Praca dyplomowa inżynierska

Process parametres of the fabrication of monodisperse calcium carbonate nanoparticles in the rotating disc reactor

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Introduction

Nanotechnology brings a broad variety of opportunities such as the control and manipulation of individual molecules and atoms. Because properties of nanoparticles highly depend on their size, structure and other factors it is essential to elaborate new technologies, which would enable getting nanomaterials of directly determined sizes and physicochemical properties. Substances of nanometrical size usually show different features than their classical, well-known counterparts, that is why they can be applied in totally different form. An example of this kind of substance is calcium carbonate.

Aim and scope of this thesis

The aim of this thesis is assessing the process parameters of obtaining monodisperse calcium carbonate nanoparticles for three different substrates and proving that used calcium hydroxide powders, which come from ore, do not impact the purity of the product. The scope of this thesis covers:

- a review of the literature on nanotechnology, nanoparticles, calcium carbonate and methods to synthesise calcium carbonate nanoparticles,
- carrying out the laboratory tests in the rotating disc reactor for the various operating parameters of the process and for different substrates,
- analysing the results and drawing conclusions.

The rotating disc reactor and measuring system

Process of obtaining of monodisperse calcium carbonate nanoparticles was carried out in the rotating disc reactor, in three-phase gas-liquid-solid system. This reactor enables development of contact surface in gas and liquid phase and running multiphase processes with controlled reagent transfer from one phase to another. Moreover, it allows to conduct precipitation selectively. System also contains a mass flow controller (GFC), gas cylinder with two pressure regulators for high purity gases, copper rod and pH-meter.

Characterisation of calcium carbonate nanoparticles

The characterisation of obtained product is of much importance. It is possible by using scanning electron microscope (SEM), thermogravimetric analysis and powder diffraction analysis.

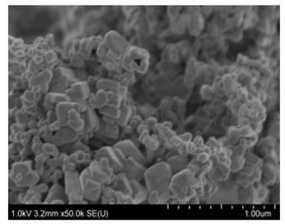

Fig. 1. The photograph of calcium carbonate nanoparticles obtained under the best operating conditions for sample Wierzbica 1

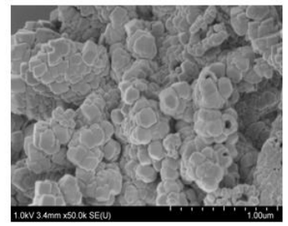

Fig. 2. The photograph of calcium carbonate nanoparticles obtained under the best operating conditions for sample Wierzbica 2

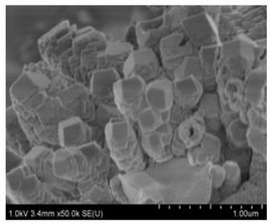

Fig. 3. The photograph of calcium carbonate nanoparticles obtained under the best operating conditions for sample Raciszyn

The results have proven that the fabricated nanoparticles for all used substrates are of great purity, with low content of water and calcium hydroxide. Moreover, the powder diffraction analysis has shown that the only form present in products is calcite, which is the most thermodynamically stable form of calcium carbonate. According to scanning electron microscopy (SEM), obtained products have monomodal or bimodal particle size distributions. Those properties depend on substrate and process conditions.

Conclusions

Running crystallisation process in the rotating disc reactor enables obtaining thermodynamically stable, nanometrical or submicrometrical calcium carbonate crystals, which can form micrometrical aggregates and polycrystalline forms. The absorption of gaseous carbon dioxide connected with chemical reaction in carbon hydroxide suspension provides an opportunity to regulate mass transfer in this system, as well as possibility to control properties of sediment. What is more, each substrate has different optimal process conditions, the products differ in the crystal sizes and crystal size distributions, the form and sizes of aggregates, the degree of whiteness and the time of the process duration. The obtained crystals have great tendency to agglomerate, creating structures of different spatial orientation, size and shape.