World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:14, No:04, 2020

Synthesis of Na-LSX Zeolite and Hydrosodalite from Polish Fly Ashes

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Abstract : In the work, the results of investigations into the hydrothermal zeolitization of fly ash from hard coal combustion in one of Polish Power Station have been presented. The chemical composition of the ash was determined by the method of X-ray fluorescence (XRF), whereas the phases of both fly ash and the products after synthesis were identified using microscopic observations, X-ray diffraction analysis (XRD) as well as electron scanning microscopy with measurements of the chemical compositions in micro areas (SEM/EDS). The synthesis was carried out with various concentrations of NaOH solution (3M, 4M and 6M) in the following conditions: synthesis temperature – 80°C, synthesis time – 16 hours, volume of NaOH solution – 350ml, fly ash mass – 14g. The main chemical components of fly ash were SiO_2 and Al_2O_3, the contents of which reached 51.62 and 28.14%mas., respectively. The input ash contained mainly such phases as mullite, quarz, magnetite, and glass. The research results indicate that the phase composition of products after zeolitization was differentiated. The material after synthesis in 3M NaOH solution was found to contain mullite, quarz, magnetite, and Na-LSX zeolite. The products of synthesis in 4M NaOH solution were very similar to those in 3M solution (mullite, quarz, magnetite, Na-LSX zeolite), but they additionally contained hydrosodalite. The material after synthesis in 6M NaOH solution contains mullite, quarz, magnetite (similarly to synthesis in 3M and 4M NaOH solition) and additionally hydrosodalite. Therefore, the products of synthesis contain relic components from the fly ash input sample in the form of mullite, quarz, and magnetite, as well as new phases, which are Na-LSX zeolite and hydrosodalite. It should be noted that the products of synthesis in the case of 4M NaOH solution contained both new phases (Na-LSX zeolite and hydrosodalite), while the products from the extreme concentration of NaOH solutions (3M and 6M) contained only one of them. Observations in the scanning electron microscope revealed the new phases' morphology. It was found that Na-LSX zeolite formed cubic crystals, whereas hydrosodalite formed characteristic aggregations. The results of investigations into the chemical composition in the micro area of phase grains in the products after synthesis reveal some dependencies, among others a characteristic increase in the content of sodium, related to the increased concentration of NaOH solution.

Keywords : Na-LSX, fly ash, hydrosodalite, zeolite
Conference Title : ICAPC 2020 : International Conference on Applications of Porous Ceramics
Conference Location : Jerusalem, Israel
Conference Dates : April 27-28, 2020