Five Years after Market Launch – Experiences with BSA 96

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Brown Fused Alumina (BFA) was for many years the only choice as a titanium-doped high alumina aggregate. Supply issues with imported raw materials combined with continuous quality problems had triggered the development of an alternative high alumina aggregate. BSA 96, a new sintered aggregate was introduced to the market in 2011 by Almatis. This high alumina aggregate is produced in Europe and is independent from Chinese raw materials [1]. Since its launch, many customers have been supplied with BSA 96. Qualification testing in the laboratory and on site convinced those customers of the potential of this new aggregate. Today, BSA 96 has found its place in the European refractory industry and is an established refractory raw material for various applications such as high alumina bricks, alumina magnesia carbon (AMC) bricks and monolithics.

1 Introduction

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2 BSA 96 – Properties

2.1 Chemical composition

BSA 96 is a refractory aggregate with an Al₂O₃ content greater than 96 %. The major impurities are SiO₂, TiO₂ and smaller amounts of Na₂O and MgO (Tab. 1). It is important to mention that because BSA 96 is produced by the sinter process, all size fractions have the same chemical composition (Tab. 2). The firing of BSA 96 takes place under a neutral to oxidising atmosphere. Later in the process strong magnetic de-ironing removes iron particles which are introduced during the crushing and sizing of the fractions. As a consequence BSA 96 does not contain carbides or metallic components that could harm sensitive bonding systems. This is different to fused aggregates where impurities often accumulate in the fine fractions. These impurities may react with water and have an adverse effect on the flow and...
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2.2 Physical properties

The sintered high alumina aggregate BSA 96 has a similar bulk density to tabular alumina. Water absorption and open porosity are also in the same range (Tab. 1). The bulk density of BSA 96 is lower when compared to brown fused alumina. This is a typical feature of sintered aggregates. The ceramic sinter process permits a well-controlled development of microstructure where small pores are entrapped inside and between the crystals. These pores are mainly closed and are the reason for the lower bulk density and low open porosity of BSA 96 [2].

Although the open porosity of BSA 96 is slightly higher than the porosity of brown fused alumina, the total volume of accessible pores >1 µm is identical for sintered BSA 96 and brown fused alumina (Fig. 1).


The general production process of BSA 96 is identical to the production of tabular alumina and sintered spinels, which is described in detail by Maćzura [4]. The sintering process route enables both a homogeneous distribution of the impurities in the product, and also stable physical properties, e.g. density, porosity, and microstructure. No carbides or metallic components are formed during the sintering process.

Sinter processes run at lower energy levels. Considering the overall impact of high energy consumption and the corresponding impact on greenhouse gas emissions, it becomes obvious that the sinter process is the more sustainable process route for the manufacturing of high alumina aggregates. Today, BSA 96 is produced in 8 different sizes to meet various customer requirements (6–15 / 3–6 / 1–3 / 0–1 / 0,5–1 / 0–0,5 / 0–0,2 / <90 µm). Coarse fractions of >15–28 mm are used in pre-cast fabrications such as EAF-roofs and ladles to give improved thermal shock resistance.

Fine milled fractions and powders such as <90 µm and 0–0,2 mm are advantageous, especially in phosphate bonded ramming mixes and mortars, due to their low metallic iron content.

4 BSA 96 – refractory applications

Close to two thirds of the volume of BSA 96 supplied today is used in castables and other monolithic mixtures as a replacement for brown fused alumina or as an up-grade for bauxite-based materials. Typical uses are the so-called “black castables” for blast furnace runners and cupolas. Brown and white fused aluminas in brick formulations were also successfully replaced by BSA 96.

4.1 AluMagCarbon (AMC) bricks

AMC bricks consist of an alumina aggregate, which is typically bauxite or brown fused alumina, calcined alumina, magnesia and carbon, normally in the form of graphites, plus resin binders. During use, AMC bricks expand at the hot face due to spinel formation. This results in reduced wear in the joints between the bricks.

Intensive testing and qualification of BSA 96 has been done at Arcelor Mittal Refractories in Poland. The influence of alumina aggregate on spinel formation during firing and on the final brick properties of AMC bricks has been investigated and the results are reported by Klewski et al. [5]. Distinct differences were observed in the permanent linear change (PLC) between BFA and BSA 96 bricks after firing. BSA 96 shows a stronger increase of PLC above 1300 °C when compared to BFA (Fig. 3).

Mineralogical investigations of the fired bricks showed that the spinel formation is more intensive and more homogeneous with BSA 96 than with BFA due to more evenly distributed impurities and the small, homogeneously distributed pores in the structure of the sintered aggregate (Fig. 4). The expansion was adjusted by slightly reducing the magnesia content of the formulation and a BSA 96 based AMC brick was developed and successfully tested in practice. Predictable expansion behaviour (PLC) of AMC bricks during use is essential for good performance in the steel ladle.

BSA 96 provides stable raw material properties, which enable smoother and controlled production and predictable and reliable performance.

4.2 Castables for blast furnace runners

Low cement and ultra-low cement castables with 60–85 mass-% Al₂O₃ and 5–25 mass-% SiC are used for the wear lining in the blast furnace main trough. Brown fused alumina is the most common aggregate for these castables although in some cases tabular alumina is also used. For many years refractory producers had to cope with wide variations in the quality of Chinese brown fused alumina. The availability of a more stable raw material for these quite complex and also sensitive formulations triggered a very rapid deployment of BSA 96 in first test castables (Fig. 5).

Because of the density differences between BSA 96 (3.50 g/cm³) and BFA (3.8 g/cm³) some recipe adjustment was required in order to achieve the same particle size distribution of the castable. The castable density
ties were found to be 3–5 % lower for the BSA 96 based mixes. Assuming the same performance level, this density difference translates directly to financial savings for a given installation.

It was also noticed, that the replacement of BFA by BSA 96 leads to a changed cement setting (EXOMax). The matching of cement setting and Al-reaction needed to be adjusted. This could easily be achieved by dispersing aluminas ADS 3 and ADW 1. Once completed, the BSA 96 based formulations show very stable setting behaviour when compared to the BFA-based formulation. This is most likely explained by the low and homogeneous impurity levels of the sintered aggregate.

Under laboratory conditions the strength of BFA 96 investigated. The outcome was that the expansion, different test castables were prepared. In order to find the root cause for such an expansion, different test castables were prepared. It was also noticed, that the replacement of BFA by BSA 96 leads to a changed cement setting (EXOMax). The matching of cement setting and Al-reaction needed to be adjusted. This could easily be achieved by dispersing aluminas ADS 3 and ADW 1. Once completed, the BSA 96 based formulations show very stable setting behaviour when compared to the BFA-based formulation. This is most likely explained by the low and homogeneous impurity levels of the sintered aggregate.

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The specific material consumption therefore providing an economic advantage in the range of 3–5%.

Customers confirmed the reliable performance of BSA 96 in the formulation and processing of their refractory materials, for example giving good flow and reliable setting behaviour in refractory castables and providing smooth brick production. More tests are on-going in tap hole clays, phosphate bonded mortars and ramming mixes, and also in various castable formulations for pre-shape production and also in special gunning applications.

References