

Hydrothermal Conversion of South African Coal Fly Ash into Pure Phase Zeolite Na-P1

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Abstract

South African coal combustion power utilities generate huge amounts of coal fly ash that can be beneficiated into zeolitic products. This chapter reports on the optimization of the presynthesis and synthesis conditions for a pure-phase zeolite Na-P1 from selected South African coal fly ashes. The hydrothermal treatment time, temperature, and molar quantities of water during the hydrothermal treatment step were successfully optimized. The optimum hydrothermal treatment time and temperature were 48 h and 140°C, respectively. Pure-phase zeolite Na-P1 was obtained with a molar regime of 1 SiO₂:0.36 Al₂O₃:0.59 NaOH:0.49 H₂O at an aging temperature of 47°C for 48 h. The optimized conditions were applied to two fly ashes from two coal-fired power utilities, and high-purity zeolite Na-P1 was obtained. The third coal fly ash with a different chemical composition gave a low-quality Na-P1 under the optimized conditions. The cation exchange capacity for the high-purity zeolite phase was 4.11 mEq/g, indicating that the adjustment of reactant composition and presynthesis or synthesis parameters leads to yields of high-quality zeolite Na-P1. The results also show that conversion of the coal fly ash into high-purity zeolite also depends on the chemical and mineralogical composition of the coal fly ash.