



REVIEW

of materials submitted for participation in a competition for the academic position of “professor” in professional field 4.2. Chemical Sciences (Processes and Apparatus in Chemical and Biochemical Technology) for the “Innovative Processes and Systems Engineering” Laboratory at the Institute of Chemical Engineering (ICHE) of the Bulgarian Academy of Sciences (BAS),

announced in State Gazette No. 37 (April 21, 2026)

with candidate Assoc. Prof. Dr. Eng. Elisaveta Georgieva Kirilova

Reviewer: Prof. Dr. Daniela Boyanova Dzhonova-Atanasova

from the Institute of Chemical Engineering (ICHE) – BAS

1. Brief scientific biography of the candidate and area of scientific interests

Assoc. Prof. Dr. Elisaveta Kirilova received her master’s degree in 2000 from the University of Chemical Technology and Metallurgy, Sofia in specialty “Processes and Apparatus in Chemical and Biochemical Technology.” In 2011, she defended her dissertation at the Institute of Chemical Engineering—Bulgarian Academy of Sciences (ICHE-BAS) in professional field 4.2. Chemical Sciences, in specialty “Processes and Apparatus in Chemical and Biochemical Technology,” on the topic “A System-Oriented Approach to Environmentally Sound Management of Multipurpose Chemical and/or Biochemical Production Systems,” and was awarded the academic and scientific degree of “doctor.” Since 2001, she has worked at the Institute of Chemical Engineering of the Bulgarian Academy of Sciences, successively holding the positions of research associate, senior assistant professor, and associate professor (since 2018). Since 2018, she has been the head of the “Innovative Processes and Systems Engineering” laboratory at the Institute of Chemical Engineering–BAS, and since 2022, she has served as the scientific secretary of the Institute of Chemical Engineering–BAS. She is fluent in English, German, and Russian.

General Description of Research and Applied Research Activities

The candidate's scientific and applied research focuses on rapidly developing areas in chemical engineering that are significant for the energy efficiency of industrial wastewater treatment, the food industry, biofuel production, and the development of nanocomposite materials for the energy sector. For the purposes of her research, she develops mathematical models and approaches and employs state-of-the-art computational methods that meet the highest standards of research tools in the field.

The candidate has published the results of her research in a total of 96 publications in prestigious international publishers, including 8 book chapters. The candidate's publications are widely cited in global databases, with a total of over 590 citations.

The candidate has participated in numerous scientific projects, including international ones, and has served as principal investigator on two national projects.

2. Overall Assessment of the Submitted Materials

The materials submitted for the competition include a comprehensive list of 96 publications. Of these, 27 publications are submitted for this competition, including a habilitation material consisting of 7 articles in journals in the top quartiles (6 in Q1 and 1 in Q2), another 18 articles in journals in the Q3 (12) and Q4 (6) quartiles, and 2 book chapters. The remaining publications from the general list are outside the scope of this competition and are related to the doctoral dissertation and the competition for the position of associate professor; they contribute toward meeting the requirement for the total number of articles as specified in the IChE regulations.

Compliance with the minimum requirements, in accordance with national criteria (in the Regulations for the Implementation of the Law on Scientific Research and Development in the Republic of Bulgaria) and the criteria of the Bulgarian Academy of Sciences and the IChE (in the Regulations on the Conditions and Procedures for Awarding Academic Degrees and Holding Academic Positions at the Bulgarian Academy of Sciences):

Indicator A—Dissertation—50 points (out of a minimum of 50 points)

Indicator B—Habilitation Thesis—170 points (minimum 100 points)

Indicator Г—Scientific Publications (Web of Science and Scopus), excluding the habilitation thesis—282 points (minimum 220 points)

Criterion Д – Citations (Web of Science and Scopus) – 418 points (minimum 120 points)

Criterion Е – Participation in, leadership of, and funding secured for scientific or educational projects – 203.7 points (minimum 150 points)

Total – 1,123.7 points (minimum 640 points)

Compliance with the additional requirements of the Institute of Chemical Engineering at the Bulgarian Academy of Sciences, in accordance with the Guidelines for the Career Advancement of Researchers at the Institute of Chemical Engineering – BAS:

1. Educational and scientific degree of “Doctor” - Yes
2. Experience required for the academic position of “Senior Assistant Professor”—8 years
3. Number of publications required for participation in the competition, which must not duplicate those submitted for the award of the academic and scientific degree of “Doctor” and for appointment to the academic position of “Associate Professor”—25 (minimum 20)
4. Number of publications for participation in the competition in journals with an ISI Impact Factor or SJR, which must not duplicate those submitted for the award of the educational and scientific degree of “Doctor” and for the academic position of “Associate Professor” - 25 (minimum 7)
5. Total number of publications—88 and 8 book chapters (minimum 40)
6. Number of publications in journals with an ISI Impact Factor or SJR out of the total number of publications—61 (minimum 12)
7. Total number of citations across all works—594 (minimum 50)
8. Recommended Hirsch index—8 (minimum 8)

