

## ANNOTATION

of the dissertation for Doctor of Philosophy PhD degree of  
the specialty 6D072000- «Chemical technology of inorganic substances»

**Smailov Bakyt Matkarimuly**

On the theme «Development of technology for obtaining chelated polymer-  
containing fertilizers based on cottrel dust and coal waste»

**Actuality of the work.** At the present stage of development of science and technology, one of the most important problems is the processing of natural and technogenic waste. In recent years, accumulated in factories and mines waste raw materials and industrial products create serious ecological problems in the regions. B Therefore, their processing in order to obtain valuable products is an actual task.

Nowadays mineral fertilizers obtained from technogenic waste do not fully solve the problems of the agricultural sector. The use of mineral fertilizers is associated with many disadvantages. One of them is that a violation of the dose when applied under plants can lead to the growth of other plants.

To increase crop yields, it is important to use chelated fertilizers. Chelated fertilizers are a chemical compound of a trace element with a chelating agent. A distinctive feature of the chelating agent is the ability to firmly hold microelement ions in a soluble state until they enter plant cells, and then release it, converting it into a biologically available form. In this case, it breaks down into chemical compounds. In comparison with mineral fertilizers, chelated polymer-containing fertilizers demonstrate high digestibility of macro-and microelements by plants, which allows several times to reduce the chemical load on the soil. It is on the basis of chelates that a new generation of preparations has been created for pre-sowing seed processing, subsequent foliar fertilization of plants and drip irrigation.

Given these advantages of chelated fertilizers, we can assume that one of the most promising areas is the process of obtaining chelated polymer-containing fertilizers using coal waste and cottrel dust with the addition of chelating agents. At the same time, it becomes possible to obtain phosphorus-containing mineral fertilizers with a rich content of useful components and trace elements.

**Relationship with scientific-research works and state programs.** The dissertation work was carried out in accordance with the scientific direction of M.Auezov South Kazakhstan University, carried out within the framework of the state budget theme B-16-02-03 scientific-research work of the Department of Chemical technology of inorganic substances “Research on the creation of alternative and innovative technologies for processing raw materials and obtaining products of synthesis of inorganic compounds from natural ore-mineral resources and technogenic waste of various industries”.

**The object of research.** Cottrel dust – waste of NDFZ LLP "Kazphosphate", coal waste from Lenger deposit and chelated polymer-containing fertilizer.

**The aim and tasks of research.** The aim of the work - development of technology for obtaining chelated polymer-containing fertilizers based on technogenic waste. To achieve the goals of the dissertation research, the following tasks were considered in the dissertation work:

- physico-chemical study of the composition of cottrel dust, conversion of phosphorus oxide to solution, and determination of optimal process parameters;
- investigation of thermodynamic and kinetic regularities of cottrel dust processing;
- physico-chemical study of the composition of Lenger coal waste and the resulting humate, on its basis the process of obtaining humic acid;
- mathematical processing and investigation of thermodynamic and kinetic regularities of the extraction process of coal waste from the Lenger deposit;
- study of the chemism and mechanism of the process of obtaining a chelated polymer-containing fertilizer based on technogenic waste;
- development of a principle apparatus technological scheme for obtaining chelated polymer-containing fertilizers;
- experimental-industrial tests and the introduction of chelating polymer-containing fertilizers for growing agricultural crops.

**Scientific novelty of the work:**

1. The thermodynamic characteristics of the decomposition of boiler dust in sulfuric acid solution were determined using the software package complex «Outokumpu HSC-6».

2. Optimal parameters of the process of decomposition of cottrel dust in a solution of sulfuric acid were determined using the method of mathematical planning of experiments.

3. Kinetic regularities of the process of decomposition of cottrel dust in a solution of sulfuric acid are determined. Processing of kinetic data carried out by the Pavlyuchenko formal kinetics equation showed that this chemical process occurs in the diffusion region. This is evidenced by the value of the "apparent" activation energy, which is  $E_{ap} = 5.94$  kJ/mol.

4. The thermodynamic and kinetic regularities of the coal waste extraction process have been established. The value of the "apparent" activation energy calculated by the Arrhenius equation  $E_{ap} = 5.94$  kJ/mol indicates that the process takes place in the diffusion region.

5. The chemism and mechanism of the process of obtaining chelated polymer-containing fertilizers based on cottrel dust and carbon waste are determined.

**The main provisions submitted for defense:**

- results of physical and chemical studies to determine the chemical composition, structure and properties of cottrel dust;
- technological parameters, thermodynamic and kinetic regularities of the process of transition of phosphorus to solution from cottrel dust;
- results of physical and chemical research to determine the chemical composition, structure and properties of coal mining waste;
- chemism, technological parameters, thermodynamic and kinetic regularities of the process of obtaining potassium humate obtained from coal waste;
- mathematical processing of research results in order to determine the optimal technological parameters of the process of obtaining phosphorus-containing compounds and potassium humate;

- chemical composition, structure of the final product, thermodynamic laws of the production process and the mechanism of formation of chelated polymer-containing fertilizers;

- principal, equipments-technological schemes of the process of obtaining chelated polymer-containing fertilizers based on boiler dust and coal waste containing trace elements.

