REVIEW

On the competition for a professor in the professional field 4.2. Chemical Sciences (specialty "Processes and apparatus in chemical and biochemical technology"), for the needs of the laboratory "Innovative processes and systems engineering" at the Institute of Chemical Engineering, Bulgarian Academy of Sciences

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With candidate Elisaveta Georgieva Kirilova, doctor, associate professor

Reviewer: Kosta Petrov Boshnakov, doctor, professor (academic position held, currently retired)

1.Brief biographical data and description of the candidate's scientific interests

Assoc. Prof. Elisaveta Kirilova graduated from the University of Chemical Technology and Metallurgy, Sofia, in 2000 and obtained the educational and qualification degree of Master of Chemical Engineering. In the period 2007-2011, Assoc. Prof. Kirilova was a doctoral student at the Institute of Chemical Engineering (ICHE), Bulgarian Academy of Sciences. On June 14, 2011, she obtained the educational and scientific degree of "doctor" as a result of a defended dissertation on the topic "System-oriented approach for environmentally friendly control of multi-purpose chemical and biochemical production systems".

In the period 2001-2011 she was a research assistant, associate at the ICHE, BAS, and from 2011 to 2018 she was a chief assistant at the same institute. Assoc. Prof. Kirilova was habilitated in 2018 and held the academic position of "associate professor". The same year she held the position of head of the laboratory "Innovative Processes and Systems Engineering", and from 2022 to the present she has been the scientific secretary of the ICHE, BAS.

The scientific interests of Assoc. Prof. Elisaveta Kirilova are visible from the next point of the review.

2.General characteristics of the candidate's scientific-research and scientific-applied activities

The scientific-research work of Assoc. Prof. Elisaveta Kirilova is characterized by developments in the following scientific and applied scientific areas:

• Reducing the computational complexity of a two-stage stochastic optimization problem related to accounting for parameter uncertainties in a conventional autothermal thermophilic aerobic digestion (ATAD) system of sludge, making decisions based on a flexibility index, and increasing the energy efficiency and sustainability of the operating conditions of batch production systems.

• Development of an approach for designing a production portfolio of a sustainable resource-supply chain (SC), an optimization model and a multi-objective approach for strategic design of a SC for biodiesel/diesel production, a mixed-integer nonlinear (MINLP) model for optimal design of SC for the production of various dairy products, an optimization approach for

managing uncertainties in the demand for dairy products at SC for their production, mixed-integer linear programming (MILP), for optimal design of a sustainable combined SC for biodiesel production using dairy waste sludge as a raw material.

- Development of mathematical models of biochemical processes with artificial neural networks (ANN) and their application in chemical engineering

- Study of the influence of geometry and mechanical loading on delamination in graphene/polymer nanocomposite, development of an analytical method for modeling the behavior of graphene/polymethylmethacrylate (PMMA) nanocomposite under hygrothermomechanical loading, conducting a two-dimensional analysis of stresses and strains in graphene-polymer nanocomposite under axial loading, development of a model for describing deformations in layered nanocomposite structures in the elastic region of applied loads.

Conclusions about the scientific and applied activities of Assoc. Prof. Elisaveta Kirilova can be drawn from her professional biography

Assoc. Prof. Elisaveta Kirilova was the leader of the following projects: Modeling of bioreactors in municipal wastewater treatment systems using the process of autothermal thermophilic aerobic sludge degradation for the purpose of energy integration of the processes, National Scholarship for Young Female Researchers up to 35 years of age, funded by the UNESCO-L'Oréal "For Women in Science" program, 2011;

Sustainable resource supply chains in terms of environmental, economic and social criteria, 2019-2022. Contract No. KP06-N37/5 of 06.12.2019. Project under the competition for funding of "Fundamental scientific research - 2019" of the National Science Fund at the Ministry of Education and Science (NSF-MES); Resource supply chains for sustainable production and distribution of hydrogen from various raw materials, 2024-2027, Contract No. KP-06-89/6 of 09.12.2024, Project under the competition for funding of "Fundamental scientific research - 2024" of the NSF-MES.

In addition to the projects she has led, Assoc. Prof. E. Kirilova has also participated in 6 scientific projects funded by the Bulgarian NSF-MES, 3 projects funded under the inter-academic cooperation between the Bulgarian Academy of Sciences and the University of Veszprém, Hungary, in 1 project funded under the "Human Resources Development Operational Programme 2007-2013" of the European Union and 6 projects funded by DFG - Deutsche Forschungsgemeinschaft, Germany.

