

REVIEW

by **assoc. prof. Daniela Simeonova Toneva, PhD**
Technical University of Varna,
department "Ecology and Environmental Protection"

of a dissertation for awarding the educational and scientific degree of **Doctor**
in the field of higher education: 4. Natural sciences, mathematics and informatics

Professional field: 4.2. Chemical Sciences

Doctoral program: "Ecology and Environmental Protection"

author: *eng. Mihai Petrov*

Form of doctoral studies: *self-study*

Scientific organization: University "Prof. Dr. Asen Zlatarov" Burgas, Department of Ecology and Environmental Protection

Dissertation title: Thermodynamic study of temperature depending on the concentrations of some pollutants of the ambient air and the global ecosystem

Supervisors: assoc. prof. Zdravka Nikolaeva, PhD
assoc. prof. Alexander Dimitrov, PhD

Reason for preparing the review: member of the scientific jury under the procedure for defending a dissertation for the awarding the educational and scientific degree of Doctor, according to Order No. UD-271/23.07.2024 of the Rector of the University "Prof. Dr. Asen Zlatarov" – Burgas

General presentation of the procedure and the PhD student

Under this procedure, I have been provided with a set of materials on electronic media in accordance with the "Regulations on the terms and conditions for acquiring scientific degrees and occupying academic positions at the University "Prof. Dr. Asen Zlatarov" – Burgas", which includes the following documents:

- Dissertation;
- Abstract;
- Reference for the fulfillment of the mandatory minimum national requirements;
- List of scientific publications;
- Copies of scientific publications;
- Declaration of originality and authenticity of the attached documents;
- CV

Mihai Petrov holds a Master's degree in Physics from the Moldovan State University since 1995 and a Master of Pharmacy from the Moldovan State University of Medicine and Pharmacy "Nicolae Testemițeanu" since 2009.

Since 2021, she has been working as an assistant professor at the University "Prof. Dr. Asen Zlatarov" – Burgas, Department of Mathematics and Physics. He is the author of over 30 scientific publications.

The presented set of documents is in accordance with the requirements of the Law on the development of academic staff in the Republic of Bulgaria, the Regulations for the Implementation of the Law on the development of academic staff in the Republic of Bulgaria, and Rules of Procedure for acquiring scientific degrees and occupying academic positions at University "Prof. Dr. Asen Zlatarov" - Burgas".

Actuality of the problem developed in the dissertation

Climate change, which has been developing at a rapid pace in recent decades, has the character of a global challenge and a deepening environmental problem. The expected effects and consequences of climate change are multifaceted and affect not only the average annual temperatures, but also the quality of ambient air, water resources, soils, biodiversity and the ability of ecosystems to provide ecosystem services, the manifestations and frequency of extreme natural phenomena, the development of the economy and human societies on a regional and global scale. There is an objective need to reveal the interconnections between anthropogenic activity, ambient air quality and climate change, including from the perspective of thermodynamics.

The emphasis in the presented dissertation is placed on the thermodynamic study of the relationship between the concentration of some pollutants in the ambient air (carbon dioxide, methane, ozone, etc.) and air temperature, as well as calorimetric parameters such as specific heat capacity and albedo. The development of an empirical adiabatic model and a calorimetric method for determining changes in atmospheric temperature depending on the levels of atmospheric pollutants is relevant and significant in scientific and applied terms. In the context of climate change adaptation and natural disaster risk management, it is particularly relevant to clarify the relationship between albedo values, density, specific heat capacity and temperature of the components of the biosphere and atmosphere.

The development of a model for determining the ignition temperature of forests depending on the concentrations of fuel greenhouse gases is highly practical.

Knowledge of the problem

In the presented dissertation, Eng. Petrov has carried out a very thorough overview and analytical review of the problem.

The good literary awareness of the candidate is evidenced by the 333 literary sources cited in the dissertation. Of these, 310 are in Latin and 21 in Cyrillic. A particularly good impression is made by the actuality of the studied scientific publications.

Based on the above, it can be concluded that Eng. Mihai Petrov has a good in-depth knowledge of the state of the problems and can creatively interpret the literary material.