Of the 27 publications submitted for the competition, the candidate has 25 articles in journals with quartiles, which is considered one of the criteria for publication quality. The distribution by quartile is as follows: 6 articles in the highest category, Q1 (24%), 1 in Q2 (4%), 12 in Q3 (48%), and 6 in Q4 (24%). The significant proportion of articles in the Q1 and Q2 quartiles makes a favorable impression, indicating the high quality of these publications due to the stringent requirements of the journals and their reviewers. I highly value the presence of 6 articles in Q1 and 1 in Q2, which accounts for more than one-quarter of the publications in quartiles. Two book chapters are included, which are not indexed in global databases but were published by prestigious international publishers (Springer and Elsevier).

As a general characteristic of the candidate's publication activity, it can be said that the candidate has publications in the three key categories: journal articles, book chapters, and conference proceedings. Articles in prestigious international journals indexed in global databases predominate.

Assoc. Prof. Kirilova assumed the academic position of "associate professor" 8 years ago and has since authored 27 publications, which amounts to no fewer than 3 publications per year, with particularly notable activity in 2022, when she published 9 papers. In quantitative terms, I consider this output to be significant.

The order of the co-authors in the presented publications demonstrates that the candidate possesses both independence (one chapter authored alone and first place on the list of co-authors in seven publications (1); (6); (7); (11); (12); (13); Chapter 1)), as well as the ability to provide skilled leadership and work effectively in a team when presenting her research.

The candidate is the principal investigator of two national research projects, the head of a laboratory, and the scientific secretary of the Institute of History, which complements the overall picture of her work, which can be characterized by a combination of scientific research and organizational activities.

3. Major Scientific and Applied Scientific Contributions

I acknowledge all the scientific, applied scientific, and applied contributions listed in the candidate's summary; the most significant of these, organized by research area, are as follows:

I. Improving the sustainability and energy efficiency of production systems with periodic processes, using the example of conventional industrial domestic wastewater treatment systems that employ the Autothermal Thermophilic Aerobic Digestion (ATAD) process for sludge treatment.

SCIENTIFIC CONTRIBUTIONS

1. Development of a stochastic optimization approach for the redesign of thermally integrated ATAD systems operating under conditions of uncertainty regarding the parameters of the input and output flows. The approach combines two thermal integration models—one with a single heat storage tank and one with two—into a common superstructure, where the heat is used to preheat the incoming raw sludge. (Publication No. 5, Chapter from Book No. 1, Project No. DN-07/14/15.12.2016).

2. Development of an approach to reduce the computational complexity of a two-stage stochastic optimization problem, applied to limit the impact of uncertain parameters on a conventional ATAD system. The resulting solutions determine the equipment parameters at minimum capital costs, based on which the lower and upper bounds of the variables from the first stage are established. (Publication No. 2, Project No. DN-07/14/15.12.2016).

3. Development of a method for evaluating the flexibility index during the retrofitting of thermally integrated ATAD systems operating under conditions of uncertainty. The method was applied to the redesign of a thermally integrated ATAD system under conditions of uncertainty through an optimization problem aimed at maximizing the flexibility index for each solution of the two-stage stochastic problem.

APPLIED SCIENTIFIC CONTRIBUTIONS

1 Development of artificial neural network (ANN) models for a two-stage bioreactor ATAD system. The developed models using static artificial neural networks (ANNs) predict the volume of volatile components in the sludge, the expected thermal shock, and the maximum operating temperatures in the bioreactors at the end of the process, enabling their use in frameworks for

energy integration and optimization. (Publication No. 1, Book Chapter No. 2, Project No. DN-07/14/15.12.2016).

2. Development of thermal integration models for ATAD systems that describe the capture, storage, and utilization of low-potential waste heat from the outgoing hot sludge for preheating the incoming raw sludge. (Publication No. 5, Project No. DN-07/14/15.12.2016).

3. Conducting simulations of the operation of the thermally integrated ATAD system using ANN, which demonstrate the applicability of the methodology as an effective tool for engineering decision-making in the design and modernization of wastewater treatment plants. (Publications No. 3 and No. 6, Project No. DN-07/14/15.12.2016).

II. Optimal design of sustainable resource supply chains for the production and distribution of biofuels using various bioresources

SCIENTIFIC CONTRIBUTIONS

1. Development of an integrated multi-criteria approach for the optimal design of a sustainable resource supply chain (RSC) at the strategic level for the production and distribution of biodiesel/diesel using first- and second-generation bio-resources. The economic criterion used is the minimum total annual costs, including investment, production, and logistics costs. The environmental criterion is the minimization of total greenhouse gas emissions (GHG), and the social criterion is the maximization of the number of newly created jobs related to the design and operation of the RSC. (Publications No. 8 and No. 9, Project No. KP-06-N37/5/06.12.2019).