Assoc. Prof. E. Kirilova is a member of the following scientific organizations and research networks: Union of Chemists in Bulgaria, Bulgarian Society of Chemical Engineering, MPNS COST ACTION MP1305 "Flowing matter", Horizon 2020, European Commission, ICT COST ACTION TD1207 "Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks", Horizon 2020, European Commission and CA COST Action CA15118 "Mathematical and Computer Science Methods for Food Science and 4 Industry", Horizon 2020, European Commission

Assoc. Prof. E. Kirilova is the winner of the National Award "For Women in Science" for young female researchers under 35 years of "UNESCO-L'Oréal", 2011 and the "Marin Drinov" Award

for a young scientist of the Bulgarian Academy of Sciences - 2013 in the field of "Energy Resources and Energy Efficiency". Her scientific and organizational activity is manifested in participation in organizational and scientific committees of 7 national and international scientific forums.

3.Evaluation of the submitted materials

To participate in the competition, Assoc. Prof. Elisaveta Kirilova has submitted the following documents: application for participation in the competition, a European-style CV, a copy of the State Gazette with the announcement of the competition for the academic position "Professor" at the ICHE-BAS, a copy of the diploma for acquiring the educational and scientific degree "Doctor", an abstract of the dissertation for acquiring the educational and scientific degree "Doctor", copy of Certificate of holding the academic position of "Associate Professor", official note for internship in the specialty, list of publications for participation in the competition for "Professor", list of all publications, list of all citations (reference from Sonix), reference for fulfillment of the minimum national requirements under Art. 2b, para. 2 and 3 and of the requirements under Art. 2b, para. 5 of the ZRASPB for the competition, reference of contributions to publications, submitted for participation in the competition for the academic position of "Professor", evidence of participation/leadership of research projects, summaries of publications for participation in the competition in Bulgarian, summaries of publications for participation in the competition in English and full text of all publications and book chapters for participation in the competition.

In the documents for participation in the competition for the academic position of "professor" by Assoc. Prof. Elisaveta Kirilova, 25 scientific publications and 2 book chapters are presented in full text, which I accept for review. A list of all publications is presented, including: Publications outside the competition for associate professor (61 pcs.), book chapters outside the competition for associate professor (8 pcs.), publications included in the competition for associate professor (17 pcs.) and publications included in the dissertation work (7 pcs.)

The analysis of the scientific papers submitted for participation in the competition shows that 6 of them belong to the first quartile (Q1), 1 - to the second (Q2), 12 - to the third (Q3) and 6 - to the fourth (Q4). In the scientific papers in question, Assoc. Prof. E. Kirilova is the first author in 6 of them and is in first place in the presented book chapters, in the second she is an independent author. In 9 of the scientific papers she is the second author and in 10 she is the third and subsequent author. From the analysis made, it can be concluded that all publications submitted for participation in the competition are in prestigious publications and the candidate has made a significant contribution to the scientific research carried out.

The fulfillment by Assoc. Prof. Elisaveta Kirilova of the minimum requirements according to the national criteria (in the PPZRASRB) and the criteria of the Bulgarian Academy of Sciences (in the Regulations on the conditions and procedure for acquiring scientific degrees and for occupying academic positions in the Bulgarian Academy of Sciences) for occupying the academic position of "professor" in the professional field 4.2. Chemical Sciences is presented in Table 1

Table 1

Group of indicators	Content	Minimum required points	Points achieved by Assoc. Prof. Elisaveta Kirilova
A	1.Dissertation for the award of the educational and scientific degree "Doctor"`	**50**	**50**
V	4.Habilitation thesis - scientific publications in journals that are refereed and indexed in world-renowned databases of scientific information (Web of Science and Scopus)		6x25=**150** 1x20=**20**
	Points under indicator 4	**100**	**170**
G	7.Scientific publication in publications that are referenced and indexed in world-renowned databases of scientific information (Web of Science and Scopus), outside the habilitation thesis		12x15=**180** **6x12=72**
	8.Published book chapter or collective monograph		2x15=**30**
	Sum of indicators from 5-10	**220**	**282**
D	11. Citations in scientific publications, referenced and indexed in world-renowned databases of scientific information, or in monographs and collective volumes		209x2=**418**
	Total number of points for indicator D	**120**	**418**
E	14.Participation in a national scientific or educational project		2x10=**20**
	15.Participation in an international scientific or educational project		6x20=**120**
	16.Leadership of a national scientific or educational project		2x20=**40**
	18.Funds raised for projects led by the candidate		**23.7**
	Total number of points for indicator E	**150**	**203.7**
	Total points	**640**	**1123.7**

The fulfillment of the additional criteria of the ICHE-BAS by the candidate for the academic position of "associate professor" is presented in Table 2.

