REVIEW

the official reviewer for the dissertation work of

Kaliyeva Assem Mukhtarkhanovna on the topic ««Obtaining and investigation of composite materials for flameless heaters», submitted for the degree of Doctor of Philosophy (PhD) in the specialty «6D073900 – Chemical Technology of Explosives and Pyrotechnics».

№п/п	Criteria	Compliance with the criteria (it is necessary to mark one of the answer options)	Justification of the position of the official reviewer
1.	The topic of the dissertation (as of the date of its approval) corresponds to the directions of scientific development and/or state programs	1.1 Compliance with priority areas of science development or government programs:	The dissertation work is devoted to obtaining optimal compositions of flameless heaters based on aluminum.
		1) The dissertation was completed within the framework of a project or target program funded from the state budget (specify the name and number of the project or program) 2) The dissertation was completed within the framework of another state program (specify the name of the program) 3) The dissertation corresponds to the priority direction of science development approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (specify the direction)	The work was done on an initiative basis.
2.	Importance to science	The work makes/does not make a significant contribution to science, and its importance is well disclosed /not disclosed	The work makes a significant contribution to science, and its importance is well disclosed. The results of research on the synthesis of powdered energy compositions based on aluminum can be used as an exothermic material in the production of heating devices that are used in the field, without access to a current source or in accidentally unfavorable conditions.
3.	The principle of independence	The level of independence: 1) High; 2) Average; 3) Low; 4) There is no independence	The level of independence is high. The author of this dissertation personally participated in setting tasks and conducting scientific experiments, analyzing literary data, determining methods of analysis and ways of application, setting theoretical and practical tasks,

			discussing the results obtained, substantiating conclusions.
4.	The principle of internal unity	4.1 Substantiation of the relevance of the dissertation: 1) Justified; 2) Partially justified; 3) It is not justified.	The relevance of the research conducted in the dissertation is well justified, emphasis is placed on the prospects of using the obtained exothermic mixtures for autonomous flameless heaters based on dispersed aluminum powders and their modification by mechanochemical activation. The proposed methods can be used to replace metal impurities, such as traditional magnesium, iron, used in flameless heaters, with a simpler and more affordable metal, as well as to improve the performance and shelf life of composites.
		4.2 The content of the dissertation reflects the topic of the dissertation: 1) Reflects; 2) Partially reflects; 3) Does not reflect	The content of the dissertation reflects its topic well, as it is devoted to experimental studies of the synthesis of energy-intensive powder compositions by preliminary mechanochemical processing, the production of composites for flameless heaters and their transformation by a mechanochemical method - chemical activation. It also consists in analyzing the composition and properties of the obtained composites and products, processing and generalizing the results obtained, determining ways to solve the set practical and theoretical tasks.
		4.3. The purpose and objectives correspond to the topic of the dissertation: 1) correspond to; 2) partially correspond to; 3) do not match	The dissertation work is distinguished by the integrity and consistency of setting goals and objectives, as well as ways to implement them. The set goals and objectives logically follow from a meaningful literary review.
		4.4 All sections and provisions of the dissertation are logically interrelated: 1) completely interconnected; 2) the relationship is partial;	All sections and provisions of the dissertation are logically interrelated, the literary review allows you to understand the background of the research, its goals and objectives, the experimental part provides

		3) there is no relationship	comprehensive information about research methods and equipment used. The discussion of the results is based on experimental material
		4.5 The new solutions proposed by the author (principles, methods) are reasoned and evaluated in comparison with known solutions: 1) there is a critical analysis; 2) partial analysis; 3) the analysis is not your own opinions, but quotes from other authors	The author of the dissertation has worked out the technology of synthesis of energy-intensive aluminum-based composites. There is a critical analysis of the advantages and disadvantages of the technologies listed for comparison. The high scientific level of the completed research is confirmed by scientific publications both in Kazakhstani journals and in the journal Scopus database.
5.	The principle of scientific novelty	5.1 Are the scientific results and provisions new? 1) Completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The scientific results and provisions of the dissertation are completely new.
		5.2 Are the conclusions of the dissertation new? 1) Completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The conclusions of the dissertation work are completely new, which is confirmed by the author's scientific publications in peer-reviewed scientific journals.
		5.3 Technical, technological, economic or managerial decisions are new and justified: 1) Completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	All technical solutions are aimed at the implementation of the tasks associated with the production of highly dispersed mixtures of heat sources. They are based on well-known methods such as mechanochemical activation for the synthesis of highly dispersed powder mixtures. After all, this allows you to effectively manage the process of forming new structural compositions, which ensures an increase in the energy capacity of the system, which allows you to obtain completely new composites with new characteristics.
6.	Validity of the main conclusions	All the main conclusions are based/not based on scientifically significant evidence or are well-founded enough (for qualitative research and areas of study in the arts and humanities)	All the main conclusions are based on reliable experimental material. A complex of modern instruments and methods of analysis was used in the work.

