

ADVANTAGES OF USING GEL BOND AND COLLOIDAL SILICA IN MONOLITHIC REFRACTORIES

What is Gel Bond?

The principle behind this bonding is the formation of a 'gel' from a 'sol' which surrounds the refractory Aggregates through a network skeleton which, with further heating, develops strength & ultimately goes through sintering to form ceramic bonding. Actually the mechanism is thixotropy, which lies in the fact that some substances, when agitated (under mechanical force), pass from the state of a 'gel' to that of a colloidal dispersion 'sol' and goes back to the state of a 'gel' again when the mechanical forces stop. The phenomenon of thixotropy is based on the theory of dispersion & subsequent flocculation of ultrafine powders. Various sols used in the bonding process e.g. Silica, Alumina, Zircon, and Titania. The incorporation of gel bond in place of conventional binders (High Alumina Refractory Cement) has made it possible to improve the high temperature properties of castable refractories considerably mainly because of the absence of low-melting phases (CA, CA₂, C₁₂A₇, C₂AS, C₄AF) and impurities.

Advantages of Gel Bond

Several advantages of the gel-bond compositions compared to LCC & ULCC as have been reported are:

- Less mixing time since gel bond formulations do not require other minor additives or deflocculants like the cement containing castables.
- Shorter drying time and so reduced drying flaws. This is because water is not added or required for mixing.
- Better refractoriness because of the absence low melting phases like- anorthite or gehlinite.
- Colloidal silica being more viscous than the water, help to maintain more separation of refractory particles which, in turn, provide better thermal shock resistance.

- Better chemical resistance.
- Because of the various superior properties of gel bond castables / pumpables as described above, they yield longer campaign life, less downtime and so reduce cost of furnace operation.
- Longer shelf life since there is no hydratable phase as in LCC, ULCC.

Applications of Gel Bond Castables / Pumpables

Because of Gel bond Castables / Pumpables have been found to give better results in terms of both conveniences of applications as well as properties in almost all type of industries:

- in cement industries - high temperature rotary kiln burning zone, rotary kiln incinerators lining
- in glass industries - outside the Glass Melting Tank furnace and sidewalls and roofs
- in Blast furnace trough - because of the better flowability these can be more conveniently installed by a pump with reduced installation time
- in Torpedo and other transfer Ladles then Tundish back-up lining, Electric furnace Deltas and Runners
- in secondary operations like - Reheating furnace hearth, roof. The installation of colloidal silica bonded castables / pumpables has shown significant improvement especially in reheating furnace roof areas, both during installation and drying (which has been found to take about 60% less time than the conventional ramming mixes & plastics)

Colloidal Silica / Silica Sol

Colloidal Silica or Sol or Silica Sol are the different names, consists of a stable dispersion amorphous silica particles. To achieve this, the silica particles must be small enough such that they are largely unaffected by gravity. Therefore, silica particle sizes are usually of the order of less than 100 nanometers.

Initially colloidal silica was used in refractories for the purpose of coating in various applications like ingot casting, investment casting etc. It was during late 80's when for the first time colloidal silica started to be used as bonding agent in monolithic refractories. During late 80's refractories based on colloidal silica became available in the market in ramming, gunning and castable formulations. The development of gel bond refractories with colloidal silica as the bonding agent has been a major breakthrough in refractory technology. Since the type of colloidal silica used in refractories is available commercially, it became easy for many to take advantage of this technology. In lieu of conventional binders, colloidal silica can be used as bonding agent in all type of monolithic refractories such as castables, ramming and gunning mixes. Its use in castables has given rise to the convenience of refractory applications by pumping, thus providing a considerable advantage over conventional binders. Another big advantage is that unlike calcium aluminate cement bonded refractories; these refractories do not require following specific temperature parameters for drying and hence reduce drying flaws, installation time. Colloidal silica bonded castables / pumpables not only perform better and reduce costs of furnace operation, but also eliminate work place hazards for workers.

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