Table 2

No	Additional criteria of ICHE	Requirement (minimum)	Achieved by Assoc. Prof. Elisaveta Kirilova
1	Number of publications for participation in the competition, which should not repeat those submitted for acquiring the educational and scientific degree "doctor" and for occupying the academic position "associate professor"	20	25
2	Number of publications for participation in the competition in journals with ISI Impact Factor or SJR, which should not repeat those submitted for acquiring the educational and scientific degree "doctor" and for occupying the academic position "associate professor"	7	25
3	Total number of publications	40	85 and 8 book chapters
4	Number of publications in journals with ISI Impact Factor or SJR out of the total number of publications	12	61

5	The total number of citations noted on all works	50	594
6	Recommended Hirsch index	8	B Scopus H-index - 8 B Google Scholar H-index – 13 B National H-index ranking H-index - 12

4. Main scientific and applied scientific contributions

In the Reference on the Contributions to the Publications Submitted for the Competition for the Academic Position of "Professor", the scientific, applied scientific and applied contributions are presented in great detail. Only the most significant contributions will be included in the review.

In the group of indicators V, Habilitation work (V.4.) is presented – 7 scientific publications in journals that are referenced and indexed in world-renowned databases of scientific information (Web of Science and Scopus), 6 of which fall into quartile Q1 and 1 into quartile Q2. According to the list of publications for participation in the competition for the academic position of "Professor", these are articles [5,6,9,12,15,17,19]. Selected articles include developments related to an autothermal thermophilic aerobic degradation system [5,6], resource-security chains [9,12,15], and the behavior of graphene/polymer nanocomposite under load [17,19].

The Habilitation thesis contains the following more important scientific, scientific-applied and applied contributions:

1.A methodology is proposed to increase the energy efficiency and sustainability of operating conditions of batch production systems. The methodology is applied to a conventional municipal wastewater treatment system using the autothermal thermophilic aerobic digestion (ATAD) process of sludge.

2. Models of the wastewater treatment system based on ATAD have been developed. Batch bioreactors have been modeled with artificial neural networks (ANN). Models of thermal integration of flows in ATAD systems have been developed. An integration structure has been developed, uniting two alternative models for indirect energy integration – with one and with two thermal reservoirs.

3.An optimization problem is solved according to the optimality criterion of the annual capital costs for the reconstruction of the heat-integrated system and its operating costs, and artificial neural network (ANN) models combined with the heat integration model are used to simulate the operation of the bioreactor system.

4.A multi-objective approach is proposed for the optimal design of a sustainable integrated supply chain (SC) for biodiesel/diesel production using first and second generation feedstocks as well as solid waste. The model includes mixed-integer linear (MILP) models of the economic, environmental and social impacts of the supply chain.

5. A multi-objective approach has been developed for the optimal design of a three-echelon resource-supply chain for the production of dairy products according to different recipes, while satisfying environmental, economic and social criteria, defined as costs. Four

optimization models of the mixed-integer nonlinear programming (MINLP) type have been formulated – one without and three with the inclusion of social impact.

6.An optimal design approach based on mixed-integer linear programming (MILP) is proposed for a sustainable combined supply chain for biodiesel production using dairy sludge as feedstock. The model includes economic and environmental assessments of the combined supply chain, constraints, and an optimization criterion expressed in terms of capital and operating costs.

7.Using a 2D variational method, an analytical solution has been derived to describe the behavior of graphene/polymethyl methacrylate nanocomposite under combined hygrothermomechanical loading. It has been established that mechanical loading is the leading factor for the occurrence of delamination.

8. A two-dimensional stress function method has been developed and applied to describe the stress transfer in a three-layer adhesively bonded graphene/polymethylmethacrylate nanocomposite structure subjected to axial loading.

The attached publications outside the Habilitation Thesis contain the following more important scientific, scientific-applied and applied contributions:

9.An approach is proposed to reduce the computational complexity of a two-stage stochastic optimization problem related to the accounting of parameter uncertainties in a conventional ATAD system, which is based on determining the boundary values of the variables from the first stage and subsequent solving deterministic optimization problems for the various combinations of the boundary values of the uncertain parameters.

