

## 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:** Aleksey Vishnyakov

I confirm the absence of any conflict of interest



(Alternatively, Reviewer can formulate a possible conflict)

**Date:** 30-08-2021

*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 thesis dissertation of Dr Mohammad Ebadi makes a mixed impression and as such cannot be defended in the present form. I have no doubt that the volume of the work and its overall significance is substantial, and the work has a lot of achievements, especially in the area of rock structure analysis, and is by itself a necessary step on the way to exploitation of poor quality collectors. Nevertheless, the work has several major deficiencies that must be corrected before the defense

First of all, it is not even clear what is being defended. Classically, a PhD (Philosophy doctor) was supposed to form a thesis and defend the thesis by the means available to philosophy. In many countries (Russia included) the theses that are put forward for defense are still to be explicitly formulated. In engineering dissertation like the one submitted by Mr. Ebadi defended should be numerical methods and approaches. But: the achievements of the entire work should be summarized and a special section (not hidden in the papers). It should also be explained how the achievements (novelty and practical importance) are confirmed. Without this summary, it is not a thesis dissertation,

but rather a collection of papers and as such, it does not suffice. The title contains a very bold word “paradigm”, but it is not clear what this paradigm is.

Another major problem: the author creates a solver for collector-wide transport of gas, which relies on presentation of the strongly heterogeneous medium as homogeneous continuous medium. This concept is called “homogenization”, which the author does not even mention, and there are certain methodology developed over the years, whether sufficient for the exact task or not. This has to be reflected in the review. The author attempt to homogenize the system with the Fick diffusion term. Such a term may be justified provided the local equilibrium between kerogen grains and surrounding transport pores in the time scale characteristic to the collector depressurization. But the mechanisms of molecular diffusion in kerogen-like organic matter make me doubt it is actually the case (PDFs of the papers are provided in the files). Even if the equilibrium isotherm can be fitted with the Langmuir equation that does not mean the adsorption obeys the Langmuir mechanism. I understand that we cannot demand too much from the first version of the solver and that homogenization of kerogen-containing media is a difficult problem that cannot be resolved in this dissertation, but the newly developed methodology needs critical evaluation in the dissertation, this is a requirement for the PhD degree.

Figures 13-14: this result also need evaluation. Does the author claim the approach can be generally applicable or is it suitable for the particular set of conditions the author had to deal with in the presented work?

Table 1: a typo probably, but  $\lambda/d \approx 10^{-3}$  is by no means the free molecular flow.

Overall: the work appears certainly sufficient for the PhD degree. The topic is relevant to the contemporary demands, and the topic correctly reflect the content of the thesis. The methods developed have been practically implemented, which by itself (+good quality journal publication, I positively evaluate them) confirms the level of the research. The text needs more effort and I have to demand the effort is made.

**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*