

REVIEW

on a competition for the academic position of "professor" in professional field 4.2 "chemical sciences" (processes and apparatus in chemical and biochemical technology) with a single candidate Assoc. Prof. Dr. Tatyana Stefanova Petrova, Associate Professor in the Laboratory "Transport Processes in Multiphase Media" of the Institute of Chemical Engineering - BAS

Reviewer: Prof. Dr. Venko Nikolaev Beshkov

**1. General information about the candidate**

Assoc. Prof. Dr. Tatyana Stefanova Petrova was born on October 1, 1966 in the city of Kharkov, Ukraine (then USSR). She graduated from the 8th ESPU "Vasil Levski", Sofia (1984) and the Technical School of Woodworking and Interior Architecture (1984) in Sofia. She received her higher education at the Faculty of Mathematics and Mechanics, Sofia University "St. Kliment Ohridski" with a specialization in fluid mechanics (1989). In the period 1989/96 she worked at the Institute of Mechanics and Biomechanics (BAS) and at the Faculty of Mathematics and Mechanics, Sofia University. Since 1996 she has been working at the IIH-BAS as research associate, and in 2008 she defended her dissertation on the path of independent preparation for the scientific and educational degree "doctor". After successfully participating in a competition in 2011, she was appointed as an associate professor at the IIH- BAS. Assoc. Prof. T. Petrova has participated and is participating as a leading researcher in 6 international projects on bilateral cooperation with Germany (Deutsche Forschungsgemeinschaft, DFG)..She has participated in three projects funded by the Scientific Research Fund, one of which she is the project leader At the IIH she has held and is holding leading positions (secretary of the Colloquium). She is now the chairman of the Scientific Council.

**2. Review of the submitted papers**

The candidate has submitted a list of 85 papers related to the topic of the competition. Of these, twenty-five are eligible for participation in the competition, worked on and published outside the first habilitation as an associate professor or included in the dissertation. Their impact in the world scientific literature is confirmed by the following facts about the quartiles of the journals in which they were published. In journals with Q1: 2; in journals with Q2: 8; in journals with Q3: 7; in journals with Q4: 4.

The dissertation of Assoc. Prof. T. Petrova includes 5 papers (4, 6, 7, 10, 11 from the full list), and in the associate professorship - 16 papers (1-3,5, 8, 9, 12-21 from the full list). All these works will not be reviewed separately, but will be taken into account in the overall assessment of the candidate's scientific output.

The candidate has submitted a list of 169 citations on 37 works. The texts themselves have not been provided and it is not possible to assess the nature of the citations. The Hirsch index of citations is  $H=7$ .

The scientometric indicators of the scientific output fully meet the requirements of the Regulations of the Bulgarian Academy of Sciences on the conditions and procedure for acquiring scientific degrees and for occupying academic positions and the rules of the IIH-BAS.

**3. General characteristics of the candidate's scientific research activity**

The main part of the works of Assoc. Prof. Tatyana Petrova is in the field of fluid mechanics with applications in multiphase processes in packed columns. The main attention was focused on the modeling and study of the distribution of the gas and liquid phases along the cross-

section of apparatuses with a fixed layer of packed bodies. These questions have a very important practical significance for the uniformity of wetting of the filling bodies in the gas-liquid flows. The residence time of the fluid phases in the apparatus and the size of the contact surface between the phases depend on this uniformity, and hence their influence on the efficiency of the facility. Solving such hydrodynamic problems (with many phases and complex geometry) is not easy and requires in-depth knowledge of fluid mechanics and mathematical methods for solving them. The candidate successfully coped with the tasks. The contributions of the dissertation work and the participation in the competition for associate professor are built on this topic.

Another, newer topic is in the field of mechanical properties of composite and nano-composite materials and their behavior under the influence of external forces (mechanical shear stress, temperature, electric field). As a main effect, the separation of layers of the treated material is studied. Using genetic algorithms, the optimal values of several model parameters are obtained, while satisfying a criterion for a minimum or zero value of the delamination length at the interface of the structures. The obtained results have practical significance in determining the operating conditions of machine parts made of composites and nano-composites. The candidate's high mathematical qualifications and her knowledge in the field of mechanics allow her to successfully solve the assigned tasks.

