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Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Anastasia Ivanova

PhD Program: Petroleum Engineering

Title of Thesis: Dynamic modelling and experimental evaluation of nanoparticles application in surfactant enhanced oil recovery

Supervisor: Associate Professor Alexey Cheremisin

Name of the Reviewer:

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	**Signature:**  **Date: 09-11-2020**

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:

Chapter 1: In chapter 1, the fundamentals of enhanced oil recovery from carbonate reservoirs by surfactant and nanoparticle systems are discussed. The literature review on IFT reduction, wettability alteration and rock-fluids interactions are also described elaborately. The discussion also includes the effect of temperature and salts on interfacial properties. The chapter is well written.

However, the chapter should include the lack of study in the relevant field and the innovative idea of the present study. The objectives of the study should also be clearly mentioned in the introduction chapter.

Chapter 2: Characterization of Organic Layer in Oil Carbonate Reservoir Rocks and its Effect on Microscale Wetting Properties

The chapter deals with the typical characteristics of carbonate reservoir rocks including wettability characteristics. The characterizations were done by XRD, SEM, EDX, etc. to discuss the microstructure. The wettability study is also reported.

In introduction of the chapter some reported studies should be mentioned to update the relevant studies in this area. It is suggested to discuss the wettability phenomena by zeta potential values. Include discussion on why the carbonate reservoir rocks are generally oil-wet.

Chapter-3: Effect of nanoparticles on viscosity and interfacial tension of aqueous surfactant solutions at high salinity and high temperature

This chapter discusses the behaviour of interfacial tension and rheology of surfactant solution and effects of nanoparticle, temperature and salinity on the properties. Substantial experimental works have been reported. The results are also explained significantly.

Here again I would suggest to mention some reported studies in the relevant field in the introduction section of the chapter. Anionic surfactant, sodium olefin sulfonate is used in the present study for carbonate reservoirs. It is well-known that for carbonate rock with positive charge the anionic surfactants are not preferred. The candidate should explain the use of the anionic surfactant in the present study for carbonate rock with justification. Incorporate the discussion in selecting the surfactants based on HLB values. From figure 23 and 24, it is observed that IFT of surfactant/oil system is less than that of surfactant/nanoparticle/oil system-justify. Figure 30 indicates that rheology of surfactant/nanoparticle system follows Newtonian behaviour. Incorporate supporting literature. It is suggested to explain the results more elaborately with scientific input and supporting literature.

Chapter 4: Molecular insights in the temperature effect on adsorption of cationic surfactants at liquid/liquid interfaces

In this chapter the self-assembly of surfactant molecules at a water/oil interface are discussed. The study is very much informative and well described. The mechanisms at the molecular level are discussed.

Chapter 5. Molecular dynamics study of ions effect on surfactant – hydrocarbon interfaces

In this chapter a detail investigation is made on the influence of typical reservoir salinities and temperature on the adsorption process of two different cationic surfactants at the water/n-decane interface at the molecular level. The study is very innovative and well described. I must appreciate it.

Chapter 6. Molecular dynamics study of surfactant – hydrocarbon interface in the presence of nanoparticles

In this chapter the study of earlier chapter is extended with nanoparticle system. It is suggested to elaborate the discussion on interaction of nanoparticle with surfactant solution and oil system. Explain how this study will be helpful in prediction of the enhanced oil recovery by the proposed mechanisms. Incorporate the settling issue of the nanoparticle from the solution. Explain how the heterogeneity in the reservoir system can be handled with the molecular dynamic simulation.

Overall, the quality of the thesis is very good. Most of the results are explained well. The publication is also good. I must recommend for award of the degree after successful completion of viva examination.

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*