REVIEW
of the official reviewer for dissertation work
RAKHYM AKMARAL BAKHYTZHANKYZY on the theme «Sorbents based on aluminosilicate raw materials for heavy metal ions, bisphenol-A and propranolol extraction from aqueous solutions» presented for the degree of Doctor of Philosophy (PhD) in the specialty «Chemistry».

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	1.1 Compliance with priority areas of science development or government programs:	
		1) **The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)** 2) The thesis was completed within the framework of another state program (indicate the name of the program) 3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)	The dissertation was carried out within the framework of the scientific projects of the Ministry of Science and Higher Education of the Republic of Kazakhstan (AP08957166 and AP09260116).
2.	Importance for science	The work makes/does not make a significant contribution to science, and its importance is well disclosed/not disclosed	The research is of **significant importance for the development of chemical and materials science** in the field of modifying natural sorbents such as zeolite and Shankanai clay for water purification from heavy metal ions, bisphenol-A, and propranolol. The significance of the work is **dislosed**, and future applications are outlined.
3.	The principle of independence	Self-reliance level: 1) **High**; 2) Medium;	The candidate's level of independence is evident from the results of the literature review, the

		3) Low; 4) No independence	variety of characterization methods chosen, the methods of testing water samples, and the use of various mathematical models to predict the mechanism of pollutant removal.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) **Justified**; 2) Partially justified; 3) Not justified.	The relevance of the thesis is **justified**
		4.2 The content of the thesis reflects the topic of the thesis: 1) **Reflects**; 2) Partially reflects; 3) Does not reflect	The overall content of the thesis fully **reflects** the topic of the dissertation
		4.3. The purpose and objectives correspond to the topic of the thesis: 1) **correspond**; 2) partially correspond; 3) do not correspond	The purpose and objectives correspond to the topic of the thesis
		4.4 All sections and provisions of the thesis are logically interconnected: 1**) completely interconnected**; 2) the interconnection is partial; 3) there is no interconnection	All the part of the thesis is logically **interconnected**
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) **there is a critical analysis**; 2) partial analysis; 3) the analysis does not represent one's own opinions, but quotes from other authors	The methods used by the candidate, including the physico-chemical techniques of characterization, ways of modification of zeolites and clays and used statistical analysis are reasonable.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 1) completely new; **2) partially new (25-75% are new);**	Most of the results, mainy of the mofidication of zeolites and clays by DDAB and SLES are new and used

		3) not new (less than 25% are new)	for the first time for the removal of heavy metals and BPA and PRO, however some of the scientific knowlegese of the use of zeolites is not new and used a lot of times in the literature.
		5.2 Are the dissertation findings new? 1) completely new; **2) partially new (25-75% are new);** 3) not new (less than 25% are new)	Most findings of the dissertation concering the modification and useod modified zeolites and clay are new. Some part like mechanism of removal by zeolites and clay are well-known and do not have any of the new findings.
		5.3 Technical, technological, economic or management decisions are new and reasonable: 1) completely new; 2) **partially new (25-75% are new);** 3) not new (less than 25% are new)	The technical and technological methods used in this theis is reasonable, and ecomical justification of use of modified mateials is proposed.
6.	The validity of the main findings	All main conclusions are/are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	The main findings of the thesis is validated by the large number of performed experiments, characterization methods, statistical analysis and used mathematical models.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 1) proven; **2) rather proven**; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; 2**) no**	The provision 1 is proven by the experiments performed to evaluate the CEC increase by surface modification of zeolites and clay. In general, the provison is not trivial and have some novelty. The application level is medium and can be applied with additional experiments.

		7.3 Is it new? 1) **yes**; 2) no 7.4 Application level: 1) narrow; 2) **medium;** 3) wide 7.5 Is it proven in the article? 1) **yes;** 2) no	The work was published in several Scopus and local journals recommended by a Committee for Quality Assurance in the Field of education and Science of the Ministry of Higher Education of the Republic of Kazakhstan
		It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 1) proven; **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 Application level: 1) narrow; 2) **medium;** 3) wide 7.5 Is it proven in the article? 1) **yes;** 2) no	In the Provision 2, only the short information of the removal of the metal ions was provided, without any graphs and justified results. Results are not trivial, application level in medium, probably new because was published in https://doi.org/10.26577/ijbch-2019-i2-17
		It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 1) proven; **2) rather proven**;	Provision 3 is mostly proven, exept of the some part concerning the mechanism of the removal. Results are not trivial, application

		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 Application level: 1) narrow; 2) **medium;** 3) wide 7.5 Is it proven in the article? 1) **yes;** 2) no	level in medium, probably new because was published in https://doi.org/10.1016/j.matpr.2020.05.672
8.	The principle of reliability Reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) **yes;** 2) no	The methodology of the modification technique and testing of the materilas for the removal of lead and organic compounds is described in sufficient details
		8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies: 1) **yes;** 2) no	The reliability of the obtained results of the thesis was obtained using modern characterization techniques like SEM, FTIR, Raman, XRD and so, while the statistical analysis and used mathematical model for the prediction of adsorption mechanism was obtained using computer technologies
		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):	The mathematical models and statistical analysis was applied

		1) **yes;** 2) no	
		8.4 Important statements are confirmed / **partially confirmed** / not confirmed by references to current and reliable scientific literature	Most of the statements was confirmed by the literature data
		8.5 Used literature sources are **sufficient**/not sufficient for a literature review	Used literature sources are **sufficient** for a literature review
9	Practical value principle	9.1 The thesis has theoretical value: 1) **yes;** 2) no	The theoretical significance justified by the provided experiments for the removal of lead and organic pollutants by modified zeolites and clay. As the results of the studies, the pattern behavior of modification agents were studied for the removal of targeted pollutants.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: 1) **yes;** 2) no	The results of the work have the practical importance because the use of the local adsorbents for water purification can replace the imported products.
		9.3 Are the practice suggestions new? 1) completely new; 2) **partially new (25-75% are new);** 3) not new (less than 25% are new)	The obtained results and the calculations of the cost of the produced materials are valuable and suggestions of the use of these materials have a practical justification.
10.	The quality of writing and design	Academic writing quality: 1**) high;** 2) average; 3) below average; 4) low.	The quality of the academica writing is high despite some grammatical errors are presented

11.	Notes on a thesis		There are several issues have to be replied: 1. The Provision 2 consist of the results of the Cd, Sr, Cr, Mn removal, but the details of the results are not provided in the thesis. Why? 2. Table 8 – total CEC of zeolite and Na-zeolite is very close if STDEV applied. How you can prove that results are really different? 3. Pp 76 you provide the EDS data for Fe, but it does not occur in the Table 9. 4. Fihure 18 – why there is not DDAB peaks in the DDAB-zeolite? 5. Figure 19 – DDAB-zeolite does not have any of pure DDAB peaks 6. PPp 83 – "No changes were found in the SMZ spectrum after interaction with SLES…", then how to prove that the modification of zeolite by SLES was successful? 7. Table 13 – why there is no zeta potential values ofr Na and H-zeolites? 8. Table 14 – why did you provide particles size distribution in terms of area? 9. Table 16 - Some contradicting results. If we recalculate the Na CEC to mg/g from the Table 15 then the CEC is 3.8 m of Na per g of clay. If I not wrong that means that 3.8 mg

			was ion exchanges (removed) from the 1 g of clay, which is 3.8%. But in EDS you have 10 times less Na content. The same is for zeolite. Any ideas why you have such contradictive data? 10. Table 18 – how do you know that 3 h of experiment is enough to reach the equilibrium? No kinetic results were provided in the thesis 11. Chapter 3.3.4 – there is no kinetic graph and results, only applied models. Why not to present the kinetic graph itself? 12. Table 12 – how is it possible to have R2 = 1 ? 13. Table 26 – most of the applied models for Na-Z + DDAB+PRO have R2 = 1, please clarify how it was obtained
12.	Scientific level of the doctoral student's articles on the topic of research (in case of defense of the dissertation in the form of a series of articles, the official reviewers comment on the scientific level of each article of the doctoral student on the topic of research)		The main results on the topic of the dissertation are presented in the form of 14 publications: - One article Q1, IF = 5.876 according to Web of Science database. - One article Q4, IF = 0.447 according to Web of Science database. - 4 articles in scientific journals recommended by a Committee for Quality Assurance in the Field of education and Science of the

			Ministry of Higher Education of the Republic of Kazakhstan.
13.	Decision of the official reviewer (pursuant to paragraph 28 of the present Model Regulations)		

In reviews, official reviewers indicate one of the following solutions:

1) to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization;

2) **send the thesis for revision (except for cases of thesis defense in the form of a series of articles);**

3) refuse to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization.

Copies of the reviews of the official reviewers are handed over to the doctoral student no later than 5 (five) working days before the defense of the thesis.

Official Reviewer:
Ph.D., associate professor,
Leading researcher,
Insitute of Physics and Technology LLP,
11 Ibragimov st, Almaty
Kazakhstan
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Alzhan Baimenov