A third group of studies is on the composition and optimization of resource-security chains (RSCs), for example in the dairy processing industry. It concerns the design of optimal RBMs under different scenarios (the production of one or several dairy products from one or more raw materials, using one or more technologies, with different numbers of suppliers, plants and markets), under different optimization criteria.

### **3. Assessment of the candidate's pedagogical activity**

Assoc. Prof. Petrova also has teaching activities as an associate professor at the European Polytechnic University, Pernik (since 2011). She has supervised one successfully defended doctoral student.

### **4. Main scientific and applied scientific contributions**

As can be seen from the early works and from the candidate, at the beginning of her scientific career she dealt with issues significant for the effective operation of packed columns, in particular determining and optimizing the distribution of fluid phases along the cross-section of the apparatus and along its length. On this topic are the candidate's dissertation and a large part of the works in the earlier period, before participation in the current competition. (works 1-17, 22-27, 29 from the general list). On the same topic are part of the works for the current competition. These are works 1-9, 14, 25 from the list for participation in the competition. The numbering is according to the list of papers submitted to the competition.

The following important contributions have been made in the publications on this topic.

1. The unevenness in the distribution of the gas phase in a column apparatus with Raschig rings (papers 1, 3) and horizontal sheet packing (paper 8) has been studied. With the help of mathematical modeling, the velocity profiles along the cross-section of the apparatus have been established. The results have been confirmed by the authors' experimental data.
2. The unevenness in the distribution of the liquid phase in a column apparatus with packing has been studied (papers 4-7, 9). With the help of mathematical modeling, the axial velocities along the cross-section of the apparatus have been calculated and the widths of the near-wall layers, where strong unevenness is observed (papers 4, 5, 7, 9), have been found. This

unevenness increases with increasing sizes of the packing bodies (paper 4). Using a three-dimensional model, the velocity profiles of the liquid in a device with a random filling were found, and from experimental data, through an optimization procedure, the model parameters were identified that take into account the exchange of liquid between the wall layer and the volume; the uniformity of the distribution over the cross section of the device and the coefficient of the radial distribution of the liquid (paper 6).

3. Using a numerical experiment, the rates of mass transfer and heat transfer in a catalytic grain during the oxidation of sulfur dioxide were determined, and the radial and axial distribution of concentrations and temperature in the grain were found (paper 2).

The topic of the mechanical properties of composite and nano-composite materials under external influence is the subject of papers 10-15. The main contributions in them are as follows.

1. Using a mathematical model, the axial shear rates and shear stresses in a two-layer composite material were calculated (11-15). The shear stresses in the material and the conditions for its delamination under various influences (mechanical shear, electric field, moisture, paper 13) were calculated.

2. The strength was calculated and the transition to elastic behavior of layered structures under dynamic loads (mechanical, electrical) with different pulse frequencies was determined. A change in the type of dependencies was established for certain complexes of dynamic parameters (papers 14, 15).

Figures 2-7 of paper 11 do not show the dimensions on the abscissa axes.

The results obtained in this series of works have important practical significance, mainly in determining the strength and reliability of gas turbine and fan blades.

In the third series of works, mathematical models are developed and applied for the compilation, optimization and management of resource-security chains on the example of dairy products (works 16-23).

The formulated optimization problems take into account various aspects of sustainability - environmental, economic and social, as well as combinations of them.

##### **5. What is the significance of the author's contributions to science and practice?**

From the above, it can be concluded that the main scientific contributions of the author are in the compilation of mathematical models and their use for processing experimental results from real processes in packed column apparatuses and on the mechanical strength of composite materials used in practice (turbine blades, etc.). The contributions of the presented scientific works are of a fundamental and scientific-applied nature.

##### **6. Can it be assessed to what extent the contributions represent the personal work of the dissertation candidate?**

I have known the candidate's work for a long time. I can say that in terms of her competence in the field of mechanics and mathematical modeling, she has a leading role in the publications with which she participated in the competition..

##### **7. Critical remarks on the candidate's works**

None.

**8. Conclusion**

The above allows me to recommend to the esteemed Scientific Jury to propose to the Scientific Council of IIH-BAS to elect Assoc. Prof. Dr. Tatyana Stefanova Petrova for the academic position of "professor" at the same institute.

Sofia, January 3, 2025 REVIEWER:

(Prof. Dr. Venko N. Beshkov)