Methodology of the study

Experimental work and the implementation of the assigned tasks, as well as the main goal in its entirety, require the use of a variety of qualitative and quantitative methods, as well as precise analytical work. The chosen methodology for conducting the scientific research allows to achieve the research goal of the dissertation in all required aspects, determined by the precisely set tasks. The combination of analytical and systematic approach in the implementation of the research is a positive side of the dissertation.

The chosen research methodology is applicable, well-reasoned and appropriate, applied in the necessary entirety.

Characteristics and evaluation of the dissertation

The dissertation is carefully and precisely developed in a volume of 164 pages. It is well structured in: Introduction; Ambient air pollutants and their impact on the climate (overview); Purpose and objectives of the study; Research methods; Study of changes in atmospheric temperature depending on greenhouse gas concentrations; Analysis of the complex unified system Biosphere-Technosphere-Humanity; Generalized conclusions; Literature. The development is well formed graphically. 97 figures and 28 tables are presented.

The presentation is presented in a logical sequence, concise, stylistically and scientifically. The individual semantic parts are presented in the necessary interconnectedness.

In the first chapter "Ambient air pollutants and their impact on the climate (overview)" an in-depth literature review and analytical review of the state of the problem under study is carried out, paying significant attention to the greenhouse effect, the role of the anthropogenic factor in changes in the levels of carbon dioxide in the air and the change in air temperature. Aspects of climate change, including albedo changes, intensification of extreme natural phenomena, and in particular forest fires in connection with an increase in the levels of certain atmospheric pollutants, are analyzed.

In the "Purpose and Objectives of the Dissertation" the main objective of the study is correctly defined, namely "the thermodynamic study of temperature depending on concentrations of some air pollutants". 6 main tasks have been formulated, the complex implementation of which allows achieving the research goal of the required integrity.

In "Research Methods" the applicable approaches, models and methods for the study are considered. The models of ideal gas are applied, the possibilities for mathematical representation of temperature gradients (dry and wet) in the study of the adiabatic process are reflected. The possibilities for applying an empirical adiabatic method for revealing the relationship between temperature changes and changes in pollutant levels are reflected. A calorimetric method for determining temperature variations as a function of carbon dioxide and oxygen levels in the atmosphere has been clarified and applied. A possibility for empirical validation of the results of the application of the calorimetric method is proposed. With regard to the studies covering the relationship in the change in albedo, density, specific heat capacity and temperature of the components of the biosphere, the models and applications used are correctly presented. Ing. Prof. Petrov demonstrated skills for constructing adequate experimental statements in research in the problematic area of the dissertation.

In the chapter "Study of changes in atmospheric temperature depending on greenhouse gas concentrations" it is confirmed that it is possible to calculate important physicochemical parameters, such as the fictitious molar mass of atmospheric air and the adiabatic constant of atmospheric air, by means of thermodynamic equations for describing the state of atmospheric air under the influence of pollutants. A model based on the thermodynamic theory of adiabatic processes in the atmosphere and The result is the derivation of an empirical expression for temperature change as a function of changes in carbon dioxide concentration. The validation of the empirical expression is finalized with the calculation of the excess mass of carbon dioxide, which is on the order of the real (of 15 billion tons/year accumulation in the atmosphere). A thermodynamic calorimetric model has been developed, which contains the values of changes in the masses of carbon dioxide and oxygen in the atmosphere. The adequacy of the model has been proven. A functional dependence of effective temperature values depending on albedo values is obtained, with high albedo values corresponding to low effective temperature values. The results of a study of the timing and temperature of ignition of forest fuel materials depending on greenhouse gas concentrations are presented. Ignition time (ms) values have been calculated for different masses of solid fuel material for different solar fluxes P as a function of

atmospheric temperature. The dependence of the temperature of the flames on the concentration of combustible pollutants in the atmosphere has been determined. An empirical expression for the relationship between the presence of combustible gases in the air and the temperature of the flame has been developed.

