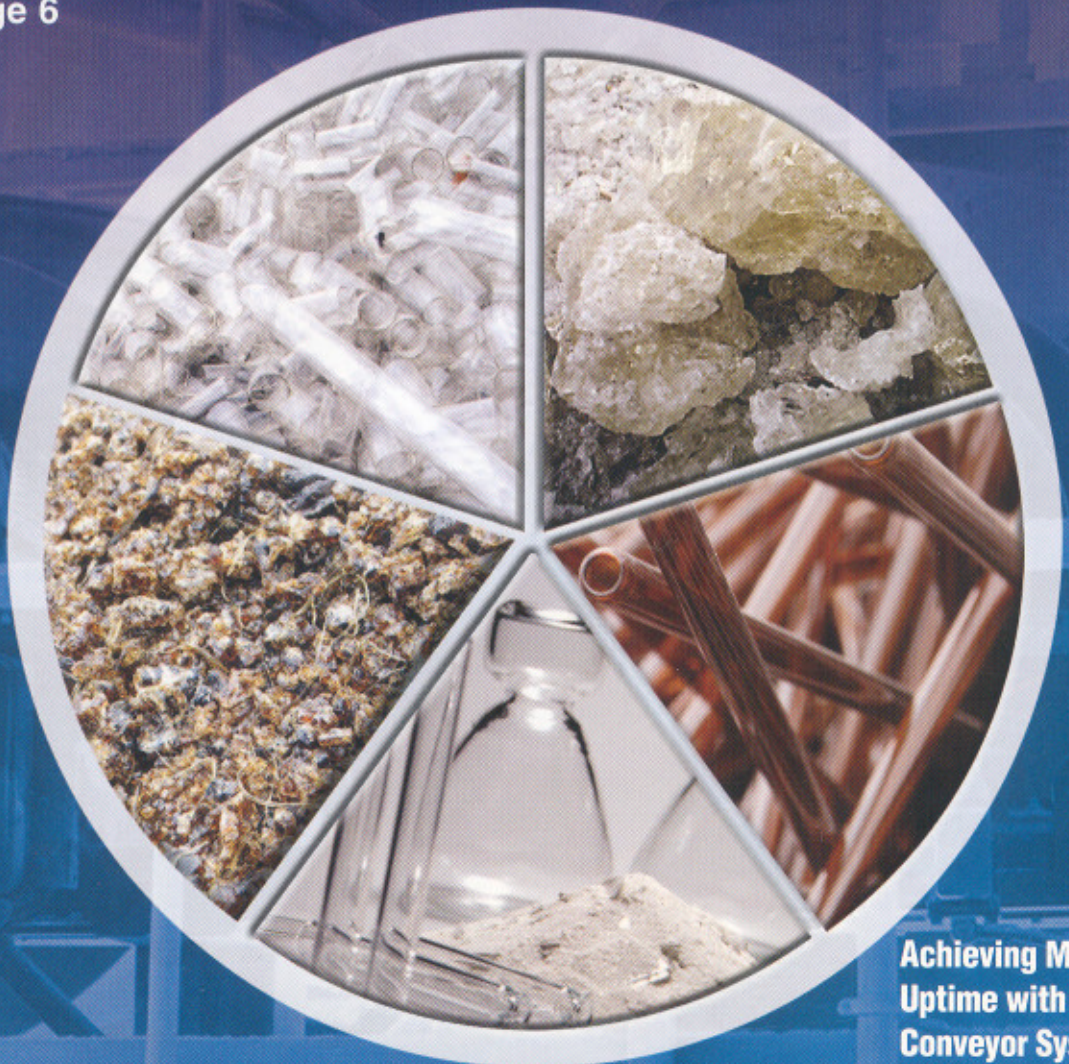

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Thorough Mixing of Ingredients Crucial for Pharmaceutical Glass Manufacturer

By Charlie Devine
Munson Machinery Co.

The manufacture of high-quality pharmaceutical glass is an exacting business that calls for careful control at all stages of the process in order to obtain the desired properties in the final product. Those properties vary, depending on what the glass is to be used for, so the initial step — the precise measurement and thorough mixing of multiple ingredients — is critical to the rest of the operation.

For example, Kimble Glass, Vineland, NJ, blends more than 120 batches/day of raw materials, using three basic recipes that include virgin sand, cullet, and a number of other ingredients, some of which are present in quantities of 1% or less. Each batch is subsequently melted and formed into tubing that ranges from 2-180mm in diameter. Kimble uses the tubing to fabricate such products as syringes, vials and ampules for medications, as well as laboratory equipment, such as graduated cylinders, beakers and petri dishes.