7.	The main provisions submitted for protection	It is necessary to answer the following questions for each provision separately: 7.1 Is the position proved? 1) proved; 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) Yes; 2) no 7.3 Is it new? 1) Yes; 2) no 7.4 Level for application: 1) narrow; 2) average; 3) wide 7.5 Is it proved in the article? 1) yes; 2) no	All the provisions put forward for defense have been proven by experimental results, are new and non-trivial. For the effective implementation of the set goal, all the tasks were solved. The results obtained in the dissertation work are confirmed by publications in rating scientific journals. *Comment:* 1. From the scientific point of view, the presented topic includes novelty with prospective of wide application, that can lead to the development ecologically and economically friendly methods/technology. These remarks do not affect the overall high level of experiments and the results of the dissertation.
8.	The principle of reliability Reliability of sources and information provided	8.1 The choice of methodology is justified or the methodology is described in sufficient detail 1) Yes; 2) no	The choice of methodology is strictly justified by well-known approaches. The methodology of the work is described in sufficient detail in the experimental part section.
		8.2 The results of the dissertation work were obtained using modern research methods and methods of data processing and interpretation using computer technology: 1) Yes; 2) no	The results of the dissertation work were obtained using modern research methods and techniques for processing and interpreting thermodynamic calculations of data using computer technology.

		8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment): 1) yes; 2) no	The theoretical conclusions, the revealed interrelations and patterns in the dissertation work are confirmed by experimental studies.
		8.4 Important statements are confirmed/partially confirmed/not confirmed by references to relevant and reliable scientific literature	Important statements are confirmed by references to modern, relevant and reliable scientific literature (161 sources).
		8.5 The literature sources used are sufficient/not sufficient for a literary review	In the dissertation work, the list of references contains 161 sources, which is sufficient for a literary review.
9	The principle of practical value	9.1 The dissertation has theoretical significance: 1) Yes; 2) no	The dissertation work has important theoretical significance. The conducted research and the results obtained can serve as research on the development of new energy-efficient materials, primarily due to the importance of their practical application in various fields. Research in the field of creating such materials includes volumetric synthesis, engineering and materials science, as well as microscopic research in the field of molecular dynamics and structure formation.
		9.2 The dissertation is of practical importance and there is a high probability of applying the results obtained in practice: 1) yes; 2) no	The dissertation work has practical significance and there is a high probability of applying the results obtained in practice. The proposed methods for producing exothermic mixtures can be used to replace metal impurities such as traditional magnesium and iron used in flameless heaters with a simpler and more affordable metal, as well as to improve the performance and shelf life of composites.
		9.3 Are the suggestions for practice new? 1) Completely new; 2) partially new (25-75% are new);	The proposals for the practical study of the results obtained in the dissertation are completely new. They

		3) not new (less than 25% are new)	can be used in the development of new technologies for the synthesis of flameless heaters.
10.	The quality of writing and design	The quality of academic writing: 1) High; 2) average; 3) Below average; 4) Low.	The quality of academic writing is high. The dissertation work is designed in accordance with the requirements for dissertations.

Decision: To award the degree of Doctor of Philosophy (PhD) or doctor of the profile

Official Reviewer:

Senior Scientist
F.Tavadze Metallurgy and Materials Science Institute
PhD, Associate Professor
Georgian Technical University

Chikhradze Mikheil