Exploring AZS Fused-Cast Refractories

AZS fused-cast refractories have evolved from a specialty product to a commodity, but is their future viability in question?

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Alumina-zirconia-silica (AZS) fused-cast refractories began to increase in popularity in glass furnace applications for the glass contact and superstructure market in the middle of the last century. AZS fused-cast refractories were intrinsically superior to the previously utilized silico-alumina sinter materials, and they enabled a significant evolution in furnace design while allowing for the extensions of furnace campaign life.

The lower consumption of refractory (per mass unit of glass produced) drove down glass defects and made it possible for glass manufacturers to achieve higher-purity glass, which was necessary for the production of some of the new glass specialty products. To a certain extent, therefore, we can say that fused-cast refractories—particularly the AZS type—promoted the evolution of glass itself.

Over the years, these refractories have improved in quality and technology. Fundamental improvements have included oxygen refining technology and the long-arc fusion process, as well as a number of chemical and mineralogical composition advances. Most of these improvements translated into even fewer glass defects while increasing corrosion resistance and reducing exudation tendencies. The increasingly competitive environment in a rapidly expanding market (and its eventual saturation) promoted a rapid evolution of fused-cast refractories in general, and AZS in particular.

For decades, glassmakers had taken a conservative approach toward AZS fused-cast materials, recognizing that high quality (and therefore a price premium) was a necessary condition to safeguard the furnace’s integrity and performance, as well as glass quality. Second-tier manufacturers (those who produced a slightly lower-quality material than the market leaders) had a hard time surviving in the market.

**Changing Scenario**

The situation began to change about 10-15 years ago due to a number of factors. Several mature segments of the glass market, such as containers, cathode ray tube (CRT) televisions, automotive and building float glass, began to reach a saturation point. In addition, the vertical supplier-customer chain in most glass segments began to break down due to market saturation, the emergence of low-cost suppliers, globalisation and new technologies. A typical example is the transition from CRT TVs (with kilograms of glass per TV) to flat screens (with just grams of glass per TV).

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In the glass industry’s refractory procurement process, the decision-making authority progressively switched from a focus on technical purchasing to financial considerations. This has led to the abandonment of the traditional conservative approach to procurement in favor of a financially aggressive attitude, leading manufacturers to accept more risks in favor of a short-term economic conve-
AZS FUSED-CAST REFRACTORIES

Figure 1. Bottom oxygen injection (left) vs. consolidated discontinuous top lancing (right).

nence. These factors are collectively and progressively opening doors to third-tier, lower-cost manufacturers that will be among the principal players in the future.

Slowing Evolution
The draining of AZS fused-cast’s business profitability and its change from a specialty product to a commodity made it hard, if not impossible, to further improve these materials. Within the last 10 years, the only real innovation has been bottom oxygen injection, which introduced the adoption of a special bottom tuyere that delivers a relatively low flow rate of oxygen into the liquid refractory (at temperatures approaching 2000°C) all along the manufacturing cycle (see Figure 1).

As illustrated in Figure 2, this technology, which is an alternative to consolidated discontinuous top lancing, enables the same amount of oxygen per liquid mass unit that is administered in the final 5-10 minutes with discontinuous top lancing to be injected during the whole manufacturing cycle (typically lasting 1 hour). Advantages include the intrinsic safety of the relatively inexpensive tuyere vs. the complex and potentially dangerous use of a copper water-cooled lance that is mechanically inserted through a liquid depth at extremely high temperatures. In addition, the continuous stirring effect of the gas stream in the new process maintains a greater level of liquid homogeneity (both chemical and thermal).

After this process improvement, most of the innovations have generally been motivated by economic pressure. For example, advances have been made that enable the utilization of cheaper raw materials, overall energy savings, molding simplifications and increased process mechanizations.

Some special AZS compositions were developed for specific applications, the most significant being the “low-exudation AZS” that was typically engineered for superstructure application in oxy-fuel-fired glass furnaces. Oxy-fuel technology, in turn, was a promising innovation 15 years ago but has seen limited applications for float and container processes. (It really only succeeded in niche applications like the declining CRT TV glass market.) In addition, the refractory problem (if any) in oxy-fuel furnaces is silica crowns, not AZS superstructures, and the technical solution for an oxy-fuel crown is fused-cast alumina (alpha-beta and beta), not AZS.

Fused-cast crowns, in spite of their outstanding technical performance, unfortunately proved challenging from an economic standpoint when compared to the inexpensive and light silica. Indeed, the economic viability of oxy-fuel technology itself mostly depends on electrical energy prices, as that is the principal means of on-site oxygen separation and delivery. Thus, low-exudation AZS enjoys limited applications today.

Troubled Relationship
Due to economic considerations, the technical evolution of AZS fused-cast refractories has almost stopped in the last 10 years, while the technological evolution of furnaces has been sustained in order to increase campaign lengths, decrease specific energy consumption (more insulation) and reduce emissions. Most of these trends have increased the performance demands of AZS fused-cast materials to the point that, in the near future, it is possible that these one-time high performers will become a limiting factor.

In the short term, as the worldwide economy continues to improve, low-cost sources of the AZS commodity will almost certainly take a very significant share of the Western market. At the same time, the top-tier manufacturers on both sides of the Atlantic will have a hard time feeding glassmakers with enough product, due to downsizing policies that were enacted during
Figure 2. The bottom tuyere delivers a relatively low flow rate of oxygen into the liquid refractory (at temperatures approaching 2000°C) during the entire manufacturing cycle.

the economic crisis. A lot of substandard AZS fused-cast materials could be installed due to price and delivery pressures, even while performance demands are on the rise. These factors could mean that the long honeymoon between glass manufacturers and AZS fused-cast refractories might be endangered.

Leading AZS fused-cast manufacturers will have to decide whether or not this commodity market in favor of low-cost alternatives or reinvesting in the AZS fused-cast technology evolution. Glassmakers will have to decide between compromising the performance upgrades of their furnaces (and, therefore, the resulting reduced capital outlays) for a while or accepting higher refractory costs in exchange for a continued quality and performance evolution.®

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