REPORT

on the defense of the dissertation: "Evaluation of mixed installations with alternative energy sources"

for obtaining: the scientific degree (SD) "Doctor of Science"

in specialty: "Processes and apparatus in chemical and biochemical technology", professional field (PF) "4.2. Chemical Sciences

with candidate: Alexander Georgiev Georgiev, PhD, Professor, from the Institute of Chemical Engineering at the Bulgarian Academy of Sciences (IChE-BAS)

Prepared by: Tatyana Stefanova Petrova, Doctor, Associate Professor, from IChE-BAS

1. Brief biographical data and characteristics of the scientific interests and scientific activity of the candidate for the degree "doctor of science".

The candidate, Prof. Dr. Alexander Georgiev, was born on March 22, 1958 in Tolbuhin (Dobrich). He graduated in 1981 from the Faculty of Energy and Mechanical Engineering, Technical University, Sofia (FEME, TU-Sofia), speciality "Heat and Nuclear Energy" as a mechanical engineer. Shortly afterwards he became a full-time PhD student at the FEME, TU-Sofia, in speciality "Energy Conversion Technologies and Systems", code 02.06.07, and acquired scientific degree "Doctor" / Candidate of Technical Sciences in 1988, with a dissertation on " Study of combined energy conversion systems heat pump-solar collectors-heating systems". Since the end of 1988 he began his teaching and research career at the Technical University of Plovdiv, Department of Mechanics, as a senior assistant, and since 2000, as an associate professor. In 2011-2013 he was an associate professor and then a professor of PF 5.4. Energy, at the European Polytechnic University - Pernik, as well as head of the Department of Green Energy. In 2021 the candidate appeared in a competition for the academic position "Professor" at IChE-BAS, and from October 2021 he is already a professor at the Laboratory "Tranfer Processes in Multiphase Media" at IChE. Prof. Georgiev's research interests can be summarized in the following key terms: energy conversion systems and installations; renewable alternative energy sources; solar heat exchange systems; shallow geothermal energy.

2. Relevance of the problem developed in the dissertation.

The topic of the dissertation is definitely relevant and significant, and in line with the strategic goals and policies of energy in the country, as well as European directives. The developed dissertation study (DS) covers experimental and model research on a wide range of mixed modern installations, using solar collectors, as well as various heat accumulators and devices - heat pumps, micro-cogenerators, photovoltaic modules, Stirling engine. The importance of DS is focused mainly on practical contributions, and the completeness of his research is based on the successful use and combination of experimental and model approaches and simulations in solving the tasks set in DS.

3. Review of the dissertation and analysis of the results.

The presented DS has a volume of 345 pages, contains 8 chapters and includes 200 figures and 29 tables. It was written in accordance with the criteria for drawing up such type of works. Its bibliography contains 229 sources, of which only 1 is before the 70s of the last century, 5 are in the period 1970-1980, 34 - in the period 1980-1990, and 25 - in the period 1990-2000. All the others are after 2000, which speaks of a very

complete and detailed approach to the collection, presentation and summarization of useful information and data on the topic of DS in Chapter 1 (Literary Review). The conclusions from Chapter 1 are clearly formulated and show both the possibilities for combining different units and components for production, conversion and production of energy (electric and thermal) under different conditions and regimes, from several types of alternative energy sources (AES) – (solar, geothermal, etc.) and the disadvantages of each. The goals and tasks of DS follow naturally from the Conclusions to Chapter 1 - research and evaluation of different types of mixed systems based on AES, as well as their main components. The formulated tasks are 9, as presented by the author in DS. Research (experimental and model) on mixed systems and their components are presented in Chapters 3 and 4. Tasks 1, 2, 3, 5 and 7 include both experimental and model/simulation research, tasks 4 and 8 are related to the creation of methodologies and sample calculations and simulations, task 9 - with the construction of a pilot system and experiments. The conclusions from the DS and the author's contributions are in Chapters 5 and 6, respectively, Chapter 7 provides a list of publications related to the DS, and Chapter 8 is set aside for the bibliography. The conclusions of the DS outline two mixed systems as the most promising - using materials that convert their phase state and ground-based heat pumps, given their wide application, energy production at a level higher than initial, and their long-term use and low capital expenditures. The combination of these two systems is extremely successful.

4. Main scientific and scientific-applied contributions.

I agree and appreciate all the Contributions, as formulated by the author in DS, giving high estimation to the experiments conducted for the study of mixed systems, and the methods used for simulation and modeling of the same.

