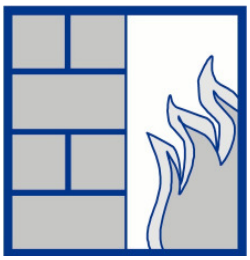
Ceramics Keramik
Céramique



Special information
Phosphate bonding

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Chemical reactions of phosphate with the raw materials as well as polymerization and poly-condensation of the phosphates take place in refractory bodies **with phosphate bond**. Furthermore, **adhesion forces** are acting within the mix. The course and extent of these processes are dependent on numerous factors. In order to be reactive the phosphate binder must be dissociated in water or a melt, since then **ion exchange** can take place.

In the first place, the hardening process of refractory materials depends on the type of cations present as reaction partner for the phosphate binder. Depending on their distribution the course of hardening varies from a chemical reaction of the phosphate up to and including a simple adherence as a result of adhesive forces. The **reaction rate and intensity depends on the cation availability of the mix and of its temperature**.

The phosphate binder reacts first with the mix components, either basic or neutral, with respect to which it possesses the greatest chemical activity. Impurities in ceramic bodies (e.g. alkaline earth carbonates, iron sulphides, iron particles, free lime etc.) can react spontaneously with phosphate binders. Apart from the high rate of reaction with such compounds, that can lead to unnecessarily high binder consumption, the reaction products, that are formed, do not possess the desired binding and refractory properties.

These complex correlations have led to the development of a large number of phosphate binders, that can be used in refractory bodies. Two typical phosphate binders will be described below, using their reaction equations as representatives of these.

Magnesia body with sodium polyphosphate

$(NaPO_3)_n + H_2O \rightarrow NaH_2PO_4$

$2\ NaH_2PO_4 + MgO + H_2O \rightarrow Mg(H_2PO_4)_2 + 2\ NaOH$

$Mg(H_2PO_4)_2 + MgO \rightarrow 2\ MgHPO_4 + H_2O$

$n\ Mg(H_2PO_4)_2 \rightarrow \textit{heat} \rightarrow (Mg(PO_3)_2)_n + H_2O$

$2\ MgHPO_4 \rightarrow \textit{heat} \rightarrow Mg_2P_2O_7 + H_2O$

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A magnesia body must be bonded using a pH-neutral or weakly basic phosphate preparation. If acidic orthophosphates were used the reaction would be too rapid and too vigorous. This is the reason for which they are not useful in practice. The polyphosphate binder hardens the body as a result of its decomposition and the production of acidic phosphates.

Corundum body with monoaluminium phosphate

$2\ Al(H_2PO_4)_3 + Al_2O_3 \rightarrow 2\ Al_2(HPO_4)_3 + 3\ H_2O$

$Al(H_2PO_4)_3 + Al_2O_3 \rightarrow 3\ AlPO_4 + 3\ H_2O$

$2\ Al(H_2PO_4)_3 \xrightarrow{heat} Al_2(H_2P_2O_7)_3 + 3\ H_2O$

$n\ Al_2(H_2P_2O_7)_3 \xrightarrow{heat} [Al(PO_3)_3]_n + H_2O$

Normally, a binding reaction does not occur at room temperature with this mixture. In order to bring about a reaction it is necessary to heat the whole mixture. Up to a temperature of ca. 280 °C monoaluminium phosphate dehydrates to acidic aluminium pyrophosphate. Aluminium metaphosphate is produced on further heating. Dehydration does not only occur in each individual molecule but even between them (intermolecular). This condensation brings about chain- and ringshaped compounds.

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