

REVIEW

for the dissertation work of Yelemessova Zhanerke Komekovna on the topic
«New nano metal organic framework energetic materials for pyrotechnics»
submitted for the degree of Philosophy Doctor (PhD) in specialty
6D073400 – «Chemical technology of explosives and pyrotechnics»

During the research on the PhD dissertation, Yelemessova Zhanerke performed a huge amount of experimental research, collecting and processing data from scientific and technical sources and established herself as a hardworking, accurate and efficient scientist, capable of independent research work and practical application of her knowledge.

Her PhD thesis on the topic «New nano metal-organic framework energetic materials for pyrotechnics» was devoted to the development of metal organic energy-intensive fuels with improved characteristics of the combustion process based on ammonium nitrate with the addition of carbon-containing materials.

The following tasks in the PhD research topic were solved:

1. New energy-intensive materials (such as MOFs) based on activated CRH with transition metal oxides with improved burning rate and physicochemical stability were obtained.
2. It was established that activated CRH has a promoting action on the AN burning rate, and provide self-sustained combustion even at low pressures (1-2 MPa).
3. The kinetics of thermal decomposition of ammonium nitrate in the presence of MOF with various metal oxides was studied;
4. The presented results of the activation energy calculation based on experimental data obtained by the DTA analysis let us make some conclusion about activation energy. The activation energy of AN decomposition in the presence of CRH-KOH was $90 \div 82$ kJ/mol. Based on these results, it could be established that activated CRH have a direct effect on the decomposition mechanism of AN in the form of a decrease in the activation energy to $8 \div 10$ kJ/mol.
5. This study indicates that laser ignition limit for the fuel depends on laser energy and ignition delay and demonstrates that AN/Mg/NC/CRH-Me_xO_y composite is a good applicant for laser ignition for some reasons.

In the dissertation, a various research technique, including an analytical literature review, patent search, the generalization of international experience in the development of energy-intensive materials, experimental research and thermodynamic calculation were used.

The novelty of the research is in the effect of activated carbonized rice husk with transition metal oxides on the nature of combustion and thermal decomposition of energy-intensive fuels based on ammonium nitrate.

It was found that activated CRH (with addition of transition metal oxides) with a high specific surface area and advanced characteristics are effective initiators of the thermal decomposition of ammonium nitrate and able to reduce the beginning temperature of decomposition of the substance and reduce the activation energy from 90 to 82 kJ/mol. It was found that activated CRH with transition metal oxides, depending on the concentration of 1-3wt.%, promote the convective burning rate of ammonium nitrate.

In realization of this research, foreign scientific adviser who provided the necessary conditions for the successful completion of the dissertation at the Nanjing University of Science and Technology (Nanjing, China), where Zhanerke had an internship and learned

the modern research methods, made a significant contribution. Moreover, the experiments for determination the physicochemical properties of the obtained activated carbons were carried out at the «Institute of Combustion Problems» and al-Farabi Kazakh National University (Almaty).

This dissertation work has a high practical importance. The theoretical significance of the work is to establish the basic regularities of the influence of activated carbons with transition metal oxides (MOFs) on the characteristics of thermal decomposition and combustion of ammonium nitrate, which can be used for both fundamental and applied work related to the composition of energy-intensive fuels based on ammonium nitrate.

The developed compositions based on ammonium nitrate with the addition of metal oxides and activated carbonized rice husk with a high specific surface area and evolved topographic structure have the prospect of being used in practice as green propellant, as well as gas generators.

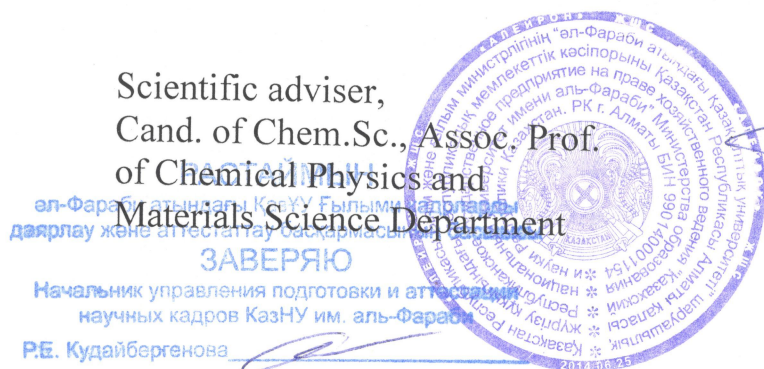
The dissertation work of Yelemessova Zh.K. contains significant experimental material and based on versatile approaches to solving the assigned tasks. It should be noted the personal contribution of Zhanerke to the development of the provisions and results offered for PhD thesis defense, having a good theoretical justification and practical confirmation. The results of the dissertation were reported and discussed in the following international scientific and technical conferences: Proceedings of IV Conference of Students and Young Scientists «Chemical physics and Nanomaterials» (Almaty, March 19, 2019); Proceedings of the conference of the students and young scientists dedicated to the 30th anniversary of creation of the Institute of Combustion Problems (Almaty, November 30, 2017); X International Symposium «The Physics and Chemistry of Carbon and Nano energetic Materials» (Almaty, September 12-14, 2018); «International Scientific Conference Modern Problems of Condensed Physics States, Nanotechnologies and Nanomaterials» (Almaty, May 17-18, 2018); «The First International Conference on Defense Technology Proceedings» (Beijing, China, October 21-25, 2018); «The 4th International Nano-Structured Energetic Materials Workshop» (Nanjing, China, November 2-4, 2018); Proceedings of IV Conference of Students and Young Scientists "Chemical Physics and Nanomaterials" (Almaty, 2019).

The main results of the dissertation work were published in 12 publications (2 articles in the Scopus database journals and 1 article in the Thomson Reuters database journal, 4 publications were published in the journals recommended by the Committee for Monitoring in Education and Science of the Republic of Kazakhstan, 4 publications in Proceedings of international conferences, and 1 application for a utility model № 2019/0488.2).

PhD thesis of Yelemessova Zh.K. by relevance, scientific level, and novelty, significance of the results and the total volume of research meets all the criteria for PhD dissertations, and its author Zh.K. Yelemessova deserves the award of a PhD degree in specialty 6D073400 – «Chemical technology of explosives and pyrotechnics».

Scientific adviser,
Cand. of Chem.Sc., Assoc. Prof.
of Chemical Physics and
Materials Science Department

B.T. Lesbayev



Начальник управления подготовки и аттестации
научных кадров КазНУ им. аль-Фараби

Р.Е. Кудайбергенова

« _____ » 20 ____ ж.г.