**Degree of reliability and approbation of results.** The reliability of the research results is achieved using modern analytical (quantitative and qualitative), thermodynamic, chemical, particle size, potentiometric, as well as computational, mathematical, laboratory and experimental industrial test methods using a scanning electron microscope (SEM) model Jeol JSM-6490I V, multiparameter portable cyber scanner (PCD 650 Eutech), FT-IR spectrometer (Zhimadzu IR Prestige-21), differential thermal analyzer (DTA) and X-ray energy dispersive microanalyzer INCAEnergy (Oxford Instruments).

In order to use chelated polymer-containing fertilizers for agricultural crops, joint pilot tests were conducted with LLP «Z-Agro», KX«Aitubai» the results of which are confirmed by test certificates and recommendations for implementation.

**Approbation the results of the work.** The main provisions of the completed dissertation research published in 20 scientific publications, including 3 scientific journals included in the database Scopus, 5 in the editions recommended by Committee for control in education sphere and science MES RK, 8 articles published in materials of international conferences, including 3 articles in materials of international conferences, 1 article in scientific journals, other publications.

The materials of the dissertation were reported and discussed at various international conferences and symposia: International Scientific and Practical Conference «Auezovskiye chteniya -16: The fourth industrial revolution: new opportunities for modernization of Kazakhstan in the field of science, education and culture» (Shymkent, 2018); V International scientific and practical conference «Industrial technologies and engineering» (Shymkent, ICITE - 2018); International scientific and practical conference «Auezovskiye chteniya - 17: New impulses of science and spirituality in the world space» (Shymkent, 2019); III International Scientific and Technical Conference «Innovative developments in the field of chemistry and technology of fuels and lubricants» (Tashkent, Uzbekistan, 2019); International scientific and practical conference «International Scientific and Practical Conference «Fundamental and applied scientific research» (Berlin, Germany, 2019); I- International Uzbek-Kazakh symposium «Actual problems of the development of chemical science and industry» (Tashkent, Uzbekistan, 2019); International scientific and practical conference «Auezovskiye chteniya-18: The spiritual heritage of the great Abai» To the 175th anniversary of Abay Kunanbayev (Shymkent, 2020); International scientific and practical conference «Sagin's readings – 12: «Integration of science, education and industry - the basis for the implementation of the Plan of the Nation» (KarSTU, Karaganda - 2020).

The main results of the dissertation were published in the following scientific journals: Bulletin of the Eurasian National University L.N. Gumilyov, (№6, Astana – 2017); Bulletin of the Kazakh-British University (№4 Almaty, 2019); Uzbek

chemical journal (№1, Tashkent 2020); Bulletin of the National Academy of Sciences of the Republic of Kazakhstan, K.I. Satpayev Kazakh National Research Technical University (№1, №6 Almaty, 2019); Rasayan journal of Chemistry (№3 Jaipur, India 2020). In addition, the main results of the dissertation research include the approved acts on the performance of research in laboratory, production and test conditions and 3 patents for a utility model with the decision of the National Institute of Intellectual Property.

**The personal contribution of the doctorant.** In the analysis of literary information, in patent search on the topic of dissertation work, setting the goals and objectives of research, in the selection of research methods and analyzes, in conducting theoretical and experimental research. In the development of new technological solutions, in their experimental and industrial testing, in the development of practical recommendations for their implementation in the practice of the agricultural sector, in the preparation and publication of scientific publications on work, in the execution of acts of implementation of the results of dissertation work in agricultural production.

**The practical significance of the work.**

- based on the research, the technological parameters of obtaining chelated polymer-containing fertilizers based on man-made waste were determined and a technological scheme was proposed.

- the use of a chelated polymer-containing fertilizer on wheat determined the effectiveness of the developed product, subject to the application methodology, wheat yield increased from 12-14 to 16-18 c/ha, that is, increased by 22-25%. Also, the growth of wheat from the usual type is 10-15 cm higher, this has a positive effect for harvesting in the field.

- the use of a chelated polymer-containing fertilizer on safflower, the yield of safflower increased from 14-16 to 22-23 c/ha, that is, by 30%.

- the use of a chelated polymer-containing fertilizer on rice, the yield of rice for the "Marzhan" variety increased from 31-40 g/stalk to 65-74 g/stalk, and it was found that rice contains an increased amount of vitamins necessary for the human body.

- chelated polymer-containing fertilizers obtained from man-made waste ensure the economic efficiency of the proposed technology due to its low market value.

The developed technology is aimed at reducing the accumulated industrial waste, which allows you to regulate the environmental situation in the region.

**The structure and volume of the dissertation.** The dissertation work is presented on 117 pages of typewritten text, contains 46 tables, 50 figures. The dissertation work consists of an introduction, 5 sections, conclusion, the list of the used sources and appendices.