Addition of K_2O and Na_2O to the Al_2O_3-CaO-FeOx-MgO-SiO_2 System

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Abstract

The aim of the study was to provide a complete database from the combination of the already available databases Al_2O_3-CaO-FeO-Fe_2O_3-MgO-SiO_2 and Al_2O_3-K_2O-Na_2O-SiO_2 which are important for the development and production of refractory materials, metallurgical slags and coal ashes.

Three new binary, eleven ternary and four quaternary sub-systems are thermodynamically assessed using available experimental information keeping the same thermodynamic description for the phases with the same structure. For example, the same thermodynamic description was used for the Cordierite phase ($Al_4Mg_2Si_5O_{18}$) with its experimentally determined wide solubility range and the Iron-Cordierite phase ($Al_4Fe_2Si_5O_{18}$) which is near-stoichiometric in the A_2O_3-FeO-SiO_2 system.

Particularly attention was given to the phases (Al,Fe)(K,Na)O_2-HT and LT and also $FeNaO_2$-δ which exhibit very wide solubility for SiO_2 in all corresponding ternary systems. This behavior could be reproduced well with the aluminium cations completely being exchanged by iron cations, and potassium by sodium.

The Beta-prime and Beta-tri phases relevant to the Al_2O_3-K_2O-MgO-Na_2O system are described as solid solution phases using four sublattices it order to reproduce the experimentally determined solubility ranges in ternary systems containing MgO.

The liquid phase was described by the associate model. The compositions of the liquid oxide species are as introduced by Spear taking two moles of cations per associate.