SUMMARY

The topic of the dissertation concerns the development of new micronutrient fertiliser formulations and includes issues in the areas of chemical technology and engineering, agricultural chemistry, environmental protection, and process safety. The realisation of the various stages of the dissertation took into account socioeconomic programs based on the principles of sustainable development, including a resource-saving economy.

A constant challenge in the area of fertilisers and fertilisation is solid micronutrient products. Currently, nitrogen micronutrient fertilisers based on ammonium nitrate(V) are gaining particular importance in effective macro- and microelement fertilisation. Consideration of innovative micronutrient compositions based on ammonium nitrate(V) requires linking various aspects including process chemistry and agricultural chemistry. When ammonium nitrate(V) is used in formulations, the problem is to ensure process safety in production, storage and use. Restrictions under current fertiliser and environmental legislation are also important.

A review of the literature shows that micronutrients play a key role in plant physiological processes and their optimal content in the environment has a beneficial effect on yield and plant quality. The uptake of individual micronutrients by plants depends on the plant species, its stage of development, soil richness, the form of micronutrient application, and climatic conditions. Simultaneous nitrogen and micronutrient fertilisation, due to the synergistic effect, especially beneficial for nitrogen and zinc compounds, increases the efficiency of fertilisation. The development of a composition based on ammonium nitrate and micronutrients was the main premise of the research work described in the dissertation.

The purpose of the presented dissertation was to develop compositions of solid nitrogen micronutrient fertilisers. Taking into account the literature and patent reports, ammonium nitrate(V) and selected micronutrient elements were used in fertiliser compositions for the study, namely: Zn, Mn, Cu, and Fe. Inorganic salts and, because of their favorable properties, micronutrient chelates were analysed in this study.

The literature part includes a review of publications, monographs, legal acts, standards, and patents. Based on the review, the purpose of the dissertation and the next stages of the research work were established.

The experimental part consists of several stages: preliminary research, development, production, and physicochemical and thermal evaluation of selected fertiliser compositions, followed by assumptions for the technological concept.

Preliminary studies include evaluation of the effects of inorganic salts (sulfate(VI), nitrate(V), carbonate) and chelates (EDTA, IDHA, DTPA, HBED, EDDHA, EDDHSA) of zinc, manganese, copper, and iron on the thermal decomposition of ammonium nitrate(V). The results of the experiments showed that, to increase the thermal stability of the tested AN – micronutrient mixtures, it is necessary to use an agent that stabilises the course of thermal decomposition processes of ammonium nitrate(V). Reevaluation was performed for complex compositions of

AN, a micronutrient source and dolomite. Dolomite, in the composition, acted as a substance with properties that stabilise thermal transformation processes. Based on obtained results, the following composi-tion of the system was selected for further study: approximately 28% mass. Ntotal. and about 0.2% mass. Zn or Mn or Cu or Fe and, as a stabilising substance, dolomite. In parallel, studies were carried out on effects of nitrogen and nitrogen-calcium-magnesium environments on the stability of the micronutrient fraction in solution and on the degree of complexation of micronutrient ions (Zn, Mn, Cu, and Fe) by EDTA and IDHA chelates. The use of EDTA and IDHA micronutrient chelates in fertiliser formulations has been shown to be beneficial in maintaining the high bioavailability of micronutrient elements.

Selected fertiliser compositions, with the composition of AN - dolomite - EDTA or IDHA chelate (Zn, Mn, Cu, or Fe), were obtained, on a laboratory scale, using: mechanical granulation - disc and coating with an aqueous micronutrient solution of CAN (AN – dolomite) type granules in a fountain apparatus. Produced granules were subjected to evaluation of physicochemical and functional properties, including chemical analysis, granulometric composition, mechanical strength, pH, and hygroscopic properties, as well as thermal stability tests. Analyzing the results obtained, it can be concluded that the alternative method of enriching fertilisers with micronutrients made it possible to obtain granules with comparable or improved, in comparison to the CAN reference, physicochemical, functional and thermal properties.

The final stage of the dissertation is the development of preliminary assumptions for the technological concept. Preliminary technological assumptions were developed for a continuous process with a production capacity of approximately 2000 kg/h, complementing existing nitrate fertiliser manufacturing facilities. Based on the results of the study, a process for producing fertiliser with a composition of AN - dolomite - EDTA or IDHA chelate was considered to have implementation potential by applying a layer of micronutrient chelate to CAN granules in a fountain apparatus. When the thermal, functional, and physicochemical properties of the formulations obtained in the experiments are compared, it can be concluded that the obtained formulations meet the established quality requirements and those related to process safety.

A measurable effect of the work related to the realisation of the doctoral dissertation and cooperation with Zakłady Azotowe in Kędzierzyn-Koźle is a joint, between GA ZAK S.A. and Wrocław University of Science and Technology, patent PL.244724 entitled. "Method of obtaining layered nitrate fertilisers".