

## Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Aliya Mukhametdinova

**PhD Program:** Petroleum Engineering

**Title of Thesis:** Investigation of reservoir properties of unconventional reservoirs using low-field nuclear magnetic resonance

**Supervisor:** Associate Professor Alexey Cheremisin

**Name of the Reviewer:** Reza Rezaee

I confirm the absence of any conflict of interest Confirmed (Alternatively, Reviewer can formulate a possible conflict)	<b>Date: 09/02/2021</b>
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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

**Comments on PhD thesis “INVESTIGATION OF RESERVOIR PROPERTIES OF UNCONVENTIONAL RESERVOIRS USING LOW-FIELD NUCLEAR MAGNETIC RESONANCE”**

**By Aliya Mukhametdinova**

The main aim of this PhD thesis is to utilize low-frequency NMR measurements to assess rock and fluid properties of several types of unconventional reservoirs. The thesis is very interesting, properly written, and well-organized. In this study, new workflows have been presented to determine the porosity, fluid saturation, wettability based on the 1D and 2D data by NMR.

This thesis is clearly the result of many years of study and research on a large scale of a database. The thesis is based on already published research by the candidate, which is integrated coherently and extended in the thesis manuscript. I found the literature review to be complete and comprehensive. I note that the citations are varied, up to date, and directly relevant to the work at hand.

In general, the candidate has demonstrated his ability to deeply understand the field of the study and has:

- adequately surveyed literature relevant to the thesis. Many updated references relevant have been cited as the state of the art and supported his logical thinking to conduct properly the research programs.
- adequate skills in the collection and critical analysis of any information and report presentation.
- demonstrated the capacity to conceive, design, and carry to completion independent research; and
- already made a substantial, original, and significant contribution to the knowledge or understanding in the field of his study.

In conclusion, I approve the work's originality and I judge the candidate is qualified for a PhD degree with very minor revision to the original thesis submission as highlighted below:

- In Figure 34 for all 13 samples, there are both Preserved and As is states. How this is possible? Does this mean that you have left the preserved samples exposed to air for a while and then conducted another NMR? Explain this in your thesis.
- Page 51, Figure 36 – Is not there any physical change to rock's pore structure after water introduction?
- Page 56: Figure 39 is against your statement “It is noted that maximum NMR porosity values are characteristic for stage 3, at which analyzed samples saturated with decane.” The figure clearly shows higher NMR porosity for the brine-saturated state. Please clarify this issue.
- Page 59: What do you mean by gamma ray-neutron porosity? Needs to be clarified.
- Page 61: “Thirdly, NMR tends to provide the highest porosity value (Figure 45). We explain this observation by the technical capability of NMR to detect the full range of pores – from nano-sized pores filled with high-viscous components to large voids

occupied by mobile fluids.” This is not simply because other methods such as LS provide connected or effective pore spaces whereas NMR provides total porosity?

**Some other minor typos, etc of this thesis are:**

- In Publications Page, correct for 5 and 6 that are one publication “5. Rock porous structure characterization: A critical assessment of various state-of- the-art techniques, Mehdi Razavifar, **Aliya Mukhametdinova**, Ehsan Nikooee,”  
6. Alexander Burukhin, Amin Rezaei, Alexey Cheremisin, Masoud
- Books’ references are cited in the body of the text incorrectly, e.g., at Page 1:  
*Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States 2013*  
You do not need to write the book's name. Author name and year would be enough. In the reference list the basic form of a **book** citation is: Last Name, First Name. Title of **Book**, Publisher, Publication Date.
- Correct Labani & Rezae to Labani & Rezaee.
- Page 29, Instead of using Objects of Investigation use Rock samples used for this study; Table 3: “List of objects under study” is better to change to “List of rocks used for this study”.
- Page 31: What is the clay type of Bazhenov Formation.
- Page 49: change “The results on the determination of porosity by NMR were complexed and displayed on a graph.” to “The results on the determination of porosity by NMR were compared and displayed on a graph.”
- Page 50, Figure 34 change Pooosity to porosity.
- Page 57: Remove “TOC (total organic carbon) values are presented in Figure 2 below.”
- Page 62: change “complexed” to “compared”.
- Page 136: “An increase in the fluid viscosity is accompanied not only by changes in the N1 and T2”; change N1 to T1.

**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*