Sand to Sculpture

Clear Borosilicate Manufacturing and Production

Contributed by Kimble Glass, Vineland, NJ

In the heart of South Jersey, the "old industry " of glass melting is dynamic and rewarding at the dawn of the 21st century. New technology has kept the industry alive and well in times of increasing foreign imports and decreasing heavy industry. Borosilicate glass is at the center of this growth. The term borosilicate glass includes a wide variety of glass compositions. These compositions revolutionized the use of glass both in the home and industry. Borosilicate glasses have three times the thermal shock resistance of lime or lead glasses and are superior for chemical stability and electrical properties. These properties permit these glasses for use a metal sealing glasses, pharmaceutical containers, artistic sculptures, household cooking utensils, laboratory glassware, and many more uses that affect modern every day living.

The melting of borosilicate glass is a great challenge. To meet the expectations of a diverse market, it is mandatory to constantly monitor and improve raw materials, furnaces, glass forming operations, and product inspection. Most people buy a product and never realize all that goes into the engineering, development and design, production, testing, and packaging. Rod and tubing of borosilicate glass though simple in appearance are complex manufactured products.

For any glass, one has to start with the raw materials. Raw materials are chosen for their purity and grain size. Sand is abundant on the South Jersey beaches, but none of the beach sands have the quality needed for borosilicate glass melting. At the Gerresheimer Kimble Vineland Plant the sand must have low iron content and a specific grain size profile. The low iron content gives the glass a very clear residual color. Residual color is the shade of green or blue that you see when you have a large mass of glass. The residual color is important to glass artists and fabricators. The grain size profile must not be too coarse or too fine. If the grain size is too coarse, it will result in stones and defects in the glass. Too fine sand results in dusting and handling problems. To meet the markets demands, the sand is mined from deep pits and processed through a series of acid baths and milling stations. The acid bath removes the iron from the grain. The milling station cracks and separates the grains according to size and removes the coarse undesirable sand grains. The sand is closely monitored and tested for compliance with glass manufacturer's specification. At Kimble, all incoming raw materials must have a Certificate of Analysis before the material is unloaded.

This protocol is repeated for all the other raw materials. Raw materials for borosilicate glass besides sand are the boron materials, the aluminas, feldspars, neptheline syenite, limes, and limestone. Each has its own specification for purity and grain size. Each must have a Certificate of Analysis before it can be unloaded. If a new raw material or a new supplier is found, that material must be tested and experimentally melted in a glass formulation to ensure good residual color and melting.

In the batch house, the raw materials are stored in silos where the prescribed amount of each material is weighted into a mixer. The weighing and mixer cycle are both computer controlled to minimize human error.

The mixed batch enters a continuous melting furnace through the back wall. The melter of a continuous melting furnace can be a large rectangular room where the batch enters at one end and travels as it melts to the other end. In the melter (e.g. 2950'F), the batch is heated for the fluxes to react with sand grains. As the batch melts, it travels down the length of the furnace. As melting batch travels, it purges itself of gases and trapped air. Also all sand and siliceous materials are melted into homogenous glass matrix.

The whole furnace is closely monitored using the latest in computer and sensor technology to control temperature profile, glass level, and combustion of fuels. Plus, the advantage of continuous melting in large furnaces is that there are no abrupt compositional and property changes; such as occur with smaller one day pot furnaces. Instead changes take place comparatively slow because of the effects of dilution in the large furnace. This gives the customer a more consistent product from shipment to shipment.

When the glass reaches the other side of the furnace, it exits through a throat (hole) in the wall. It enters either a refiner or distributor where the glass is cooled to its working viscosity and delivered to the forming process.



For tubing and rod, the forming process is one of three types: Danner, Vello, or Downdraw. In all three processes, the glass is pulled and inflating air is blown into the center of the drawn glass. This inflating air maintains the bore and diameter dimensions until the glass tubing has set and hardened. The tubing is carried down a conveyor (alley) on rollers to a cutting machine. If the inflating air is turned off, the glass collapses into rod instead of tubing. As the tubing or rod travel to the cutting machine, it passes through a series if light gauges which measure the dimensions, (outer diameter, wall weight, defects). Sections of the tubing, which are not within specification, are automatically discarded at the cutting machine. At the packing area, samples are taken and measured by trained personnel. All this data is entered into a Statistical Process Control Program. The SAP program permits Kimble to monitor the manufacturing process and control a tighter tolerance on the product dimensions. Every alley has its own computer for tracking the SAP data. The "live "data is sent automatically sent to the furnace operator to make adjustment to keep the dimensions and glass quality within specification.

Quality Assurance performs a final inspection. Glass stress, end cuts, trims and glazes, visual defects and other cosmetic defects are evaluated. These defects are the most noticeable to the customer and great concern to the Kimble and other glass manufacturers. If the glass passes all the inspections, now it sent to the warehouse and shipped to the customer or a distributor, where additional value is added to the raw tubing and rod products.