

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Valentina Ekimova

PhD Program: Petroleum Engineering

Title of Thesis: Experimental modeling of gas hydrates interaction with a salt solution in permafrost

Supervisor: Dr. Evgeny Chuvilin

Name of the Reviewer: Dr. Sergey Stanchits, LabAdvance LLC

I confirm the absence of any conflict of interest

Date: 19-09-2022

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

The Ph.D. thesis of Valentina Ekimova entitled “*Experimental modeling of gas hydrates interaction with a salt solution in permafrost*” analyses the results of experimental study of the mechanisms and regularities of the interaction of gas hydrates with salt solutions in the pore space of hydrate-saturated sediments under various thermobaric conditions. Valentina studied frozen sediments obtained from drilling in the permafrost zones and found that salt migration can accelerate the melting of ice, leading to a possible destabilization of gas hydrates and release of methane into the atmosphere. Based on the analysis of obtained experimental data, Valentina proposed a conceptual scheme describing destabilization of gas hydrate formations. It is obvious that methane emissions can cause serious environmental problems in the Arctic zone, so I consider the topic of Valentina’s study important.

The thesis is well-written, 221 pages long and contains nine chapters, including a detailed literature review, an analysis of the conditions of gas hydrate formation in the Arctic, a description of various techniques applicable to the study of salt ion migration, as well as conceptual models of the interaction of hydrates with salt solutions, and conclusions.

The content of the dissertation and the implemented methods are fully consistent with the topic of the Ph.D. study. The results obtained during Ph.D. study using the state-of-the-art techniques of monitoring salt ion migration are significant.

I have a few comments related to the text of the thesis.

- PhD studies have clearly shown that knowing the value of the critical salt concentration is very important. How was the critical salt concentration calculated or determined?
- Chapter 7.5 presents the results of the analysis of salt ion migration in frozen hydrate-saturated sediments with different content of silt. What is the reason for more active migration of salt solutions in sand with a high content of silt than in sand with clay particles?
- In the Chapter 5.6, pages 97-99, I recommend to use Equation Editor to write equations in the format of full-fledged formulas instead of writing equations in text mode using slash symbols.
- I am sure that possible application of the results of the study to the field conditions is extremely important. Valentina has demonstrated the potential danger of destabilization of gas hydrate formations in the Arctic area. I would recommend Valentina to add to her thesis, for example, in the Conclusions section, some ideas regarding two important issues:
 - a) Is it possible to predict the destabilization of gas hydrate? If so, what needs to be done in the field to make a reliable prediction?
 - b) Is it possible to prevent the destabilization of gas hydrate in the Arctic area? Is it possible to formulate at least some recommendations on what can be done in the field to reduce the risk?

Overall, despite the above remarks, the results of Ph.D. research certainly represent a significant step forward in the study of interaction of gas hydrates with salt solutions in the pore space of hydrate-saturated sediments. Valentina Ekimova has demonstrated this with her presentations at four International conferences and six publications in WoS/Scopus indexed journals.

Summarizing the above, I believe that the candidate is definitely qualified for a Ph.D. degree.

Provisional Recommendation

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