

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Maksim Zhmaev

PhD Program: Petroleum Engineering

Title of Thesis: Experimental evaluation of filtration properties of cryolithozone rocks under conditions of formation and decomposition of gas hydrates

Supervisor: Dr. Evgeny Chuvilin

Name of the Reviewer: Xuebing Zhou

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	Date: 17-11-2024
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The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

In this thesis, Mr. Maksim Zhmaev did experimental evaluation of filtration properties of cryolitho-zone rocks under conditions of formation and decomposition of gas hydrates using a custom-designed filtration device. After reviewing the thesis, it is believed that the method used in this work is reasonable and the experimental data are convincing. The sediment permeability measurement device mentioned in this paper can better simulate the low temperature and high-pressure environment, and can truly reflect the gas permeability of hydrate bearing permafrost. The absolute permeability and relative permeability models proposed in this paper have good accuracy and expansibility. Therefore, the content of this study has good innovation, which provides data support and theoretical basis for the study of basic physical properties of hydrate bearing permafrost. I recommend Mr. Zhmaev to start the doctoral graduation defense.

1. In chapter 1, the distribution and occurrence of hydrate bearing permafrost are summarized in detail. I think the author tries to emphasize the importance of hydrate bearing permafrost related research. I think author can first introduce the distribution of hydrate bearing permafrost, then the potential threat of decomposition of hydrate, at last, the necessity of gas migration of study in hydrate bearing soil.
2. In chapter 2, the permeability measurement of sediment and relevant soil properties were introduced. I think the author tries to point out the filtration properties of cryolitho-zone rocks are not well understood. In this case, it is recommended to divide the reference statements by $0\text{ }^{\circ}\text{C}$, which can highlight the insufficient research on the permeability of hydrate permafrost.
3. In chapter 3, the basic properties of natural soil samples were tested, including composite, particle size and water saturation. The custom designed filtration unit was also described in detail. How did the author determine the porosity of the soil samples? Did you make any repeated test to each experimental run?
4. What is the definition of equation (23), (24), (30) and (31)?
5. In chapter 5, the equations used for permeability test are recommended to be provided in detail. Did the author consider the viscosity change of methane in different temperature and pressure?
6. In chapter 6, how did the author get a transition of 42% of the pore ice to hydrate? How did the hydrate distribute in frozen rocks? Fig. 46 is not easy to read? The unit should be included in brackets.
7. In chapter 6, the explanation to permeability change in $\text{CH}_4\text{-CO}_2$ replacement was based on the assumption that hydrate did not migrate in pores. Did you consider the hydrate migration that block the pore throat?
8. The figures should be improved which cannot be understood at first sight.
9. The abstract needs more data to support your major conclusions. What about the experimental method, running conditions and variation range of permeability?
10. In chapter 1, the goal should stress the permafrost. This may be the novelty of your thesis.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense