SUPERVISOR'S REVIEW

of the dissertation by **Kalymbet Arailym K.** entitled:

"Research of Properties and Development of Technology for Obtaining Sorption-Filtering Materials from Domestic Raw Materials"

submitted for the degree of Doctor of Philosophy (PhD)

in the educational program **8D07109 – "Innovative technologies and new inorganic materials"**

The dissertation of Kalymbet Arailym K. is devoted to a relevant scientific and engineering problem – the development of efficient sorption–filtering materials based on technogenic waste for the removal of heavy metal ions from water. Under conditions of increasing anthropogenic impact and the necessity for rational use of mineral resources, this research area is of significant scientific and practical importance.

The study includes a comprehensive analysis of Kazakhstan's mineral resource base to identify suitable raw materials for functional material synthesis. Based on comparative investigations of beneficiation wastes from several deposits, flotation tailings of the Akbakay deposit were justified as the most promising precursor due to their favorable mineralogical composition and chemical reactivity.

The author developed a synthesis method for sorption–filtering materials based on acid–thermal modification using orthophosphoric acid followed by controlled thermal treatment. The influence of acid concentration and calcination temperature on phase composition, textural characteristics, and surface properties was systematically established.

A wide range of physicochemical characterization techniques (XRD, FTIR, SEM, BET, zeta potential, etc.) enabled a comprehensive understanding of the structure and properties of the synthesized materials. It was demonstrated that despite relatively low specific surface area, the materials exhibit high sorption performance due to the chemical nature of active sites and the formation of functional phosphate groups.

Equilibrium, kinetic, and dynamic studies of copper ion (Cu^{2+}) sorption were carried out in detail. The adsorption process follows pseudo-second-order kinetics and is characterized by rapid uptake. The experimental data are well described by advanced isotherm models, indicating surface heterogeneity and specific interactions between the sorbent and metal ions.

Particular attention should be given to dynamic experiments, which confirm the effectiveness of the materials under flow conditions, significantly enhancing their practical applicability in water treatment technologies.

The scientific novelty of the work lies in the development of an approach for the targeted transformation of mineral waste into functional silicophosphate sorbents

with controlled properties. The practical significance is associated with their potential as a polishing sorbent for advanced water purification

The dissertation is performed at a high scientific and methodological level, characterized by logical structure, well-founded conclusions, and sufficient experimental data. The main results have been published in scientific journals, including international peer-reviewed publications.

The candidate has demonstrated a high degree of independence, critical thinking, and perseverance in achieving the research objectives.

In conclusion, the dissertation meets the requirements for the degree of Doctor of Philosophy (PhD), and the author deserves to be awarded this degree.

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