Defect-free glass delivery at AGR from batch and furnace operations

When it comes to glass-making, chemistry is king. Indeed glass composition determines the material properties of the product and has a major influence on quality. Consequently, monitoring and understanding batch and furnace operations is an essential, routine function of a well-run glass plant.

COMPOSITIONAL ANALYSIS

Regular monitoring of batch material quality is the first step, as raw materials can shift in composition over time as different areas of a quarry or mine are accessed. American Glass Research's (AGR) laboratory in Maumee, Ohio is specially equipped to perform compositional analysis on sand and other raw materials so that the data can be used

Atomic Absorption (AA) Spectrometer, used for measurement of alkali elements and heavy metals

As American Glass Research advances glass quality through expert monitoring of batch and furnace operations from raw material analysis to final melt composition, Dr Brandon Aldinger, a Senior AGR Scientist, looks here at how the company is ensuring defect-free, consistent glass by leveraging cutting-edge techniques powered by decades of expertise in chemistry, colour and regulatory compliance.

for batch formulation. In addition, measuring iron impurities in sand can be vital for production of ultra-clear products such as high-end liquor bottles, tableware, or low-iron float glass.

BATCH MEASUREMENT

After the glass has been formed, the final properties of the melt can be compared to specifications. Perhaps most importantly, the bulk glass composition should be periodically compared with batch calculations. This measurement is performed by slumping approximately 40g of glass in a graphite crucible. The puck is polished to obtain a flat surface and analyzed with a Wavelength Dispersive X-ray Fluorescence (WDXRF) spectrometer to obtain the percentages of the component oxides. For analyses of elements to the parts-per-million (ppm) level, different techniques are used such as Inductively Coupled Plasma (ICP) spectrometry, UV/VIS spectrometry, or Atomic Absorption (AA) spectrometry is used. Adequate sensitivity is needed to measure elements such as cadmium, hexavalent chromium, lead, and mercury to ensure regulatory requirements are met.

COLOUR FACTORS

The ability to tailor colour is one of the most desirable properties of glass. AGR can provide transmittance measurements that include LAB colour, dominant wavelength, and redness ratio. Redness ratio, in particular, is used to specify colour in amber glass, which is designed to protect liquid products from ultraviolet (UV) light. Blocking UV light is important to lengthen the shelf life of beer and to shield some active pharmaceutical ingredients. Glass colour, in turn, is heavily influenced by the 'redox' state of the furnace. All furnaces are oxidizing, in the sense that most batch compounds end up as oxides in the glass; however, altering certain batch components can make the combustion environment more 'reducing.' Because the oxidation state of metal ions determines their colour, furnace redox (an abbreviation of reduction/oxidation) must be controlled. The analytical lab at AGR measures the relative proportion of FeO to Fe_2O_3, which can then be used to adjust the batch.

Graphite crucibles are needed to form the pucks used for XRF compositional analysis

THERMAL EXPANSION

Certain applications rely on the mechanical or thermal properties of the glass, which are determined by glass composition. The softening point is defined as the temperature at which glass begins to deform under its own weight. The coefficient of thermal expansion (α) describes the expansion or contraction of a

material as a function of temperature. Although glass density is not vital for most applications, this physical property can be measured to four decimal places using a sink-float comparator. Consequently, density is regularly monitored as a leading indicator of glass composition issues. Sudden changes in density can provide a warning of an undetected change in the raw materials or an upset in the furnace. In addition to manufacturing sink-float instruments, AGR can perform density measurements, create oils with a known density, or provide a glass density standard.

