

Summary of the doctoral dissertation

Research of structural changes in anthropogenic materials subjected to magnetic activation

The research carried out as part of the presented doctoral dissertation broadens knowledge of the impact of mechanical activation on structural changes in anthropogenic material, on the example of silica fly ash. The paper also presents the results of research showing the influence which the fly ash activation had on its functional properties, as an additive to concrete.

The paper presents the thesis that it is possible to increase the reactivity of silica fly ash through its mechanical activation with the use of electromagnetic mill technology.

Laboratory tests were preceded by a review and analysis of national and foreign literature. The literature review was begun with issues related to the formation and accumulation of anthropogenic materials, with particular emphasis on fly ash as promising for wider economic use. Then, a short characteristic of fly ash is presented, focusing in particular on the chemical composition and properties of siliceous fly ashes from hard coal combustion. In the next subsection, selected directions of economic use of fly ash are analyzed, focusing not only on their typical application, but also on developing new technologies using these anthropogenic materials. Then, the technology of valorization of fly ashes was reviewed by subjecting them to physical, chemical and mechanical effects. By distinguishing the design of the electromagnetic mill as a device for mechanical activation of fly ash. In the next presents the subject of the processes taking place during mechanical activation is presented, which constitute the theoretical basis for further analyzes of structural changes in the mechanically activated material. Based on the literature analysis, it was found that the application of mechanical activation leads to structural changes and an increase in the reactivity of the activated substances. Detailed recognition of structural changes taking place during the activation process of this type of fly ash may positively influence the development of its economic application.

The experimental studies presented in this paper were divided into two stages. The first one included carrying out the activation process on the test stand of an electromagnetic mill. Samples of silica fly ash were treated in a closed activator chamber, taking into account different process times. In the second stage, the material of the reference sample and selected activated samples were subjected to a series of tests to determine the impact of the activation on structural changes occurring in the tested material. The paper analyzes the results of the research carried out: grain distribution, grain morphology, porous structure, amorphous structure and electron magnetic resonance spectra. Moreover, studies were confirming the improvement of functional properties of activated fly ash as concrete additives were carried out.

Based on the analysis of the images from the electron microscope and the atomic force microscope, a model of the grinding (valorization) process of the tested ash was developed.

The research and analysis carried out in the work have made it possible to prove the research thesis presented. It was shown that the activation of fly ash consisted of the desagglomeration of grain aggregates and crushing some grains, mainly larger ones and those containing voids. As a result of the modification, the specific surface area of the ash was enlarged, there was also an opening of the space in the grains containing numerous smaller ash grains and, moreover, microfractures were formed on the surface of the ash grains. The obtained results also allowed for the conclusion that: there is a possibility of the phenomenon of amorphization of crystalline phases and the weakening and breaking of chemical bonds.