REVIEW

on the thesis for the scientific degree "Doctor of Sciences" at the Institute of Chemical Engineering, Bulgarian Academy of Sciences

Author: Prof. Eng. Alexander Georgiev Georgiev, PhD

Title: Evaluation of Mixed Installations with Alternative Energy Sources

Scientific domain 4. Natural sciences, mathematics and informatics

Scientific direction 4.2. Chemical sciences

Reviewer: Prof. Venko N. Beschkov, DSc.

1. GENERAL INFORMATION ABOUT THE CANDIDATE

Prof. Eng. Alexander Georgiev Georgiev, PhD was born on March 22, 1958. He graduated in "Heat and Nuclear Energy" from VMEI (now TU) in 1981. He defended his doctorate at the Faculty of Energy and Mechanical Engineering of the same university in 1988. He worked successively at the Institute of Meat Industry (Sofia, as a research associate); as a senior assistant in the Department of Mechanics at the Technical University (branch-Plovdiv), chief assistant in the same department and associate professor since 2000 in the same department. In the period 2011/13 he was an associate professor and professor at the European Polytechnic University in Pernik, where he is also head of the Department of Green Energy. He was elected as Professor in Institute of Chemical Engineering, Bulgarian Academy of Sciences (in 2021). He has been a guest researcher at the University of Siegen (Germany), the Technical University of Valparaiso (Chile) and as short-term specializations in Udine (Italy), Valencia (Spain), Hanover (Germany), Göttingen (Germany). He has participated in eight projects as a leader (one international, with Kazakhstan) and in nine international projects as a participant, including five under the EU COST program.

As a teacher he has the following teaching activities:

• Lectures and guided exercises on "Energy-transforming technologies and systems", heat engineering, energy and energy efficiency, thermodynamics and heat transfer, hydro and pneumatic propulsion.

• Management of defended doctoral students - 2 people.

• He has lectured as a state lecturer in Kazakhstan (Al-Farabi University, Almaty, 2014/16) and in China (Chinese University of Science and Technology, Hefei, 2018/19).

• He has published three textbooks on heat engineering (one in English) and 3 manuals on thermodynamics and heat transfer.

The candidate is the author (in co-authorship) of 116 scientific papers, of which 61 are in journal with impact-factor, thirteen – in SJR journals and 26 full text presentation on international scientific fora. There are 542 citations noted on them.

2. EVALUATION OF THE SCIENTIFIC PAPERS THE THESIS IS BASED ON

The DSc thesis is based on 36 scientific papers, with fifteen of them published in IF journals as follows:

Brennstoffe, Waerme, Kraft (IF 0.62); Renewable Energy (IF 0,607, 0.85, 6.274)-4; Energy Conversion & Management (IF 1.244); Applied Thermal Engineering (IF 3.043); Bulgarian Chemical Communications (IF 0.238) – 8.

The rest ones are published in other international and Bulgarian journals (8) and in full text in proceedings on scientific fora (13). The thesis comprises the most interesting results of scientific value presented in the scientific papers.

There are 244 citations on the publications included in the thesis presented according to the Additional Requirements of IChe-BAS. There is a list of 148 citations on the papers included in the thesis and published in IF journals. It is not clear, however, why paper D11 is included in this list being a presentation on scientific conference and not published in an IF issue.

The scientific-metric indicators of the candidate cover both the requirements of ZRAB and BAS and the specific requirements of the Institute of Engineering Chemistry at BAS for the scientific degree "Doctor of Sciences".

3. MAIN SCIENTIFIC AND APPLIED CONTRIBUTIONS OF THE CANDIDATE

1.Relevance of the developed research

The development of new environmentally friendly and renewable energy sources and processes is a top priority in economic policy and research and applied activities in developed countries. The topic of the peer-reviewed dissertation fully corresponds to this priority. It examines new opportunities for combining renewable sources (mainly solar energy) with known technical solutions for capturing, storing and utilizing heat energy (heat pumps, phase transfer heat carriers). Eight such combinations with practical value of the obtained results are considered and characterized in detail. Therefore, the topic developed in the dissertation is highly relevant, both from a theoretical and applied point of view.

