Fused-cast Refractories for the Glass Industry: a Troubled Future and new Competitive Refractories

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For a very long time, fused-cast refractories have dominated glass refractory applications in the most stressed areas of glass contact and superstructure. These materials, revolutionarily new when introduced in these applications, rapidly filled up all viable niches and led to great success for the few Western companies that developed the necessary level of technology and know-how, and successfully marketed the relevant products and services.

Introduction

SEPR (now SEFPRO) of Saint Gobain in Europe, Carborundum Monofrax (now RHI-AG) and Corhart (now SEFPRO) in the USA dominated the relevant western markets for several decades without any significant level of conflict, until 1987 when SEPR acquired Corhart in the USA, triggering global competitive conflict.

In the Far East, two Japanese fused-cast refractories manufacturers, Toshiba-Monofrax (now TMKK of SEFPRO) and Asahi (AGC Ceramics), developed different types of connection with SEPR and Monofrax, enabling them to cover both the developing and well-established domestic markets in the Far East.

Two new factors further destabilized the global equilibrium, starting two decades ago:

- The loss of profitability in the glass business (as a consequence of market globalization) and, shortly after, the beginning of the first ever global financial and economical crisis.
- The penetration of western markets by low-cost (mostly Chinese) fused cast refractories produced by a large number of players, utilizing locally developed (and sometimes imported) technology.

The combined effect of these factors led to a collapse of profitability in the AZS fused-cast market, and the progressive commoditization of specialities (fused-cast aluminas, HFZC to be the next).

Market evaluation

The reaction of the western companies was consolidation (SEFPRO acquired competitive players) and further development of customer fidelization by improving servicing and progressive implementation of technical action teams.

Another way of coping with this situation has obviously been delocalization of manufacturing units, although this has not always been successfully pursued.

SEFPRO of Saint Gobain took control of Japanese TMKK and Indian CUMI, and delocalized commodity production in low-cost countries (China, India); the same has been done by the Japanese Asahi moving mass production to Zibo (China).

On the other hand, the second globally operating western fused-cast refractories manufacturer (now RHI-AG), which has been growing as a result of the acquisition of Refel (I) and Monofrax (USA), is still manufacturing almost all its products at high-cost locations in Europe and the USA, and grounds its strength on the status of a global supplier for the glass industry, being the major player in the segment for basic and neutral sinter materials, with some reach in the silica niche and an outstanding technical reputation.

While the (few) major Western players, being able to provide very similar top-level products, have developed harsh competition based on service and support excellence, the Chinese low-cost manufacturers have great potential to further increase their market share in the future.
Fig. 2 Manufacturing cost of low-cost refractories increased more than for Western players due to a combination of raw materials and labor cost inflation

leverage on cost basis (thanks mostly to the extremely cheap labour in China), being able to deliver products to the West at a price well below the cost of the equivalent Western-made products, while remaining profitable. This was surely the situation when, about two decades ago, low-cost fused cast showed up in certain Western markets. The profits thus generated by low-cost suppliers, however, have not been re-invested in the business at all or not enough in order to improve technology (and therefore product quality), automation (and therefore production costs), nor utilized to develop the minimum necessary level of customer support indispensable to generate a stable clientele and cut costs incurred for third party involvement (Western agents, promoters, intermediates).

Meanwhile, the global unit cost for low-cost producers has been steadily increasing as a consequence of the rise in the price of the main raw materials (global rise for Bayer calcined aluminas and high-grade zircon sands) and materials (for example graphite electrodes), energy. These increases have generally hit, to a varying extent, the Western manufacturers too. The Chinese labour cost, however, has jumped up well over 100% over the last decade, while in the West the inflationary labour cost rise has been very marginal and, in some cases, labour costs have actually decreased “thanks” to the global financial/economical crisis, organizational streamlining and certain implemented cost-saving programmes. The overall result has been a differential increase of costs in the low-cost segment versus the western segment; the combined effect of this rise and the unresolved labour efficiency gap (still a factor of 2,5X in the men-hours/tonne produced) is having devastating effects on the capability to maintain marketing penetration of low-cost fused-cast refractories in the west, largely fuelled by cost advantage.

