SUMMARY

Presented doctoral dissertation, entitled *„Research on the possibilities of thermal enrichment of clay raw minerals in the fluidized bed”*, has an experimental character. In presented study an innovative solution of pre-preparing clay granules was used. The clay raw material came from Polish geological deposits accompanying lignite. The tested materials were varied in terms of chemical composition, moisture content and particle size.

In the first part of the study, a literature review was made, in which the properties of the clay raw materials were presented and the basic operations of clay mineral processing and methods of enriching the clay raw materials were discussed. Great attention was paid to the calcination of clay raw materials and their importance in the industry. In this place also process parameters and technologies used so far (muffle kiln, shaft kiln, rotary kiln) were described. The calcination temperature using mentioned technologies is approx. 1000°C. They are characterized by a long-lasting calcination process (even up to several hours) without guaranteeing complete combustion of coal accompanying clay raw materials. Due to difficulties in temperature control, recrystallization and formation of a new stable phase (mullite, cristobalite, etc.) may occur, leading to a decrease in the reactivity of the calcined product. Among the new technologies for the calcination of clay raw materials, the following were characterized: solar calciners, microwave calcination, plasma calcination, and flash calcination however, these methods have many limitations in the implementation on a large scale. An alternative method of calcining clay raw materials in a fluidized bed, which offers many advantages over other techniques, were demonstrated.

The presented state of knowledge and practical needs, in the field of calcination of clay raw materials, allowed for the formulation presented doctoral dissertation theses:

1. The use of fluidized bed technology enables the calcination of enriched granulates and give the possibility of regulating the chemical composition and standardization of products for the needs of the recipient.
2. The use of fluidized bed technology in the calcination of clay raw materials allows for reducing the energy consumption of the process resulting from lowering the firing temperature from about 1000°C (in the technologies used so far) to 850°C and even

lower (750 and 650°C) while maintaining a high degree of calcination throughout the volume material.

3. Obtaining a stable, fixed fluidized bed is determined by the properties of the clay material, its particle size and moisture content.
4. Calcination of clay raw materials in fluidized bed conditions requires much shorter time than the process taking place in a rotary and shaft kiln.
5. During fluid bed calcination, carbon-organic impurities are completely burnt out, allowing them to be used to support energetic calcination process.
6. It is possible to use coal fuel for calcination process in a fluidized bed reactor.
7. The use of coal fuel in a fluidized bed reactor requires the appropriate selection of the type of fuel, as well as its prior preparation for the process.

The research part of the work consisted of two stages. In the first stage, experimental studies were carried out on the possibility of calcining clay material in a fluidized bed. The scope of work included determining the characteristics of the research material (technical analysis, chemical analysis, particle size distribution analysis) and determining the parameters of the fluidization process. Then, experimental studies of the fluidization process of selected materials for calcination at ambient temperature were carried out. The obtained results constituted the basis for undertaking basic research on the calcination of materials in a fluidized bed reactor. After establishing the assumed calcination process conditions (temperature, fluidization velocity, calcination time), calcination tests of clay raw materials in the fluidization process were carried out and then the verification of the calcination process was done, i.e.: determination of the loss on ignition and the degree of calcination, and comparison of the particle distribution of the charge material and the calcination product.

The second stage was devoted to experimental studies of fluidized bed calcination in a coal fueled reactor. An analysis of the influence of: the type of coal, its particle size and its mass share in the raw granulate on the calcination process and the final product of the process, was undertaken. During the tests two types of coal fuel were used : hard coal type 31.2 and anthracite. The initial temperature in the reactor chamber during the calcination tests was 850°C. The fluid bed calcination time was set at 10 min. In order to determine the amount of fuel required for the calcination process: a technical and elemental analysis of coal and calculations of the heat demand for the calcination process in the reactor were performed, and on its basis the minimum demand for fuel in the tested process was calculated. The calcination and verification tests of the the calcination process were performed.

The performed tests indicate that the calcination of various high-alumina clay granules in fluidized conditions was possible while maintaining the appropriate particle-size distribution of the material in the range of 0.25 to 3.0 mm. Granules <0.25 mm were exhausted in the fluidized bed process with post-reaction gases, while the granulates with a significant share of particles >3 mm did not form a stable fluidized phase. It was found that the moisture content of the particles can affect their behavior during fluidization. Very good results of the calcination process for granulates with <5% moisture, were obtained. The process of calcination of the tested clay granulates in a fluidized bed was possible in the temperature range of 650-850 °C while maintaining a high degree of calcination. Calcination in the fluidized bed was not change the chemical composition of the tested clays, and the carbon contained in the clay was completely burnt out. It was found that coal fuels can be used in the process of fluid bed calcination of clay materials. The key, however, was the particle distribution of fuels. Coal particles <0.75 mm can be exhausted from the reactor chamber causing energy deficit of the process and increasing the loss of incomplete combustion. However, the time needed to completely burn particles >1.6 mm was too short. As a result, there was a carbon residue in the final product, which disqualifies the product. During the fluid bed calcination process, the clay granulate was fragmented for two reasons. The first was the process of abrasion of its outer surface, as a result of the interaction of granulate particles of clay material, and the second was mechanical impact and rapid dehydration and dehydroxylation processes, which in turn leads to the disintegration of granulate particles.