ABSTRACT

The growing cost of CO_2 emission allowances and the costs associated with the disposal of fluidized bed combustion fly ash (FBCFA) make it necessary to look for new solutions for the management of these ashes and carbon dioxide from flue gases. Simultaneous combination of the carbonation process with the granulation process will make it possible to obtain a new type of product based on FBCFA, which can be used in the form of granulated aggregate in underground mining.

In this doctoral dissertation entitled "**Environmental and economic efficiency of the use of processed fluidized bed combustion fly ash in underground mining** the thesis formulates that there is a technical possibility of using processed FBCFA in underground mining technologies and it is environmentally and economically justified. The main goal is to demonstrate the environmental and economic efficiency of a novel and innovative technology (patent granted) for processing FBCFA by carbonation with carbon dioxide in the granulation process for use in underground mining. The scientific goal formulated in this way allowed to achieve a utilitarian goal, which was to develop a technology for the production of granulated aggregate as a market product for use in underground mining. An additional goal was to assess the environmental and economic efficiency of the proposed solution. On the basis of the literature review, novelty in the research area was determined, which is processing fluidized bed combustion fly ash during the process of carbonization with carbon dioxide and simultaneous granulation.

The dissertation describes the process of obtaining granulated aggregate based on FBCFA by simultaneously conducting the process of granulation and carbonization in one mixer. This process is seen as a real solution to reducing the emission of carbon dioxide, while at the same time mitigating the environmental effects of disposing of fly ash. The dissertation demonstrates the technical possibility of simultaneous carbonization with carbon dioxide and granulation in one mixer. This method makes it possible to manage coal combustion waste and reduce CO_2 emissions from flue gases. This is possible due to the high content of free CaO in FBCFA, which enables their saturation with carbon dioxide. The mixer used in the tests was an intensive counter-rotating mixer granulator capable of supplying water and carbon dioxide and ensuring airtightness of the process. The granulated aggregate obtained in the process of carbonization and granulation is durable in the mine water environment. After examining the technical possibilities of processing FBCFA, the possibility of using the new product in underground mining was shown. Then, the environmental and economic efficiency of the new granular aggregate production technology and its application were analyzed. In order to analyze the environmental impact of the production and use of granulate in underground mining, a Life-Cycle Assessment LCA was performed. In the economic and financial analysis of the new technology using a selected example of its application and the assessment of the project's profitability, the following economic efficiency indicators were used: the net present value to assess the project's profitability, the internal rate of return to determine the return on investment and the payback period to determine how many years the investment will pay off.

The use of FBCFA as well as the capture and utilization of carbon dioxide are in line with the concepts and the idea of a circular economy. The developed technology responds to the needs of the energy sector for the environmentally safe use of UPS. The obtained results are a significant contribution to the development of technology for the processing of FBCFA and the management of carbon dioxide for use in underground mining.