Optimising with premium aluminas

Although there are numerous refractory raw materials, choosing the right combination of raw materials can optimise the performance of refractory formulations. As *Leslie Power* and *Dr Andus Buhr* of leading speciality alumina producer Almatis explain, there are a range of premium aluminas which can enhance the overall performance of refractories to meet the ever stringent demands from refractory end users

Courtesy Almatis GmbH

EVERY REFRACTORY formulation contains a combination of natural and/or synthetic minerals. These minerals are available as coarse, fine, or ground aggregates; ground calcined and reactive aluminas; sub-micron alumina; or silica fume fillers and binders.

Speciality additives are also used for dispersing, deflocculating, minimising liquid addition, controlling working life or strength development.

The Almatis Premium product focus is on synthetic minerals and on supplying value to the customer. Our high purity synthetic aluminas have proven to be cost effective as they are consistent over time and increase the life of the refractories in severe service applications.

Building blocks of high performance refractories

The synthetic minerals of choice for dense refractories are tabular alumina, magnesia rich and alumina rich spinels, calcium aluminate cements, calcium hexaluminate bonite, calcined and reactive alumina, and silicon carbide.

The specific mineral needs are defined by service temperature, frequency of thermal cycling, strength or loading requirements, and service environment such as corrosive liquid or gas vapours. These synthetic minerals are available in different particle size distributions as this is a requirement for building the optimum formulation:

- Coarse aggregates are used as the bricks to build the foundation.
- Fine aggregates are used to fill the intermediate voids between the coarse aggregate
- Matrix fines fill the micron size voids without adding excess liquid. The amount used impacts rheology thus setting the properties for vibration, self flow, or pumpable castables. The particle size distribution of the matrix fines can result in either dilatant or shear thinning behaviour.
- Binders hold the formulations together until thermal sintering occurs.
- Additives are used as water reducing agents such as dispersants, deflocculants, and plasticisers. They are also used as retarders or accelerators to control setting behaviour of the refractory formulation.

The importance of particle size distribution

The overall particle size distribution of minerals impacts refractory performance by affecting wear resistance, chemical and thermal shock resistance, overall water required for installation, and the porosity of the finished product.

High quality tabular and spinel aggregates offered by Almatis in the coarse and fine fractions are instrumental in achieving the ultimate chemical and thermal shock resistance due to their dense structure, closed porosity and consistent particle size distribution.

Matrix fines in the Almatis portfolio such as ground aggregates and reactive and ground calcined aluminas, range in particle size from 0.4 to 75 microns. They strongly determine the rheology, strength and setting behaviour of a refractory castable.

Optimising the combination of matrix fines in a formulation greatly reduces the water demand by filling the voids within the combination of synthetic mineral structures. The mono-modal reactive aluminas provide full flexibility in designing the refractory matrix particle size distribution. The multi-modal reactive aluminas can further enhance the performance by optimising the particle size distribution with super-fine components that have been intensively homogenised while being manufactured.

In true high performance refractories suited for temperatures greater than 1,400°C, reactive aluminas and ground tabular and spinel aggregates typically replace standard calcined aluminas and silica fume in order to attain the performance requirements.

Almatis dispersing aluminas combine water reduction and set-controlling additives with a fully ground matrix alumina. The dispersing additives are coated on the alumina allowing easy homogenisation in the matrix fines. The set control capability is designed to function perfectly with Almatis 70%

cement and hydrateable alumina binders. It offers the flexibility to achieve short, intermediate or long set time.

The ADS-3/ADW-1 dispersing aluminas are for use in monolithics that do not contain silica fume. The M-ADS 1/M-ADW 1 are used in silica fume containing monolithics.

Upgrading existing formulations

Almatis premium aluminas are used to upgrade the performance of existing refractories to meet the more demanding requirements of today's steel and non-ferrous industries. The synthetic aggregates may be required substitutions for natural minerals.

When the need is to improve the mineralogy or rheology of the matrix, the options and the opportunities are very broad. Well controlled, low water demand calcined aluminas are available to replace loosely controlled commodity aluminas.

Fully ground reactive aluminas and ground aggregate minerals can replace partially ground calcined aluminas to dramatically lower the mixing water requirement, the in-service porosity, the molten metal and slag penetration, the in-service strength, and the ease of placement even in difficult installation conditions.

When pre-formed alumina rich sintered spinel is utilised in severe service applications, such as steel ladles at 15% to 30% of a low or ultra low cement castable, slag and metal penetration is practically eliminated and erosion wear due to low strength is greatly reduced.

Choosing the right minerals and sizes

Synthetic aluminas play an ever-increasing role in refractory requirements for modern steel making processes. Product consistency and chemical purity are critical to the successful performance of refractory formulations.

Almatis takes great pride in having the ability to provide both premium aluminas and technical solutions to our refractory customers. With close to 100 years of technical alumina expertise and strategically placed global manufacturing capability, Almatis is able to quickly deliver a variety of consistent, high purity premium aluminas and the technical support to help customers meet today's challenges.

Sag test of castables at 1,550° C/ 5 hours. Tabular/Spinel castable shows no deformation versus bauxite castable which forms liquid phases and shows deformation.
Courtesy Almatis.

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