A Long History

As is the case with many glass-making plants, Kimble's is a venerable operation with a long history; the facility is more than 100 years old, and the batch house has been retrofitted several times. For many years, the mixing operators got along with an old barrel mixer (installed in 1978) that required ever-increasing care and maintenance. For backup, the company used a much older Munson GB-60 rotary mixer (installed as used equipment in 1961) that nonetheless proved to be more reliable than the barrel mixer, says John Schwab, senior furnace engineer at the plant. Another problem was that both of the machines had a capacity of 60 cu. ft. — too large for the plant's needs.

The plant was given the go-ahead in May 2002 to install new mixing equipment, and went on stream with two GB-35 rotary mixers made by Munson Machinery Company, Utica, NY — the same company that made the old rotary machine. Each of the GB-35 (for Glass Batcher) mixers cost $53,000 and has a theoretical volume of 100

Figure 1. Raw materials are discharged from the scales above and flow through the diverter gate (center, rear) into either mixer No. 1 or No. 2. The pipe in the foreground is not integral to the mixing operation, but is used only if material has to be transferred from one storage bin to another.

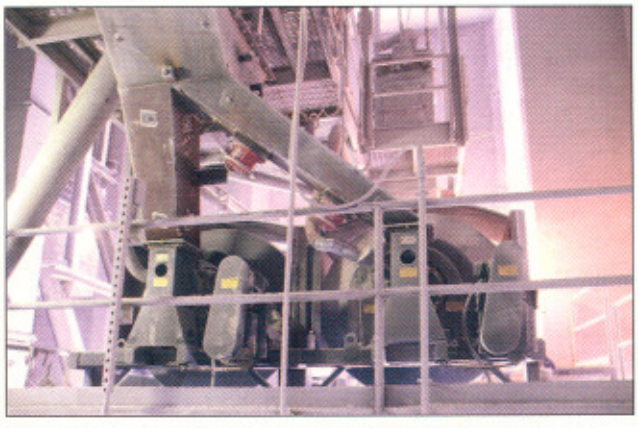

Figure 2. This view of the feed system, from the scales to the mixers, shows the fill end of each mixer with mixer number one on the left, and number two on the right. Only one mixer is used at a time.

Figure 3. Mixed batches are discharged from a mixer via the discharge chute on the right. In the left foreground is a dust collector, and behind it, to the right, is a discharge port for purged material.

Figure 4. A view of the mixer discharge gate. A pneumatic cylinder forces the stopper-like gate inward, into the mixer, allowing the batch of mixed material to discharge into a can.

cu. ft. The working capacity of rotary mixers of this size is typically 50 cu. ft., but they are rated at 35 cu. ft. for glass-batching to minimize contact between the highly abrasive glass and the machines' seals.

"We bought two small mixers to have flexibility, so that if one goes down we could still keep operating," says Schwab. "This is important for us because we don't have the capacity to store more than eight hours of mixed batch material." In the unlikely event that both machines were to break down, the backup is the old, 60-cu.ft. Munson mixer.

Need to Minimize Downtime

The main reason for buying the Munson mixers, says Schwab, was to minimize downtime. "Our contacts at Munson say they can supply parts off the shelf for any mixer they've made since 1940, but in our experience nothing breaks on these machines.

"We didn't look for increasing efficiency because we felt we already had an efficient operation and efficient mixing and we didn't want to lose anything by switching to another type of mixer. Many people recommended pan mixers, but we make three recipes every day, and if we used a pan mixer we would have to pull it apart and vacuum it out every time we changed the recipe." In contrast, says Schwab, the rotary mixers can be purged in three to four minutes — about the time it takes to run a batch.

The GB-35 consists of a horizontal, rotating drum that has a stationary inlet at one end and a stationary outlet with a discharge gate at the other. The mixing vessel is supported by two oversized trunion rings, which ride on heavy-duty alloy roller assemblies. Material is charged via the inlet chute while the drum is rotating. Mixing flights or vanes tumble the batch materials in a multi-directional manner, while simultaneously moving the material toward the outlet.

Figure 5. Recycled cullet is an important component of the recipes for making pharmaceutical glass at Kimble Glass. The cullet shown, stored in outdoor bins, is residue drained from a glass furnace.

Figure 6. Recycled cullet includes material rejected from the manufacturing process. Some examples are rejected amber tubing (Figure 6) and rejected clear (flint) tubing (Figure 8).

Figure 7. Recycled cullet is an important component of the recipes for making pharmaceutical glass at Kimble Glass. The cullet shown, stored in outdoor bins, is residue drained from a glass furnace.

Figure 8. Recycled cullet includes material rejected from the manufacturing process. Some examples are rejected amber tubing and rejected clear (flint) tubing(figure 6).

