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„Refractory materials: manufacture, research methods, application”

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Peculiarities of protective layer formation in fireclay-based castables during potassium attack

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The potassium released in biomass boilers (used for wood incineration) during fuel burning and penetrates deep into the fireclay-based castable, forming new corrosion compounds (kalsilite, leucite, etc.). The volume of new compounds increases and causes degradation of fireclay-based castables. In addition, the thermal expansion coefficient of altered zones becomes significantly different from that of the original zone in a refractory promoting stress and later degradation of material. However, it was found that dispersive quartz additive retards corrosion process, due to formation of high viscosity amorphous layer.

According to SEM and EDS research results it was established the thickness and chemical composition of formed protective layer in fireclay-based castables (conventional (CC) and medium cement castables (MCC)). X-ray diffraction analysis showed that the amount of amorphous phase in the protective layer increases compared to unaffected castable. The products of alkaline corrosion in the crystalline state were identified: kalsilite, leucite and potassium silicate. Potassium silicate and additional amorphous phase are formed by the reaction of potassium and free silica.

The reaction products fill the pores and capillaries of the material, together forming a protective layer and making it more difficult for potassium to penetrate into the deeper layers of the material. Maximum log differential intrusion decreased approximately 50%, compared with reference sample. The maximum difference of pore quantity was established, when diameter of pore was approximately 1 μm . The porosity of less than 1 μm pore diameter has not changed significantly, due to the formation of a high viscosity melt. However, in cases, when the amount of potassium is high, viscosity of melt decreases; this melt penetrates to deeper layers of fireclay-based castable starting dissolution of material and increasing its open porosity.

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