

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Ayomikun Bello Sunday

PhD Program: Petroleum Engineering

Title of Thesis: Co-optimization of the methods of oil recovery and CO₂ storage using nonionic-based binary surfactant foams

Supervisors: Professor Alexey Cheremisin

Co-supervisor: Dr. Anastasia Ivanova

Name of the Reviewer: Professor Sergey Stanchits

I confirm the absence of any conflict of interest

Date: 09-11-2024

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

In his PhD research, Ayomikun Bello studied methods applicable for oil recovery and CO₂ storage using underground injection of nonionic-based binary surfactant foams. I consider the topic of the study to be valuable, since it is very important to organize the capture of carbon dioxide from industrial processes with subsequent utilization and safe storage underground in order to prevent a global warming of the atmosphere. It is well known that a massive volume CO₂ storage requires the development of efficient and reliable strategies, and foaming of injected CO₂ may be a promising solution for a reliable underground storage. The results of PhD study showed that foams produced with developed novel surfactant systems can enhance an oil recovery and also improve the CO₂ sequestration in depleted formations. During his PhD study, Ayomikun successfully developed and characterized nonionic based binary surfactant systems, and proposed them as an alternative to traditional commercial foaming agents for carbon utilization and storage in depleted oil formations under high salinity conditions. He demonstrated that CO₂ foams produced using binary surfactant mixtures are more stable under high salinity conditions and in the presence of oil. In addition, during his study Ayomikun applied a novel approach to a foam production with a gas diffuser, providing a more reliable and efficient way to inject a gas, which is crucial for maintaining a foam stability over a long time. I consider the main objective of Ayomikun's PhD study to be important, I am sure that obtained results correspond to the international level and have a high potential for possible industrial application.

The thesis is well-written, text contains 166 pages, consists of seven chapters, including an introduction, a literature review, an overview of applied experimental procedures, followed by a detailed description of the obtained results and conclusions accompanied by recommendations for a future work and an appendix. The content of the thesis is fully consistent with the topic of the Ph.D. study.

I have a few comments related to the text of the PhD thesis.

- In the PhD thesis, special focus was made onto the stability of the foam, the author presented results of numerous testing of foam with different surfactants, confirming its stability for one hour, during which the foam volume was measured. However, what about longer period of observation, do the obtained results provide an opportunity to assess the stability of the foam within the period of several hours or even days after the fabrication?
- Is it possible to develop a reliable predictive model for assessing a long-term foam stability based on the results of short-term laboratory measurements?
- Considering the possible industrial application of the results of the study, is it possible to manufacture the foam in the direct vicinity to the injection well in the field?
- In page 47 it is written about the measurements of apparent foam viscosity using the capillary tube of Diameter = 0.051 mm, but in page 85 using a capillary tube of Diameter = 0.51 mm
 - First of all, I recommend the author to double check the values of the capillary diameter, I suppose it is difficult to manufacture a 12-meter tube with a diameter of about 50 microns;
 - Secondly, I recommend to point out: is it the inner (ID) or outer diameter (OD) of the capillary tube?

Ayomikun Bello has published the results of his PhD study as the first author in seven papers, including two papers in high-ranking Scientific Reports journal, and presented them at 10 international conferences. To summarize the above, I believe that the candidate is definitely qualified to receive a Ph.D. degree.

Provisional Recommendation

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