REVIEW REPORT
on
A promotion to Associate professor position
at the Institute of Chemical Engineering, BAS

Related to the concurs about the scientific specialty **4.2. Chemical Sciences**
(Unit operations in chemical and biochemical industries)

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Applicant: senior assistant, doctor c Petya Georgieva Popova-Krumova

Reviewer : prof. Dr. Jordan Yankov Hristov, Ph.D., D.Sc.

1. Brief on the applicant's biography

Doctor Popova graduated from the university "Assen Zlatarov", Burgas, in 1989 with a BS in ecology. She got a master's degree in ecology in 2004. From 2004 to 2008 she is a Ph.D. candidate at the Institute of Chemical Engineering-BAS and the Ph.D. thesis entitled "Determination of parameters in models of chemical engineering processes" was defended in 2008. Since 2008 doctor Popova works as a research fellow / 2008-2011./ and a senior assistant professor /2008-present/ at the Institute of Chemical Engineering-BAS

2. General characteristics of the scientific and applied activities of the applicant

Doctor Popova works on problems related to the modeling of processes in chemical and biochemical technologies. Previously, the research is oriented toward the development of models for parameter determination in incorrect problems. As a result, there are models of absorption columns, published and defended as 5 patents and applied models

The work of doctor Popova is related to participation in 10 scientific projects funded by the National Scientific Found and with international collaborations. Doctor Popova is awarded a golden medal for her works on " Absorption-adsorption device and method for SO2 removal from waste gases"", 10th national exhibition" Inventions, transfer and innovations „Изобретения, трансфер, иновации"- 2017.

Doctor Popova is active in the organization of various scientific initiatives and forums, among them :

- International Symposium "Power and Chemical Engineering (29.06.2018-02.07.2018);
- 16th Workshop on Transport Phenomena in Two-Phase Flow (15.09.2020-18.09.2020);
- Challenges in Chemical and Biochemical Technologies and Environmental Protection " (25.10.2021-27.10.2021)
- 1st International Scientific Conference on Cleaner Energy and Chemical Engineering for Sustainable Circular Economy (28.08.2022-31.08.2022);
- 17th Workshop on Transport Phenomena in Two-Phase Flow" (22.09.2020-25.09.2020)

3. Evaluation of the materials applied

There are **18 published articles, at a required minimum of 15 articles, after the Ph.D. thesis, as follows** :

1. As a habitation work: 8 articles corresponding to the requirements of BAS and IChE, and the minimal requirements related to section B, for the associate professor positions, are obeyed; the scores are 224, concerning the minimum of 220 required.
2. In section G, of the requirements, there are applied: A monograph, with 2 editions, and 1 publication in Q1, 4 publications in Q4, a chapter of a contributed book, and 5 inventions defended by issued patents as well as 1 published claim for a patent.

The citations on applied works are 32. The h-index, at the moment of application, is 3.

4. Main scientific and applied contributions

The main scientific and applied contributions, in according with the applied publications, are outlined as follows :

4.1. A regularization method for the solution of parameter identification in ill-posed problems has been developed.

4.1.1. It was proved that in the mathematical models of chemical engineering problems, there are many ill-posed cases due to the existence of small parameters as coefficients of the higher derivatives. The regularization method and the simplex method *fminsearch* in case of ill-posed problems concerning the parameter identification by MatLab have been compared.

4.2 A hierarchical approach for the solution of multi-parametric models, based on polynomial approximations of experimental data, for parameter identification has been developed. The parameter values obtained can be used as zero-order approximations in parameter identification problems and form the starting hierarchical level of the identification procedure.

4.2.1. A hierarchical method for parameter identification of air-lift bioreactor has been developed. The values of the parameters obtained are based on experimental data about biomass, oxygen, glucose, and gluconic acid concentrations. The approach developed applies to various fermentation processes

4.2.2. A hierarchical approach to modeling of kinetics of red microalgae growth in a solar air-lift bioreactor has been developed. The possibility to replace missing experimental data with artificial ones, upon conditions imposed, dependent on the kinetic model parameters, has been demonstrated. The applicability of the correctness of the parameter identification problem and the model developed has been proved.

4.2.3. A method for fermentation process modeling in the case of crude glycerol treatment q as by the process of biodiesel production has been developed. A mathematical model of biodegradation of bio-glycerol from *Klebsiella oxyto*ca towards organic products (1,3-propanediol; 2,3-butanediol), allowing improvement of productivity and energy efficiency has been developed.

4.3. Mathematical models and algorithms of processes of physical and chemical counter-current absorption, non-stationary adsorption, and heterogeneous catalytic processes in columnar devices have been developed. A novel method for modeling inter-phase mass transfer such as distillation, absorption, adsorption, and catalysis, through the application of convection-diffusive models of a pilot and industrial-scale columnar devices, has been developed.

4.3.1. Models for descriptions of heterogeneous processes of physical and chemical countercurrent absorption, adsorption, and catalytic process have been developed

4.3.2. A mathematic model for moisture transport from an adsorbent bed to the air filtrating through it has been developed. The model considers a packed bed column and water diffusion and adsorption by a novel composite „CaCl2/alumina".

4.4. A mathematical model for the specific case of absorption –adsorption process in columns with bubble caps trays, based on convection-diffusion models and models of mean concentrations, has been developed.

4.4.1 A mathematical model of the absorption-adsorption process oriented toward SO2 removal from flue gases has been developed.

4.4.2. The model is based on the mechanics of continua allowing the application of the convection-diffusion approach and the mean concentration concept.

4.5. An approach for modeling mass transfer in industrial columnar units, by application of two steps, and the convection-diffusion models and the mean concentration concept has been developed-see point 4.3

4.5.1. New approach for two-step mass transfer modeling allowing applications to large-scale columnar devices have been developed.

4.5.2. The models developed and the related solution algorithms allow the modeling of industrial-scale operations in cases of simple and complex processes involving chemical reactions, and physical processes, in both co-current and counter-current modes.

The results obtained are summarized in two monographs and form the basis of two patents and two applied models.

4.6. A new absorption-desorption approach (described in point. 4.4), combining innovative contacting devices and a method for SO2 removal from waste gases has been conceived.

4.6.1. Now absorption-adsorption closed cycle, wasteless, approach with contacting device, and a method for SO2 recovery from waste gases has been developed. The results are published in 2 monographs and form the bases of 2 patents

4.6.2. A new device and related method for SO2 recovery from waste gases by the application of regenerable adsorbent, without emissions of CO2 q and useful final products have been developed.

6. **References to the applied publications in the literature**
The citations encountered at the moment of application are 32. On this base, the h-index is 3.

7. **Critical comments and suggestions.**
There are no critical comments. The only suggestion for the future is more hard work and publications in high-level journals.

8. Personal comments

I know doctor Popova since the very beginning of her work at the Institute of Chemical Engineering and I am aware of her entire academic development. I believe that if she will be promoted to the associate professor position, she will be able to get new results and fruitful contributions to the laboratory where she will be assigned.

CONCLUSION-RECOMMENDATION

Based on the applied and reviewed materials, and applying the conditions imposed by the Law of Academic Development of the Republic of Bulgaria, I may suggest doctor Popova be promoted to the position of associate professor in 4.2. Chemical science (unit operations in chemical and biochemical technologies) at the Institute of Chemical Engineering, BAS

Date: 07.03.2023

Reviewer:
Prof. Dr. Jordan Yankov Hristov, Ph.D., D.Sc.