

## REVIEW

### **Of scientific supervisor of the dissertation of Kalmakhanova Marzhan Seitovna, for the degree of PhD in specialty 6D060600 - "Chemistry", titled "Application of natural and pillared clays in water treatment by adsorption and catalytic wet peroxidation"**

Kalmakhanova Marzhan Seitovna graduated in 2011 at the Eurasian National University named after L.N. Gumilyov, majoring in Chemistry, and entered the magistracy at Taraz State University named after M.Kh. Dulati, being graduated in 2013. From 2016 to 2019, she studied at the PhD doctoral degree at Taraz State University named after M.H. Dulati. The dissertation was carried out at the Department of chemistry and chemical technology of TarSU named after M.H.Dulati and at the Associate Laboratory LSRE-LCM (Laboratory of Separation and Reaction Engineering-Laboratory of Catalysis and Materials), at the pole of the Bragança Polytechnic Institute, Portugal.

The work was also included in the IPB scientific project "AIProcMat @ N2020 - Advanced Industrial Processes and Materials for a Sustainable Northern Region of Portugal 2020" NORTE-01-0145-FEDER-000006 (2016-2019), funded by European and national research funds. The aim of the thesis is the development of catalysts by modifying natural clays with active metal ions to remove organic pollutants by wet peroxide oxidation, as well as increasing the clay porosity in order to obtain an adsorbent for removing heavy metals from wastewater. As a result of the work, catalysts for the wet peroxide oxidation of 4-nitrophenol were synthesized based on natural clays of Kazakhstan modified with Zr, Fe-Zn and Fe-Cu-Zr from the Akzhar, Karatau and Kokshetau deposits. The obtained results demonstrate a higher catalytic activity of Zr, Fe/Zn and Fe/Cu/Zr pillared clays in the reactions of wet peroxide oxidation of 4-nitrophenol in comparison with natural clays.

The presented dissertation is of economic and scientific importance due to the use of accessible, cheap and safe reagents and raw materials, the high catalytic activity of the obtained catalysts, leading to the formation of environmentally friendly end products of the oxidation of organic pollutants.

The thesis presented by Kalmakhanova M.S. is a completed research project. It provides extensive experimental and theoretical material for the production of pillared clays modified with active metals based on domestic natural clays for the mineralization of organic pollutants by wet peroxidation. During her training in doctoral studies, Kalmakhanova M.S. successfully coped with the tasks assigned to her. A thorough analysis of the literature of foreign and domestic authors and a high level of professional knowledge allowed the candidate to competently and efficiently solve the problem. Together with the laboratory staff of the Bragança Polytechnic Institute, physicochemical studies of the obtained catalysts were carried out.

The results obtained by the dissertation are published in 5 articles and 8 abstracts at international and national conferences. On the method of preparing a catalyst based on domestic natural clays for the oxidation of phenolic organic compounds, a conclusion was obtained on the grant of a patent for a utility model, which indicates the novelty of the results.

In my opinion, the dissertation work carried out by Kalmakhanova Marzhan Seitovna on the topic: "Application of natural and pillared clays in water treatment by adsorption and catalytic wet peroxide oxidation", submitted for the Ph.D. degree in specialty 6D060600 - "Chemistry", is of relevance and have scientific novelty and practical significance of the results. Thus, the dissertation meets the requirements of the "Rules for awarding scientific degrees" of the Committee for Control of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, and its author is a worthy candidate for the award of a Ph.D. degree in specialty 6D060600 - "Chemistry".

**Scientific Advisor:**  
**Ph.D., Associate Professor,**  
**Head department of**  
**"Chemistry and chemical technology"**  
**TarSU named after M.Kh. Dulati**

 **B.K. Massalimova**

**Scientific Secretary**  
**TarSU named after M.Kh. Dulati**





**A.M. Zhumabaeva**