Munson says the mixing action produces a "fluidized zone" with random dynamics that results in uniform mixing without segregation. At the same time, the mixer is an "extremely gentle blender" that will not degrade the size or shape of particles. When the blend is complete, the discharge gate pivots into the machine and directs the material down a discharge spout. Kimble's three batch recipes consist of a hard borosilicate glass and two neutral borosilicates, one of which is a flint (clear) material and the other amber-colored. The hard borosilicate is of alpha 33 expansion, designed for use with corrosive chemicals and reusable laboratory equipment. The neutrals are alpha 51 expansion and are used for medical applications. Virgin sand is typically the main ingredient, ranging up to 80% of a recipe, followed by cullet, whose content varies from 20% to as much as 70%. The cullet is mostly recycled from Kimble's operations and some is purchased. It is crushed to a maximum particle size of about .75-in. diameter, which is a suitable size for melting, then dried to reduce the moisture content to 1% or less. Other ingredients include a few percent each of nepheline or nephelite (a silicate of sodium), 5-mol borax and boric acid, and about 1% each of barium carbonate, sodium chloride and potassium carbonate. For amber glass, Kimble uses trace quantities of rutile and iron oxide, which are weighed by hand before being added to a batch. "It only takes 0.2% of those materials to get the amber color," says Schwab.

Thorough Dispersion is Critical

Thorough dispersion of the materials is crucial, notes

Figure 9. Examples of some finished goods - syringe cartridges and vials - together with the raw material from which they are made.

Schwab, so initially Kimble ran trials at its onsite laboratory to establish mixing times for the new machines. The upshot, he says, is that the mixing time for a 3300-lb batch is two minutes 15 seconds, "and we get complete dispersion — a complete, homogeneous mix."

Kimble blends batches of two weights, 3,300 and 2,500 lbs. that are dictated by the arrangement of the equipment in the furnace house. "Our batch house is remote from the furnaces, so we discharge each batch into a can of 3,300 or 2,500 lbs. and transport the cans to the furnaces on a monorail," Schwab explains. "We don't have day bins and we don't mix mass quantities, because when borax gets warm and the humidity is high it hardens. This is a problem with long-term storage of raw materi-

als, so we mix them as we need them and don't store anything for more than 24 hours."

The cans are about 72" tall by 42" or 48" in diameter, with a truncated cone and a swivel plate for discharge on the bottom. In the furnace house, each can is manually dumped into hoppers above screw chargers that feed the furnace. The building configuration doesn't lend itself to automation, says Schwab. Kimble runs two shifts and has a daily production of about 74 3,300-lb. cans and 54 2,500-lb. cans, for a total of about 2.6 million lbs./week. Raw materials are stored in silos and gravity-fed onto scales under computer control, in accordance with the recipe. On high-volume items such as sand, feeding is controlled by a gate and a jogger. Smaller-volume materials are fed to the scale by a rigid auger. "We have a major scale and a minor scale," says Schwab. "Anything above 200 lbs. (91 kg) goes on the major scale."

A typical recipe run consists of 18–20 cans. Each batch is mixed in two minutes 15 seconds, as noted earlier, and then it takes 45 seconds to discharge the batch into a can, for a total of about 3 minutes. "As soon as a batch starts mixing we start weighing the next batch so that we're ready to load it as soon as the mixer is emptied," says Schwab. Purging is necessary only when there is a recipe change.

The GB-35 mixers are constructed of abrasion-resistant materials suitable for this demanding application. There are also wear liners in places that are subject to the greatest abrasion, such as the feed spout and the discharge cone. Even so, Kimble replaced the liner at the inlet with a special steel alloy that has a Rockwell hardness rating of 80. "We wouldn't need this if we didn't use a lot of cullet," says Schwab, "but cullet is very abrasive — much more so than sand. Also, there is a freefall of about 20 ft. from the point where materials are discharged from the scale to the point where they enter the mixer, so the cullet has a lot of velocity."

The bulk density of the glass batch is about 100 lbs./cu. ft. For a 3,300-lb batch, this equates to 33 cu. ft. — within the mixer's rated capacity of 35 cu. ft. "We limit the batch size to keep abrasive material away from the seals, which are probably the parts that are the most likely to wear," he says. "We have been resealing about every 3–4 months as preventive maintenance." He adds that it takes about 90 minutes to change the seals, which are made of ceramic fiber.

"We have been running these machines for three years," says Schwab, "and so far we have had no problems and there is no sign of significant wear."

Charlie Devine is Vice President, Sales & Marketing, Munson Machinery Co., Utica, NY.

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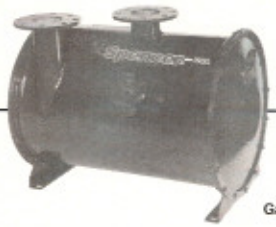

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