Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Alexandra Scerbacova

PhD Program: Petroleum Engineering

Title of Thesis: Investigation of alkyl ether carboxylate surfactants performance in carbonate reservoirs

Supervisors:
Professor Alexey Cheremisin, Skoltech
Associate Professor Ahmed Barifcani, Curtin University
Co-supervisor:
Associate Professor Chi Phan, Curtin University

Name of the Reviewer: Dmitry Koroteev

I confirm the absence of any conflict of interest	**Date: 27-11-2023**

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 PhD thesis of Alexandra Scerbacova entitled "*Investigation of alkyl ether carboxylate surfactants performance in carbonate reservoirs*" covers the application of anionic-nonionic surfactants for chemical enhanced oil recovery. Alkyl ether carboxylates were selected as main objectives of the study. Alexandra studied the major trends in the behavior of AECs under different conditions that reproduce reservoir ones. A combination of various experimental techniques and molecular dynamics simulations provides a complete picture of the performance of linear AECs depending on their structure. The research is concluded with the optimization of a commercial surfactant composition for further pilot test.

The text is written well, despite some typos. The thesis organization is good; it consists of 7 chapters that include literature review, description and discussion of obtained results, conclusions and recommendations. Chapter 1 includes an up-to-date literature review that highlights the main challenges associated with effective development of carbonate reservoirs.

Chapter 2 describes the interfacial behavior of AECs on the boundary with hydrocarbons. A detailed analysis of cations and anions present in reservoir brines was performed.

Chapter 3 continues experiments conducted in Chapter 2 with molecular dynamics simulations. Experiments were adapted for comparison with simulation results. Using the simulations of a wider range of AECs that could be tested experimentally, it was found how the lengths of heads and tails influence on the adsorption of surfactants on the liquid-liquid interface.

Chapter 4 covers main rock-fluid interactions of surfactant compositions with carbonate rock samples from a real field. The mechanisms of wettability alteration and adsorption of selected surfactants were described relying on previous publications.

Chapter 5 is devoted to evaluation of fluid flow in porous media. The coreflooding test was conducted with in-situ X-ray saturation control, and distribution of oil and water phases was determined. The experimental design allowed to demonstrate strong wetting properties of AECs by introducing a shut-in stage that is typically used for low-permeability/shale core samples.

Chapter 6 shows how a commercial AEC-based surfactant blend can be optimized for further field application and thus demonstrates the importance of studies conducted in Chapters 2-5.

Chapter 7 contains main research outcomes and recommendations.

I have just one comment for the thesis. I would highly appreciate to gain more understanding or discussion on how exactly the results of MD simulations linked with the design of the actual core flooding experiments. I believe, that the straightforward upscaling routine is hardly possible here, but some physics-based rules on how the outcomes of MD simulations influence the particular regimes/fluids/rocks in a flooding experiment would be nice to see.

The thesis topic fully corresponds to its content. The experimental study was done meticulously, laboratory methods applied are relevant to the present work and are used in the majority of modern papers published in peer-reviewed journals, as well as in PhD projects conducted in institutions with high world ranking. Some techniques were used for the first time as alternatives for commonly used methods, such as Rock-Eval pyrolysis application for analyzing surfactants after contact with rock. This method should be developed further.

Currently, the problem of effective oil production from carbonate reservoirs is one of the priorities in the petroleum industry. The present work is in compliance with the current state-of-the-art as the candidate

makes an attempt to optimize surfactant flooding for carbonates taking into consideration main challenges.

The results of this work are published in three Q1 journals and one Q3 journal, and presented at three international conferences. The quality of the papers is high with the deep analysis of the main outcomes.

Summarizing the above, I have no doubt that the thesis is of high standard for the engineering science and Alexandra definitely deserves PhD degree.

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*