2. Development of a deterministic approach for the optimal design of a sustainable integrated bio-refinery at the strategic level for the production and distribution of dairy products and biodiesel, using dairy waste slurry as the feedstock for biodiesel production. The model integrates the material and financial flows of the two interconnected integrated production and distribution systems into a single optimization framework. (Publications No. 10 and No. 15, Project No. KP-06-N37/5/06.12.2019).

APPLIED SCIENTIFIC CONTRIBUTIONS

1. Implementation of an approach for the optimal design of biorefineries for the production and distribution of biodiesel/diesel on a national scale in Bulgaria. Optimal solutions were obtained for the number, location, and capacity of biorefineries and waste processing facilities; the allocation of agricultural land between sunflower and rapeseed; as well as for the logistics and transportation schemes for the delivery of raw materials and the distribution of fuels. (Publication No. 9, Project No. KP-06-N37/5/06.12.2019).

2. Implementation of an approach for the optimal design of a biofuel production and distribution network for biodiesel/diesel production and distribution, using environmental and economic criteria under two scenarios: one with 27 blending centers and one with a single blending center covering the entire territory of Bulgaria. Four optimization problems were formulated and solved for two scenarios—Scenario 1 with 27 blending centers and Scenario 2 with a single blending center—based on economic and environmental criteria (Publication No. 14, Project No. KP-06-N37/5/06.12.2019).

3. Implementation of an approach for the optimal design of an integrated circular economy system for the production and distribution of dairy products and biodiesel on a national scale in Bulgaria, using data on dairy farms, dairy processing plants, and biorefineries. The results demonstrate the applicability of the methodology as an effective tool for supporting strategic decisions in integrated sustainable supply chains. (Publications No. 10 and No. 15, Project No. KP-06-N37/5/06.12.2019).

III. Optimal Design of Sustainable Resource Supply Chains for the Production and Distribution of Dairy Products

SCIENTIFIC CONTRIBUTIONS

1. Development of a deterministic approach for the optimal design of resource supply chains at the tactical level for the production and distribution of dairy products manufactured using different technologies (recipes). The models are integrated into a common optimization framework with economic, environmental, and social criteria combined into a single objective function, formulated in monetary terms to achieve an optimal trade-off between the three aspects of sustainability. The

models were implemented in the GAMS environment and solved using the BARON solver. (Publications No. 7, No. 11, and No. 12, Project No. KP-06-N37/5/06.12.2019).

2. Development of a stochastic optimization approach for the optimal design of resource-supply chains at the tactical level for the production and distribution of dairy products manufactured using different technologies (recipes) with c (Publications No. 13, No. 21, No. 22, No. 23, and No. 24, Project No. KP-06-N37/5/06.12.2019).

APPLIED SCIENTIFIC CONTRIBUTIONS

1. Implementation of the deterministic approach for the optimal design of supply chains for the production and distribution of dairy products manufactured using different technologies (recipes) in a real-world case study from Bulgaria. It was found that the inclusion of social and environmental criteria has a significant impact on the choice of production recipes, the product portfolio, and economic outcomes. The resulting solutions provide an effective tool to support management decisions in achieving a balance between economic efficiency, environmental sustainability, and social responsibility. (Publications No. 7, No. 11, and No. 12, Project No. KP-06-N37/5/06.12.2019).

2. Implementation of the stochastic approach for the optimal design of resource supply chains for the production and distribution of dairy products manufactured using different technologies (recipes) based on a real-world case study from Bulgaria. The models cover various combinations of uncertain factors—product demand, raw material and product prices, environmental and social costs—while simultaneously satisfying economic, environmental, and social criteria. The incorporation of uncertainty through scenario-based and interval models leads to stable and practically applicable solutions, while allowing decision-makers to balance the various objectives according to the specific strategy of the supply chain. (Publications No. 13, No. 21, No. 22, No. 23, and No. 24; Project No. KP-06-N37/5/06.12.2019).

