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Review
of doctoral dissertation of Mario di Serio MSc
"Catalysis, Kinetics, and Chemical Reactor Engineering
for Alkoxylation Reactions"
supervisor dr hab. inż. Wiesław Hreczuch

The review was carried out based on the decision of the Discipline Council of Chemical Sciences of the Faculty of Chemical Technology of the Poznań University of Technology of October 8, 2024.

General characteristics of the doctoral dissertation

The presented doctoral dissertation is unusual due to the outstanding scientific achievements of the PhD candidate. This is the first time I have had an opportunity to review the doctoral dissertation of such an experienced researcher. Both, the number of publications 296, the Hirsch index of 46, over 8000 citations of his publications and their great increase in the years of 2020-2022, from 500 to 700 citations per year (15/05/2024 SCOPUS, Scholar Google) deserve the highest recognition.

The presented work is very extensive (218 pages) and required a lot of effort from the PhD candidate during editing. In my opinion, it would have been much simpler to

formulate thesis basing on hist five publications with their introduction (guide) containing.

Layout of the reviewed work

The reviewed work is divided into two basic parts. The first part, divided into four chapters, is a literature part summarizing state of the art in the research topic until 2023.

I consider the literature review to be complete and to cover the scope of the research topic presented by PhD Candidate. This part of the work contains 76 pages, and among the cited literature items, quite numerous works by the PhD Student are noteworthy, including those published with co-authorship by the Supervisor of this doctoral thesis. In the list of literature, I counted 84 items (it's a pity, that there is no numbering here!). These are diverse sources with a significant share of patent literature.

I do not have any substantive comments to this part of the work.

The second part of the work is the actual description of the works published by Mario di Serio and forming the basis of the dissertation. PhD candidate starts with the description of the novelty and originality of the undertaken research.

The next three chapters contains a description of the research of processes taking place in various types of reactors.

The last, fourth chapter contains a summary and conclusions from the conducted research. The work ends with a list of symbols used and a list of literature.

The last part of the work consists of two appendices.

The first one contains full texts of five publications which are the main part of the doctoral thesis. In addition to the texts of the publications, the Author Copyright of the publishers' to include them.

The manuscripts were published in journals with average (especially for Chemical Sciences) impact factors: Chemical Engineering Research and Design IF = 3.7 (one work), Frontiers in Chemical Engineering – IF = 3.5 (three works) and Chinese Journal of Chemical Engineering – IF = 3.7 (one work).

The aim of the work was formulated clearly and I have no comments on it, although I would rather found research hypotheses than a work plan.

Overall assessment of the work

The work covers well the issues described in the introduction to the dissertation. The five publications presented, which according to PhD Candidate opinion constitute a doctoral thesis, describe research on modeling of various types of reactors. The exception is publication no. 4. It is a review of publications and as such it is difficult to consider it as part of a doctoral thesis. It should therefore be recognized that in fact the presented doctoral thesis is the result of four articles published in the literature.

Main achievements of the dissertation

In the introduction to the second part of the doctoral dissertation, author characterizes the elements that, in his opinion, characterize the elements of the scientific novelty of the work. He lists the following points:

1. Presentation of the idea of new Enhanced Loop Reactor (ELR) and comparing its performance with both state-of-the-art systems: Spray Tower Loop Reactor (STLR) and Venturi Loop Reactor (VLR), based on the developed mathematical simulations of the reactors.

As a result, research has been undertaken on the development of innovative synthesis nodes for the alkoxylation process, particularly in the modelling and development of new, efficient and safe reactors for this process.

Based on the comparison of simulation results of the performance of known STLR and VLR reactor systems and the developed concept of a hybrid ELR synthesis node, the advantages of the new solution were demonstrated.

The novelty is the development and application of a suitable mathematical model to describe the operation of the compared reactors as well as the concept of the new ELR synthesis node.

2. Critical analysis of the most recent efforts reported in both, the scientific and patent

literature dealing with the alkoxylation processes in continuous mode, as published with the participation of the doctoral candidate in the form of a review article. Novelty is the first extensive examination, comparison and discussion of-the-state of the art of such proposals, considering a possible industrial perspective in terms of productivity of the systems. This complements the original research work contained in Chapter 5 and leads to the description of the research work in Chapter 7, devoted to the further development of the technology of oxyalkylation towards microreactors.

3. Elaborating on the data collected in the microreactors, where for the first time a laminar flow model was used to study the kinetics of ethoxylation of the analyzed system. For this purpose, a dedicated mathematical algorithm was developed and successfully applied for continuous ethoxylation using microreactors, under dynamic conditions.

The research part of the dissertation presented in point 1 and 3 represents a novelty in the description of the state of the art and is the achievement of the team in which the doctoral candidate made a leading or significant contribution.

The dissertation part described in point 2 is a literature study of the achievements of other authors as well and is essential for laying the groundwork for further advances in microreactor-based oxyethylenation technology, as investigated in point 3.

The indicated elements of scientific novelty are consistent with my opinion after reading the entire doctoral thesis. The only doubt is raised by point 2. Although the literature review is very important for the conducted research and simulations, it is difficult to consider it as own research work.

Elements constituting a significant contribution to the development of a scientific discipline

In my opinion, important from the point of view of the development of the discipline is the development of an innovative method for modeling various types of reactors. This will enable process optimization and the selection of the best method from the point of view of targeted synthesis.

Understanding the processes taking place in the selected reactor implementation will allow for a reasonable and logical increase in the scale of the processes. A separate issue is the assessment of the impact of the entire PhD Candidate work. As I mentioned in the introduction, this is a separate story that the PhD Candidate included in the literature part, considering the part described in the second half of this monograph as the purpose of the doctoral thesis.

In works on reactor modeling, an important role is the determination of kinetic equations used in models. Therefore, during the doctoral defense, I would like to hear from the PhD Candidate, what methods he considers to be the best. Is always the recognition of the best fit of experimental data to the proposed kinetic equation an error-free method?

Summary

In summary, I declare that the doctoral thesis of Mr. Martino Di Serio meets the requirements for doctoral theses contained in the Act of 14 March 2003 on academic degrees and academic titles and on degrees and titles in the field of art (Journal of Laws No. 65, item 595, as amended) and the Regulation of the Minister of Science and Higher Education of 19 January 2018 (Journal of Laws of 2018, item 261). I declare that the condition described in art. 13 section 1 of the aforementioned Act has been met. The thesis is an original work that brings new findings to modern reactor chemistry. In connection with the above, I request the High Discipline Council of Chemical Sciences of the Faculty of Chemical Technology of the Poznań University of Technology to admit the thesis to further stages of the doctoral procedure.