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Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Mohammad Ebadi

PhD Program: Petroleum Engineering

Title of Thesis: Fluid transport in tight rocks: multi-scale AI-driven characterization paradigm

Supervisor: Associate Professor Dmitri Koroteev

Name of the Reviewer: Associate Professor Alexey Cheremisin

I confirm the absence of any conflict of interest	 **Date: 29-08-2021**

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

The dissertation is presented in coherent academic treatise format based on five articles in Q1 SCOPUS journals.

The dissertation deals with constructing a model of void space based on the methods of X-ray tomography and microscopy. The author (together with the research team) proposed methods for increasing the signal-to-noise level and refining the digital model of void space based on deep machine learning algorithms. The author (together with the research team) proposed approaches to refine the calculations of porosity and permeability for low-permeability reservoirs. The dissertation considers methods for solving the filtration equation in a porous medium, taking into account additional characteristics of low-permeability reservoirs, such as gas adsorption, filtration, and adsorption of a gas on kerogen nonlinear effects during gas filtration in a low-permeability reservoir.

The issues discussed in work are relevant for the oil and gas industry. The issues of using machine learning methods for constructing digital models of void space and solving filtration equations at the micro- and macro-levels are relevant. They can significantly increase the accuracy and speed of calculations.

The research results were published in five Q1 SCOPUS journals and presented at three international conferences. The obtained scientific results make it possible to apply the proposed approaches for building digital models and modeling multiphase flows in porous media, demonstrated by the example of samples of the Achimov formation.

Before defending the thesis, I recommend making the following changes:

1. To change the structure of the thesis, it seems to be more logical in the first part to consider issues related to the construction of a digital model of void space; in the second part, issues associated with modeling multiphase filtration in a porous medium.

2. It is necessary to formulate the goals and objectives of the study.

3. It is necessary to generalize the obtained results and formulate the advantages of the obtained results compared to the existing approaches.

4. Add appropriate references to titles of Figures, Equations and Tables.

5. p. 15, Fig. 1: If the image is borrowed from the source, a link is required in the title of the figure.

6. p. 21, Eq. 2 and 3: Please use metric units.

7. p. 23, What difficulties with Newton solvers will be overcome with a novel approach?

8. p. 26, Fig. 2 Link is required in the title of the figure.

9. p. 28, Fig. 4 Step “Calculation of Eq. 26”, clarification is required, as well as other equation numbers.

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*