IV. Mechanical Behavior and Delamination of Layered Nanocomposites—Analytical Methods and Optimization

SCIENTIFIC CONTRIBUTIONS

1. Development of a 2D analytical method for analyzing stresses and strains in three-layer nanocomposites (graphene/SU-8/PMMA, hBN/interface/PMMA, WS₂/SU-8/PMMA). Based on the solution obtained for the nanolayer, the stresses and strains (axial, normal, and shear) were also derived for the remaining layers in the nanocomposite structure (Publications No. 16, No. 19, No. 20, and No. 25, Project No. KP-06-N57/3/15.11.2021).
2. An analytical model criterion for delamination in nanocomposites under static loading. The criterion has been applied to predict the debond length under various mechanical loads and geometries, with the results showing good agreement with experimental data from the literature. (Publications No. 16, No. 17, No. 19, and No. 25, Project No. BE 1090/48-1, Project No. KP-06 N57/3/15.11.2021).
3. Analytical modeling of the hygrothermomechanical behavior of a graphene/PMMA nanocomposite. It has been established that mechanical loading is the leading factor in the onset of delamination (critical value 350 MPa), while temperature and humidity have a weaker but measurable influence. (Publication No. 17, Project No. BE 1090/48-1, Project No. KP-06 N57/3/15.11.2021).
4. Investigation of the effect of the type of adhesive on delamination in piezoelectric structures subjected to dynamic loading, using an analytical method to examine the influence of three different types of adhesives on the interfacial shear stress and debond length in a BaTiO₃/ epoxy structures under quasi-static harmonic mechanical loading and an electric field. Analytical equations for resonance frequencies were derived for both types of solutions and for the three adhesives studied. (Publication No. 18, Project No. KP-06 N57/3/15.11.2021).

APPLIED SCIENTIFIC CONTRIBUTIONS

1. Analytical modeling of interfacial shear stress and strains in nanocomposites with WS₂ and hBN. The method has been extended and validated for deformations in a three-layer nanocomposite containing new classes of 2D nanomaterials—tungsten disulfide (WS₂) and hexagonal boron nitride (hBN)—in a polymer matrix. The obtained solutions for axial strain show good agreement with experimental Raman spectroscopy data in the elastic loading range. (Publications No. 20 and No. 25, Project No. KP-06 N57/3/15.11.2021).

2. Determination of safe load ranges and geometries for nanocomposite structures. The results obtained provide a basis for the development and improvement of nanocomposite devices for applications in sensor technology, nano- and optoelectronics, and energy systems, where interfacial integrity is a key factor for operational reliability. (Publications No. 16, No. 17, and No. 25; Project No. BE 1090/48-1; Project No. KP-06 N57/3/15.11.2021)

3. Multivariate optimization of the geometry and loading of an hBN/PMMA nanocomposite using a genetic algorithm. Quantitative relationships between loading, geometry, and interfacial shear stresses were established; the applicability of genetic algorithms for multiparameter optimization was validated; and practical recommendations for the design of reliable nanocomposite devices were obtained. (Publication No. 25, Project No. KP-06 N57/3/15.11.2021).

4. Validation of the analytical method using experimental data from Raman spectroscopy. An average relative error of less than 10–20% was established in the elastic range, confirming the validity and applicability of the method. (Publications No. 19 and No. 20, Project No. KP-06 N57/3/15.11.2021).

There is no doubt that the contributions are the candidate's own work, achieved in equal collaboration with the co-authors.

The research topics are significant and hold promise for continued research in these areas as part of the candidate's upcoming work on the competition's subject matter over the next 5 years.

4. Impact of Scientific Publications in Bulgarian and International Literature

The citation of publications, as reflected in global databases, is an important criterion for assessing their quality, usefulness, and adoption by the scientific community. The citation count of the candidate's publications in global databases is impressive, reaching over 590 citations for the entire publication period (25 years) and 209 citations for the publications submitted for the competition, which far exceeds the requirements for this indicator. The candidate has the recommended Hirsch index of 8.

4. Critical Comments and Recommendations

I have no critical comments.

5. Personal Impressions of the Candidate

I have known Assoc. Prof. Kirilova since she joined the IChE. My impression of her is that she is a true professional, a responsive colleague, and a person of integrity. She possesses focus and perseverance as a researcher and scholar, as well as the ability to address current and important issues in her field of research.

CONCLUSION

Overall, Assoc. Prof. Kirilova's research is characterized by basic scientific, applied scientific, and practical contributions. They address issues of importance to science and society, which makes them significant and relevant. The criteria for optimizing production encompass economic criteria—such as total annual costs, including investment, production, and logistics costs—as well as environmental criteria, such as total greenhouse gas emissions, and social criteria, such as the number of newly created jobs. As a result, valuable new knowledge has been gained regarding the efficient production of biofuels, wastewater treatment, the food and beverage industry, and the energy sector. The candidate's work is focused and yields significant, beneficial results.

All quantitative indicators for evaluating the candidate's research and academic work meet, and in some cases significantly exceed, the requirements for the academic position of "professor."

Based on my review of the scientific works submitted, their significance, and the basic scientific, applied scientific contributions they contain, I find it justified to propose that Assoc. Prof. Elisaveta Kirilova be appointed to the academic position of "professor" in professional field 4.2. Chemical Sciences (Processes and Apparatus in Chemical and Biochemical Technology).

August 31, 2026

Reviewer:



/Prof. Dr. Daniela Dzhonova-Atanasova/