2. Does the candidate know the state of the problem and creatively evaluate the literature?

The applicant has been working in the field of heat engineering and processes in energy technologies for over 35 years. The review of his publications for this period shows the development and consistency in the set goals, the used methodology and equipment. The overall impression of the presented text is that the dissertation master excellent literary material, experimental research methods and convincingly derive working hypotheses about the observed phenomena.

3. Can the chosen methodology give an answer to the set goal and tasks of the dissertation?

The dissertation combines mathematical modeling with modern experimental methods and techniques with which to prove the operability of the equipment and offer practical solutions for their application. The main parameters determined in the experiments are the temperature profiles in time in the tank, as well as the inlet and outlet of the thermal devices. The presented results show that the author is well versed in the methods used and receives reliable and practically significant results.

4.What are the scientific and scientific-applied contributions of the dissertation?

The topics discussed in the dissertation are distributed between several technical solutions for the utilization of solar energy by different methods. Some of them have been tested abroad (Chile, Turkey) and at the same time in Bulgaria on real sites.

Vacuum solar collector connected to a flat absorber and heat pipe. With the help of a mathematical model and experimental studies of a pilot installation, the limits of the temperature differences in which the CP D is highest are determined, and constructive solutions for this purpose are offered.

Heat accumulators. They consider the storage of heat energy from sunlight with different devices: with stratified layers, heat exchanger with coil, underground storage, heat carriers with phase change. The research contains mathematical modeling and experiments in conditions close to the real ones.

Solar collectors combined with heat accumulators. Along with them, refrigeration installations operating on this principle were also considered. In all cases, experimental temperature measurements were performed to support the results of mathematical modeling.

Photovoltaic and thermal installations. In this case, the generated electromotive force from the solar energy is used to supply the thermal installation with energy, as well as to utilize the thermal energy released during the operation of photovoltaics.

Ground-based heat pumps, combined with a solar collector and with the ability to utilize the energy of phase transition. The work on these systems is the subject of

mathematical modeling. The approach used, as well as the results obtained, provide opportunities for assessing the operability and determining the mode of operation of the installations.

In most cases, it is shown experimentally that the installations are well protected from fluctuations in ambient temperature (soil).

I classify the contributions of the dissertation as scientific (research of phase transfer heat carrier, mathematical models for solving differential equations under complex geometric and physicochemical conditions) and scientific-applied (creation of different constructions of heating and cooling installations combined with the use of solar energy and their experimental study).

I define the contributions of the dissertation as "proving with new means of significant aspects of already existing scientific problems" and "creation of new constructions and technologies".

5. Is the abstract made according to the requirements, does it correctly reflect the main provisions and the main contributions of the dissertation?

The abstract correctly reflects the content of the dissertation.

IV. CRITICAL NOTES AND RECOMMENDATIONS

The dissertation is well organized and easy to read. I would note that in some places the description of the experimental methods and conditions is set out in detail, even unnecessarily in detail (pp. 154, 158, 165-167, 187-193).

The concept of "enthalpy porosity" is introduced when solving the differential equations for heat transfer using a material with a change in phase state. I understand it as a replacement of the heterogeneous system that occurs when a new phase of the phase transition occurs with a quasi-homogeneous medium. The heterogeneous "slurry" zone has a porosity between 0 and 1. How is the profile of such a zone set and how is this indicator selected for a specific case? If it is variable in space, how is it determined?

On page 200, the term "moment" equation (3.75) is used. It is an equation of motion (momentum in English).

V. CONCLUSION

A large number of different applications of solar energy have been studied, such as combinations with various constructions and processes for heat recovery.

The comprehensiveness of the tasks set in the dissertation, the established dependencies and their experimental confirmation, research and explanation of the observed phenomena, developed guidelines for future applications of installations for combined utilization of solar energy allows me to strongly recommend the distinguished jury to award the degree "Doctor of Sciences" to Prof. Dr. Eng. Alexander Georgiev Georgiev.

Sofia, February 10, 2022.

REVIEWER:

(Prof. Venko N. Beschkov)