

BORON IN CERAMICS

Frit and Glaze:

Frit and glaze formulations can contain concentrations as high as 25% borates and the entire market accounts for more than 13% of the global borate demand.

Borates improve glazes: facilitating the production process, ensuring a good fit between the glaze and the item it covers, and enhancing the chemical and mechanical strength.

Borates are used to initiate glass formation and reduce glass viscosity, helping to form a smooth surface; and to reduce thermal expansion; thus facilitating a good fit between the glaze and the clay. Borates also increase the refractive index, or lustre, of glazes and can enhance their resistance to chemicals.

Many glaze ingredients including borax are soluble in water. If these



ingredients were applied wet to the surface of a clay body, they would be absorbed into the clay for which they are meant to provide a glassy outer surface. The process of fritting-or fusing the solubles with silica- renders these ingredients insoluble.

Fritting also starts the glass formation process well before the glaze is applied to the ware,

significantly lowering the glaze firing temperature. Advanced ceramic components are increasingly being used in diesel and automotive engines where their light weight, high temperature and wear resistancy result in more efficient combustion and significant fuel savings.

Ceramics are also used to contain oil spills and encapsulate nuclear wastes. Despite established procedures and limits, industries and governments are under pressure to find alternative ingredients to Lead (Pb) in ceramic glazes, particularly those used to serve food. Two of the most viable alternatives to Lead (Pb)-based glazes are Bismuth and advanced Borosilicates (glass containing high levels of borates), or combinations of both. Therefore, Borates may serve as a viable alternative to enhancing safety while maintaining quality.

Boric oxide is a network former, but allows more fluxing oxides to be introduced without destroying the silicate lattice. The oxides of only four elements (boron , silicon, germanium and phosphorus) are

able to form glasses alone.

Tile bodies:

Adding borates to tile bodies can make the tiles themselves stronger, and reduce energy used and waste in the process. Including borates in the batch also allows manufacturers to use a broader range of clays. Borates may also reduce furnace emissions at ceramic tile plants. These environmental benefits are associated with borates' dual role in the bodies.

Borates act as a flux and as a powerful inorganic binder in ceramic tile body compositions: non more effectively than boric acid. A small amount of boric acid used in ceramic body can have a significant effect during the firing process by promoting the formation of a glassy phase with low viscosity. In the pressed body, the dry mechanical strength is increased, typically by about 40%.



For the porcelain floor tile composition, the main benefits of adding borates include:

- Reducing the firing cycle typically by 10-20%, that translates the increased throughput in the furnace.
- Reducing tile thickness due to a substantial increase (30-80%) in the dry mechanical strength of the unfired tiles. For example, an increase of 25% in dry mechanical strength allows the thickness to be reduced by around 10%.
- Reducing the body formulation cost by substituting up to 20% feldspar and balancing with lower cost silica to maintain the peak temperature and cycle length. Alternatively, the binding effect of the boric acid can be used to substitute some high quality clay with lower quality, less plastic clay to further increase cost savings.
- Reducing firing temperature by more than 25°C, keeping the same cycle length, and thereby producing energy savings.

Furthermore, addition of boric oxide to porcelain stoneware bodies raises the vitrification temperature and improves the densification properties, as well as increasing the modulus of rupture. Boric acid is added in the milling stage; mixing and distributing homogeneously in the composition. Its strong fluxing power-1% boric acid has the same fluxing power as 10-20% feldspar in the

body composition- optimises the fluxing system wherever feldspar, talc, spodumene or other fluxing agents are used.