Вх. № 19 / 16.01 2026

OPINION

regarding the defense of a dissertation: **CFD MODELING OF MEMBRANE SEPARATION THROUGH NANOFILTRATION**

for acquiring the educational and scientific degree Doctor

in the specialty "Processes and Apparatuses in Chemical and Biochemical Technology" within professional field 4.2. Chemical Sciences.

Candidate: Eng. Stela Plamenova Panyovska

Prepared by: Prof. Nina Yankova Penkova, PhD, University of Chemical Technology and Metallurgy (UCTM)

1. Relevance of the problem addressed in the dissertation

The dissertation describes model studies and analyses of hydrodynamic processes determining the mass transfer in various nanofiltration cells for liquids. Nanofiltration is increasingly used in water purification, desalination, and other practical applications, and is the subject of a growing number of research studies, as illustrated in the dissertation. Computational Fluid Dynamics (CFD) is a modern and rational approach for analyzing and improving the efficiency of such systems. Therefore, the topic of the dissertation is contemporary and the research objectives are achieved using modern methods and tools, forming a solid basis for applicability and future development of the obtained results.

2. Review of the dissertation and analysis of the results

The dissertation consists of 151 pages and includes 62 figures and 2 tables. It is structured into 5 chapters, contributions, and a list of 169 references—English-language articles and online sources providing information about the systems studied.

The main objective of the dissertation is mathematical modeling and numerical simulation of hydrodynamic processes and mass transfer through membranes in nanofiltration cells of different configurations to determine optimal process conditions.

Three nanofiltration cells are studied—one with stirring and two without stirring of the solution. Hydrodynamic processes are simulated at various velocity fields and Reynolds numbers, obtained by varying the stirring speed of the first cell and the flow rates of feed and discharge solutions in the other two. The mass transfer coefficients through the membranes are determined based on the obtained velocity fields and share stresses on the membrane surfaces via a modified correlation between the Sherwood, Reynolds, and Schmidt numbers,. These coefficients are applied to analyze cell effectiveness during different simulated operating regimes.

3. Main scientific and applied contributions

The contributions in the dissertation are classified into three groups:
- analysis and evaluation of hydrodynamic fields in filtration cells using specifically developed models;
- prediction of mass transfer processes through membranes;
- assessment of membrane efficiency.

In summary, the main contribution is a computational algorithm for analyzing the effectiveness of filtration systems, based on mathematical models, CFD software tools, and concepts for modeling membrane filtration. The research results have scientific and applied significance, enriching existing knowledge and theories and supporting the application of scientific achievements in practice.

The PhD candidate participated in the developing the mathematical models, their solution by the finite volume method, visualization and analyzes of the results. These activities that have strong educational value and form a basis for her future development in chemical engineering. A plagiarism check confirming the originality of the dissertation is also provided.

4. Description and evaluation of the submitted materials

Parts of the dissertation have been published in 4 papers:
- one in a proceedings volume of the University of Food Technologies,
- and three in impact factor journals.

Results from the dissertation have been presented at 8 scientific forums. The PhD candidate received an award in 2021 for achievements in the scientific field "Energy Resources and Energy Efficiency" from the Bulgarian Academy of Sciences (BAS) for her work on the topic. These accomplishments exceed the minimum requirements for defending a dissertation according to the Bulgarian Law for the Development of the Academic Staff, its regulations, and the rules of BAS.

5. Impact of the candidate's publications in Bulgarian and international literature

A list of 33 citations of publications related to the dissertation is presented, demonstrating that the research results are useful to the global scientific community.

6. Critical comments and recommendations

Several unclear points, omissions, and technical errors were identified while reviewing the dissertation. The first three also raise questions.

1) Equation (33) for determining the mass transfer coefficient is applicable to various processes. Which specific parameters of the studied nanofiltration systems were used in the modeled cases?

2) If the laboratory cell with stirring is not filled entirely with liquid, a free surface exists, separating liquid from air. This surface deviates from the horizontal plane at higher stirring

speeds. Neglecting it may lead to discrepancies in velocity fields and stresses. Was an analysis conducted to determine whether this free surface can be neglected, and what deviations arise compared to real hydrodynamics in the cell?

3) The modeled fluid is stated to be water at the cylindrical filtration cell with tangential flow (p. 96). Yet Fig. 47 shows concentration fields at Reynolds numbers outside the experimental range (as seen in Figs. 60, 62 and mentions on p. 20). How were the concentration fields obtained?

4) Additional issues were found:
- inaccurate terminology of fluid flow parameters;
- omissions in mathematical models and schematic representations of filtration cells;
- errors in figures, captions, variable descriptions, and units.

These comments and questions were shared with the PhD candidate and her supervisors and have been taken into account. I believe they do not diminish the achievements presented in the dissertation.

7. Personal impressions

I know Eng. Stela Panyovska from her studies at UCTM as a diligent, responsible, curious and intelligent person with interests in computer modeling. The research in the dissertation shows that she has advanced her knowledge in chemical engineering processes and the computational fluid dynamics. I wish her successful future development as a young researcher, engineer and teacher.

Conclusion

The dissertation fully meets the requirements for obtaining the educational and scientific degree Doctor. I give a positive evaluation of the achieved results and contributions.

I propose to the Scientific Jury to award Eng. Stela Plamenova Panyovska the educational and scientific degree PhD in Professional field 4.2. Chemical Sciences, specialty “Processes and Apparatuses in Chemical and Biochemical Technology.”

16 January 2026 Member of the Scientific Jury: .....
Sofia (Prof. Nina Penkova, PhD)