Since the gap of product and services quality between low-cost and Western fused-cast refractories is almost unchanged, so is the premium in savings that a Western glassmaker requests in order to decide for a low-cost procurement. Based on recent investigations, this price advantage, on a delivered book cost is at least 20 – 25%.

Under these conditions, the hypothetical Chinese manufacturer is left with a very low to zero financial margin, making it less and less viable to push for an increase in the western market share. This is indeed one explanation for the relatively good position of the major traditional Western manufacturers like SEFPRO and RHI-AG, despite a greatly reduced margin. As the global result, in a couple of decades, AZS fused-cast has turned from a profitable milk-cow into a bony business; fused-cast aluminas are following and in the medium term even HZFC (high-zirconia fused-cast) will fall into the commoditization whirlpool. One major consequence of this pauperization process has been, and is, the reduction of investments in research and development aimed at improving products.

The commitment to better glass quality, particularly in the Western markets, has been therefore maintained in the recent decades, and the target has been achieved with a more informed selection of raw materials for the batch, better cleaning of collected cullet and an improved fusion and refining technology. The combination of such factors has, in most cases, reduced the amount of glass defects resulting from batch contamination and inefficiency of the fusion/refining process.

Technology driver: energy efficiency and glass quality

Meanwhile, the requested improvement in energy efficiency has pushed glassmakers toward increased specific pull and higher operational temperatures, glass velocity. These functional changes have been all increasing the stress in fused cast refractories; the relatively lower occurrence of defects related to raw materials and fusion/refining have again put AZS fused cast under the limelight as a significant source of defects. Glass defects coming from glass contact (sidewalls, pavers) and superstructure, which turned into a minor issue when, almost a
century ago, fused cast replaced the old sinter Si-Al blocks, are now under scrutiny again as a significant troublemaker, since other causes have been better controlled in the recent decades. It goes without saying that the utilization of sub-standard AZS fused-cast and the advent of a new technological platform like oxy-fuel have not improved the situation at all. Knots, Zr/Al enriched cords, primary/secondary ZrO₂ stones, some types of blisters are undoubtedly AZS-related defects; they can originate from the superstructure as well as glass contact. Their average rate of occurrence in a given production is extremely difficult to forecast; the actual frequency can be relatively low in steady operational conditions, after equilibration of the furnace, but can exhibit remarkable surges in case of variations in glass level, temperature, colour, pull that, in turn, occur when you change the items produced (weight, colour of containers, thickness in float and so forth).

The convergence of a number of circumstances is thus generating, for the first time in a century, an environment highly favourable to the development of improved refractories for the glass tank, in the traditionally exclusive application niche of fused-cast refractories.

The key news, this time, is that these new products, so far with some limitation (tank superstructure), are not members of the fused cast refractory family.

Advanced sinter materials, based on recent development of a traditional forming technology can now offer a modern solution for superstructure that, after medium-long term field tests, have been proven to perform well in advanced container furnaces, with outstanding durability and intrinsically no exudation. These materials, offered today by a highly specialized US company (Special Shape Refractory Co. of Alabama), are progressively replacing the traditional AZS refractories in the superstructure of large advanced container glass furnaces, offering a number of advantages, of which the virtual elimination of defects is only one.

The same concept for advanced sinter materials is applied in the glass container distribution (channels), where AZS and alumina fused cast, or traditional sinter materials, can be replaced by S.S.R.Co. alumina channel blocks showing a performance close to the alpha/beta fused cast, combined with advantages sprung from a great deal of body homogeneity and reduced thermo-shock vulnerability. These newly developed products, which represent an opportunity for a western manufacturer to still profitably manufacture from a western factory, will possibly mark the most significant evolution in the refractory-for-glass after the advent of commercially available fused cast (almost a century ago) and will possibly lead to the replacement of a significant amount of fused cast refractories in superstructure, distribution and other future applications.

Macro-economical changes, market globalization and other factors have made possible the development and application of conceptually new products. New equilibria will be progressively achieved in the global marketing of refractory-for-glass within the next decades, and this will inevitably go through reduction of overall fused-cast capacity, particularly in the Far East region. Innovative refractory and advanced applications will competitively conquer new areas, while the era of domination of fused cast in the most stressed area of glass furnaces will have to come to terms with continuously evolving exigencies of glassmakers.