Online Exclusive: Case Study: Improved Glass Batch Mixing

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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 the intended application of the glass, so the initial step-the precise measurement and thorough mixing of multiple ingredients-is crucial to the rest of the operation.

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

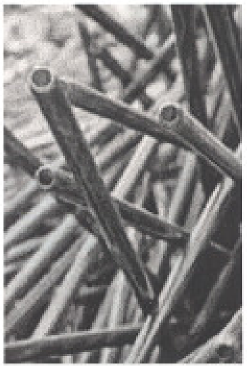
Kimble Glass, Vineland, N.J., blends more than 120 batches per day of raw materials, using three basic recipes that include virgin sand, cullet and a number of other ingredients, some of which are present in quantities of 1% or less. Each batch is subsequently melted and formed into tubing that ranges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

Kimble's operation has 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 used 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). Both of the machines had a capacity of 60 cubic feet, which was too large for the plant's needs.

Minimizing Maintenance

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 Co., Utica, N.Y. Each of the mixers has a theoretical volume of 100 cubic ft. The working capacity of rotary mixers of this size is typically 50 cubic feet, but Kimble's mixers are rated at 35 cubic feet 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 John Schwab, senior furnace engineer at the plant. "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-cubic-foot Munson mixer.



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

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 new mixer 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 through 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.

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.

A Challenging Mix

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.

Recycled cullet is an important component of Kimble's pharmaceutical glass recipes. The cullet

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, although some is purchased. It is crushed to a maximum particle size of about 0.75-in. in diameter, which is a suitable size for melting, then dried to reduce the moisture content to 1% or less.

shown here, stored in outdoor bins, is residue drained from a glass furnace.

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 of the materials is crucial, notes 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 2 minutes and 15 seconds, "and we get a complete, homogeneous mix."

Kimble blends batches of two weights-3300 and 2500 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 3300 or 2500 lb 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 borax hardens when it gets warm and the humidity is high. This is a problem with long-term storage of raw materials, so we mix them as we need them and don't store anything for more than 24 hours."

The cans are about 72 in. tall by 42 or 48 in. 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.

A Durable Solution

Kimble runs two shifts and has a daily production of about 74 3300-lb cans and 54 2500-lb cans, for a total of about 2.6 million lbs/week. Raw materials are stored in silos and are 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 goes on the major scale."

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

A typical recipe run consists of 18 to 20 cans. Each batch is mixed in 2 minutes and 15 seconds, as noted earlier, and is then discharged into a can in 45 seconds, 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 mixers are constructed of abrasion-resistant materials suitable for this demanding application. Wear liners are used 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/cubic foot. For a 3300-lb batch, this equates to 33 cubic feet-which is within the mixer's rated capacity of 35 cubic feet. "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," Schwab says. "We have been resealing about every three to four 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. "So far we have had no problems, and there is no sign of significant wear."

For more information about glass batch mixers, contact Munson Machinery Co., Inc., 210 Seward Ave., Utica, NY 13503-0855; (800) 944-6644; e-mail info@munsonmachinery.com; or visit www.munsonmachinery.com.

More information about Kimble Glass can be found at www.kimble.com.