IDENTIFYING STONES

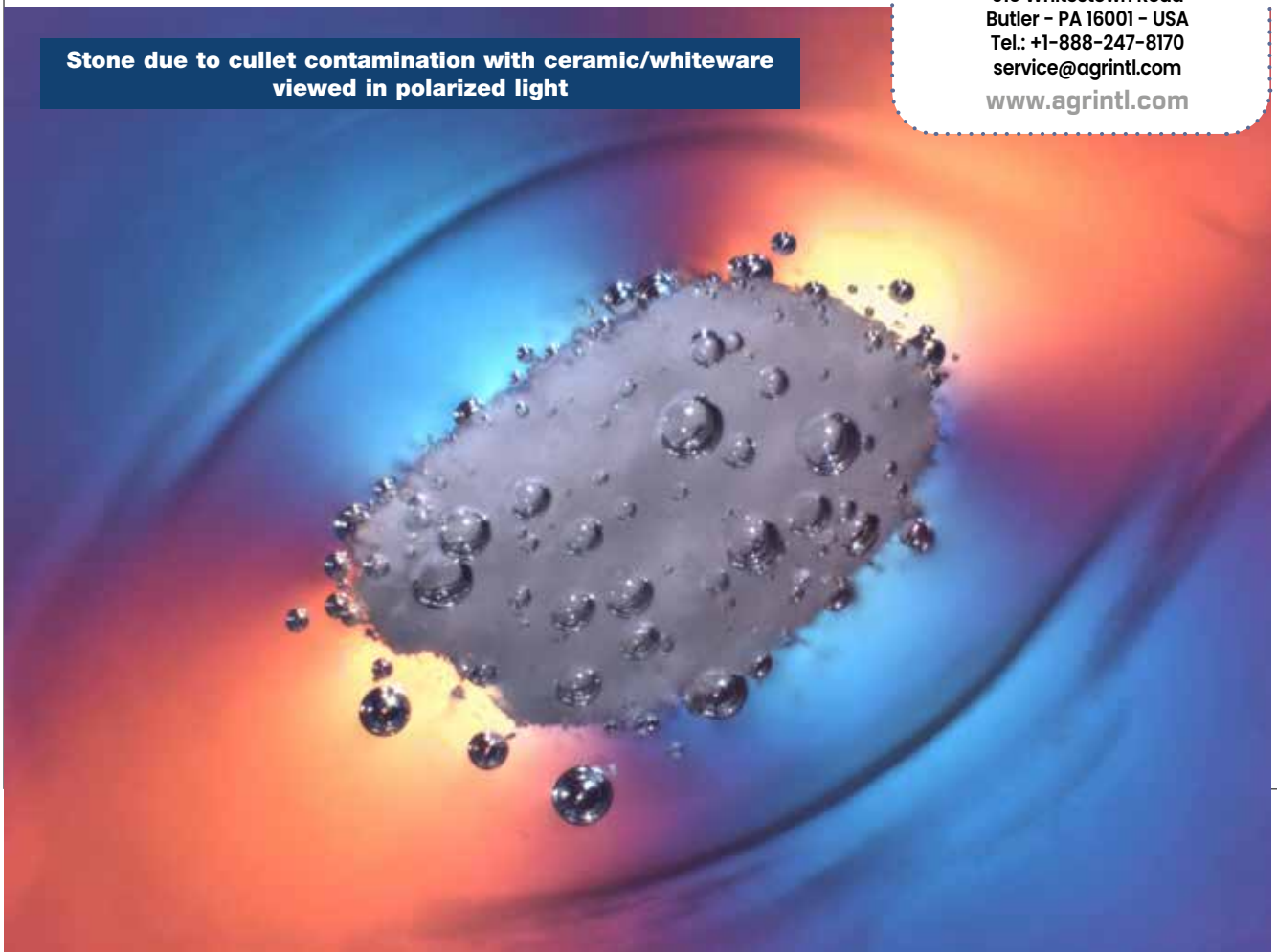
Unfortunately, glass problems can occur even with proper monitoring. Solid inclusions in glass, referred to as stones, are a common cause of glass breakage. Stones can arise from inadequate melting of batch materials, furnace upsets, refractory erosion, contaminants, or devitrification. Identification of stones is needed to determine appropriate corrective actions. AGR's lab in Butler, PA, provides stone analysis services and training on using stereomicroscopes, polarized light microscopy, and SEM-EDX to analyze stones.

PUTTING THE ENVIRONMENT FIRST

Sustainability in the glass plant goes hand-in-hand with cost savings. Post-consumer glass cullet (broken, recycled glass) decreases the energy required to melt the batch, which directly saves on energy costs and indirectly increases furnace lifetimes. Cullet, however, can vary in composition. Thus, periodic analysis of cullet composition must be performed so that batch calculations can be re-adjusted. Another focus on sustainability occurs in furnace exhaust processing at a glass plant. Electrostatic precipitators (EP) help to remove fine particulates from the combustion gases that normally go up the stack. This dust is not a waste product, however, and consists of batch material and scrubber reaction compounds that can be reintroduced into the furnace. AGR can analyze the composition of "EP dust," which can then be factored into batch calculations.

DEFECT-FREE GLASS

In conclusion, the goal of batch and furnace operations is to deliver homogenous, defect-free glass to subsequent forming equipment. Careful monitoring of the glass chemistry, both before and after melting, is essential to successful glass manufacturing. At AGR, scientists with decades of experience focused on glass technology are available to partner with companies. ■



Stone due to cullet contamination with ceramic/whiteware viewed in polarized light

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