

## Jury Member Report – Doctor of Philosophy thesis.

**Name of Candidate:** Evgenii Kanin

**PhD Program:** Petroleum Engineering

**Title of Thesis:** Asymptotic models of coupled geomechanics/fluid mechanics phenomena of hydraulic fracture growth

**Supervisor:** Professor Andrei Osipov

**Co-supervisor:** Professor Dmitry Garagash, Dalhousie University, Canada

### Name of the Reviewer:

I confirm the absence of any conflict of interest

**Date: 22 08 2022**

(Alternatively, Reviewer can formulate a possible conflict)

*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

Review on PhD dissertation "ASYMPTOTIC MODELS OF COUPLED GEOMECHANICS/FLUID MECHANICS PHENOMENA OF HYDRAULIC FRACTURE GROWTH" by EVGENII KANIN

07 | 29 | 2022

The thesis is focused on the influence of the properties of the fracturing fluid on the crack propagation and flow during the hydraulic fracturing. The work is thorough, convincing, and appears to be of high quality. The author definitely put a lot of effort and simply the size of the thesis is astonishing.

Novelty of the work: pretty sizable. The author considers several important effects that might have been considered before but were not comprehensively studied

(a) finite permeability of the rock, especially the pressure –dependent leak-off and leak-in in different areas of the crack

(b) Viscous drag vs inertia of the fluid in the propagating crack

(c) non-Newtonian rheology of the fracturing fluid (in the frames of Herschel–Bulkley representation), which is quite important

Significance: I am not really qualified to evaluate the significance of the work. But provided the novelty, the author considered several interesting physical features that affect the crack propagation and flow. There are definitely methodical achievements that will eventually lead to the improvement of fundamental understanding and better practical solutions in hydraulic fracturing design

Quality of the text: excellent and poor at the same time. I certainly like the systematic way of presentation, thorough explanation of the physical effects and the models. The language is expressive with few errors. At the same time, the structure is far from perfect in my taste. I really recommend that the novelty and the significance of the work be separate sections (2 pages and mostly copy-paste): what is actually done that was not done before and how it affects the science in general and the practice of hydraulic fracturing. This will greatly benefit the thesis. If there is a sense to introduce the “statements brought to defense” this should be done as well. It appears not very hard to do, at the qualitative level at least.

What I really like is the presentation of the results. The figures are well thought and well built; even the fonts are well sized, the captions are thorough and clear. Great job.

Question: there is only one, but a big one. How the outcome of the modeling can be experimentally verified? Either by means of smaller laboratory experiments or even from the results of actual hydraulic fracturing practice?

Another question: the author mentions foams as fracturing fluids. It is true the foams are non-Newtonian (of course) and can be described with the Herschel–Bulkley formalism, but the foams have many features, like inherent instability, Poisson ratio and compressibility, which are out of the intervals the author continues

Instead, the author claims that his calculations are to be used as benchmark for more complex models. This might be understandable in the context he proposes such an idea, but still very much “inside the model”.

Overall, the dissertation definitely qualifies as a PhD work and the author certainly deserved to be awarded PhD in the field of Petroleum Engineering.

**Provisional Recommendation**

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

*X 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*