5. Description and evaluation of the submitted materials.

The applicant has submitted for the present procedure the full set of required documents and evidence certifying: (a) meeting the minimum requirements of the Rules and the procedure for acquiring scientific degrees and holding academic positions at BAS/2019, and (b) - meeting the additional requirements of IChE-BAS, according to the Methodology for growth of scientists in IChE-BAS, Appendix 1, for acquiring SD "Doctor of Science".

In addition to the DS and the Abstract (in Bulgarian and English), Prof. Georgiev presented a CV, a copy of his diploma for the previous SD "Doctor", a list of publications (36 in total) related to the DS, as well as Information on implementation of the minimum requirements of the Rules and the procedure for acquiring scientific degrees and holding academic positions at BAS / 2019, and the Additional Requirements of IChE-BAS. A detailed list of citations from the above scientific publications is also included in the Information.

I checked the sources indicated by the candidate for each of the indicators in item a) and item b), and I accept with slight corrections the points calculated by the candidate. According to the two tables below, the presented assets fully meet and significantly exceed the minimum number of points for meeting the minimum and additional requirements (especially in indicator D and E, required by PF 4.2) for the acquisition of the SD "Doctor of Science", namely:

Table 1. Implementation of minimum requirements of the Rules and the procedure for acquiring scientific degrees and holding academic positions at BAS / 2019 for SD "Doctor of science"

	A.	B.	C.	D.	E.	F.
Completed	**50 p.**	**100 p.**	N/A	**246 p.**	**258 p.**	N/A
Required	min 50p.	min 100p.	N/A	min 100p.	min 100p.	N/A

Table 2. Implementation of additional requirements of IChE-BAS for SD "Doctor of science"

	T.1 **Total papers ≥25, from which at least 15 in journals with IF/SJR or in full text with editor and publisher from conferences abroad**	**T.2** **Citations≥50**
Completed	**36 (14 with IF/SJR +8 with editor from conferences abroad)**	**236**
Required	25 (15)	50

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

As can be seen from Tables 1 and 2, sections E and T.2 above, the impact of the publications included in the DS significantly exceeds the required minimum values.

7. Critical remarks and recommendations to the scientific works of the candidate.

The layout of the Goals and Tasks of the DS, as well as the Conclusions, Contributions and Bibliography as separate chapters may make it easier to read, but I do not consider it is appropriate. Usually, the Goals and Tasks follow from the Conclusions of the Literary Review, as well as the Contributions from the Conclusions at the end.

Eight (8) of the 36 submitted papers, included to the DS, namely – No.No.1,2,4,5,6,7,8 and 16 were used in the competition for associate professor of A. Georgiev in 2000. Of these 8, only 1 has an IF – No. 4, which is why it is not counted in both tables.

From the citations I have not counted 8 pcs. - those who are in the dissertation for SD "Doctor" of E. Toshkov, PhD student of the candidate, as required by the Rules and the procedure for acquiring scientific degrees and holding academic positions at BAS / 2019 for SD "Doctor of science". There are also a few quotes that are dated 1 year before the publication of the full bibliography of the cited article, I guess it is due to online access and the long period from submission to the release of the final pages.

The above remarks and corrections are only recommended and clarifying and do not change my final positive opinion about the presented materials - the dissertation and the additional asset of Prof. Georgiev.

8. Personal impressions of the reviewer about the candidate.

I know Prof. Georgiev briefly from joint participation in conferences, as well as from the time when we were colleagues in the EPU. From October 2021 he is my colleague in IChE.

CONCLUSION

Based on the above, I believe that the all documents and DS, presented by candidate for the procedure for acquiring the SD "Doctor of Science" in the specialty: "Processes and apparatus in chemical and biochemical technology", PF "4.2. Chemical Sciences "at IChE-BAS, Prof. Dr. Alexander Georgiev Georgiev, satisfies and fully meets the minimum requirements under the Rules and the procedure for acquiring scientific degrees and holding academic positions at BAS / 2019, as well as additional requirements of IChE-BAS for the acquisition of the SD "Doctor of Science". Based on my opinion about the dissertation, abstract, scientific papers, their significance and the contributions contained in them presented by Prof. Georgiev:

I propose to the Distinguished members of the Scientific Jury and to the National Assembly of Institute of Electrochemistry and Energy systems – BAS, to vote positively on the following proposal for decision: " To give the scientific degree "Doctor of Science" in Professional field 4.2. Chemical Sciences, specialty "Processes and Apparatus in Chemical and Biochemical Technology", to Prof. Dr. Aleksandar Georgiev Georgiev".

Date

Prepared the report:

09.02.2022

/Assoc. Prof. Dr. Tatyana Petrova, IChE-BAS/