10.A decision-making approach is proposed, based on calculating a flexibility index of already obtained solutions from a stochastic multi-scenario optimization model for the reconstruction of a thermally integrated two-stage bioreactor system for autothermal thermophilic aerobic sludge digestion (ATAD) for domestic wastewater treatment, operating under conditions of uncertainty.

11.A deterministic optimization approach is proposed for designing a production portfolio of a sustainable supply chain (SC) including suppliers, manufacturing plants and markets for the production of dairy products according to different recipes. The optimization problems are formulated as MINLP (mixed-integer nonlinear programming).

12.A deterministic mixed-integer linear programming (MILP) model has been developed for the strategic design of a sustainable integrated supply chain (SC) for the production and distribution of biodiesel/diesel from first-generation (sunflower and rapeseed) and second-generation (waste vegetable oils and animal fats) bioresources.

13.A MILP approach has been developed for the optimal design of a sustainable combined SC for dairy and biodiesel production, using waste dairy sludge as the feedstock for biodiesel production. The model integrates economic and environmental assessment of the efficiency of the combined SC.

14.A robust optimization approach is proposed for managing uncertainties in the demand for dairy products in a resource supply chain for their production according to different recipes, while simultaneously satisfying environmental and economic criteria.

15.An extended version of a developed approach based on mixed-integer nonlinear programming (MINLP) is proposed for the optimal design of a sustainable resource supply chain for the production of various dairy products according to different recipes under uncertain demand and uncertain product prices. The model takes into account economic, environmental and social aspects.

16.A theoretical study was conducted on the influence of geometry (layer thickness and length) and the magnitude of the axially applied tensile load on delamination in a three-layer nanocomposite structure.

17.A 2D analytical method for stress and strain analysis in three-layer nanocomposites has been developed and validated.

18.The influence of the type of adhesive/glue on delamination in piezoelectric structures subjected to dynamic loading has been investigated.

19.An integrated multiparametric approach for optimization of nanocomposite structures is proposed, combining analytical modeling and genetic algorithms to determine areas of safe operation without delamination.

5. Reflection of the candidate's scientific publications in Bulgarian and foreign literature

One of the main indicators of the impact of scientific publications in Bulgarian and foreign literature is the number of citations and the editions in which the scientific publications citing them are printed. 209 citations made in 48 publications indexed in Web of Science or Scopus were submitted for participation in the competition. The total number of citations of scientific works with the participation of the candidate is 594.

The large number of citations is an indicator that the scientific publications of Assoc. Prof. E. Kirilova have gained popularity in international scientific circles and have a significant impact on the scientific literature.

6.Critical notes and recommendations

I believe that it would be much better if the articles forming the habilitation thesis were on a similar topic.

7.Reviewer's personal impressions of the candidate

I know Assoc. Prof. Elisaveta Kirilova from joint administrative commitments and participation in scientific forums. I have very good impressions of her work, honesty and professionalism.

CONCLUSION

Assoc. Prof. Elisaveta Kirilova participated in the competition with 25 scientific publications in publications that are referenced and indexed in world-renowned databases of scientific information (Web of Science and Scopus) and with two book chapters, one of which she is a co-author and the other an independent author. The books were published by Elsevier and Springer, respectively. A total of 594 citations were noted, 209 of which in scientific publications, referenced and indexed in world-renowned databases of scientific information, or in monographs and collective volumes.

The scientific papers submitted for participation in the competition contain a large number of scientific, scientific-applied and applied contributions.

Assoc. Prof. Elisaveta Kirilova has led 2 research projects and participated in 6 other projects funded by the Bulgarian NSF-MES, participated in 3 projects funded under the inter-academic cooperation, in 1 project funded under the "Operational Program for Human Resources Development 2007-2013" of the European Union and 6 international research projects funded by DFG - Deutsche Forschungsgemeinschaft, Germany.

Assoc. Prof. Elisaveta Georgieva Kirilova satisfies all the requirements of the ZRASRB, the Regulations for its implementation, the Regulations on the conditions and procedure for acquiring scientific degrees and holding academic positions at the Bulgarian Academy of Sciences, as well as the requirements for holding the academic position of "professor" at the ICHE-BAS.

My assessment of the candidate's overall performance is positive!

Everything stated in the review gives me reason to propose Associate Professor Dr. Eng. Elisaveta Georgieva Kirilova to occupy the academic position of "professor" in the professional field 4.2. Chemical Sciences (Processes and Apparatus in Chemical and Biochemical Technology) at the Institute of Chemical Engineering - Bulgarian Academy of Sciences.

Date: 17.08.2026.

REVIEWER:

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/Prof. Dr. Kosta Boshnakov/