In the chapter "Analysis of the complex unified system Biosphere-Technosphere-Humanity", the system is described from the point of view of entropy. Stationary states of the system, related to its stability, have been investigated.

The conclusions presented in "generalized conclusions" follow logically from the empirical material and analyses and fully cover them. A dissertation has the characteristics of a fully completed scientific research, achieving the goal set in the implementation of the defined tasks.

Contributions and relevance of the development to science and practice

In the dissertation and the abstract, four contributions are stated, which I accept as significant for theory and practice contributions of scientific and applied value, namely:

1) An adiabatic method has been developed, which allows to compare the actually measured values in temperature change, which are of the same order of magnitude with those calculated by this method.

2) A calorimetric method has been developed, allowing the explanation of natural phenomena, e.g. the intensification of natural disasters from sudden changes in atmospheric temperature, which is a consequence of changes in the specific heat capacities of the atmosphere, influenced by pollutants.

3) The results of the study of the albedo values of the unified Earth-Atmosphere system make it possible to explain the changes in the physicochemical properties of the components of the Biosphere, which are important for the formation of the microclimate of the respective ecosystem. For example, an increase in albedo values in soils leads to their compaction. At the same time, there is a decrease in their specific heat capacity.

4) The recent increase in spontaneous natural fires is intensified by the presence of combustible pollutants, gases and particles in the atmosphere. The developed empirical expression for the flame temperature, based on the laws of thermodynamics, allows us to emphasize the following aspect that when there are no combustible gases, the flame temperature reaches the minimum possible values with the possibility of limiting the fire.

The presented results represent an original contribution to science of high importance.

Based on the materials submitted to me for review, I believe that the results and contributions presented in the work are a personal work of Eng. Mihai Petrov.

Evaluation of the publications on the dissertation

The attached documents present 8 scientific publications, and their content is reflected in the dissertation. Six of them are scientific articles, and two are published conference reports. Three of them were published in refereed and indexed in world-renowned databases with scientific information in the period 2020-2023, and they fall into quartile Q4. presented in connection with the dissertation, are independent, and the remaining six are the work of a team of authors, in which Eng. Petrov is a leading author.

I have no data regarding citations of the presented publications. Ing. Petrov has presented a list of participations in scientific conferences and projects, with 2 participations in international scientific conferences with reports and 1 participation in a project, on topics related to the dissertation.

With the presented material, the minimum national requirements for acquiring the degree of Doctor in the professional field 4.2. Chemical sciences are completed by the PhD student. The requirements arising from the Regulations on the terms and conditions for acquiring scientific degrees and occupying academic positions at the University "Prof. Dr. Asen Zlatarov" – Burgas.

Assessment of the abstract

The abstract is developed qualitatively in a volume of 53 pages and reflects the main results, conclusions and contributions from the dissertation research, as well as the author's publications on the topic of the dissertation. In terms of structure and content, it corresponds to the requirements of the regulations of the University "Prof. Dr. Asen Zlatarov" - Burgas.

Critical remarks on the Dissertation

The presented dissertation demonstrates the necessary depth of research. The high degree of awareness and competence of the PhD student is visible. In essence, I do not have critical notes on the dissertation. The dissertation is carefully formatted, but some stylistic weaknesses and sporadic inaccuracies in the use of terminology are allowed. Some of the attached figures are of poor quality (Fig. 52, Fig. 53), and some diagrams include text in English (Fig. 90, Fig. 91). This does not affect the significance, scientific and scientific-practical value of the dissertation contributions.


Conclusion

The dissertation contains results of scientific and scientific-practical significance, representing an original contribution to science and meets all requirements of the Law on the development of the academic staff in the Republic of Bulgaria, the Regulations for the implementation of the Law on the development of the academic staff in the Republic of Bulgaria and the Regulations on the terms and conditions for acquiring scientific degrees and occupying academic positions at the University "Prof. Dr. Asen Zlatarov" – Burgas. The presented materials and dissertation results fully comply with the specific requirements of the University "Prof. Dr. Asen Zlatarov" – Burgas.

The dissertation shows that the PhD student, Eng. Mihai Petrov, has in-depth theoretical knowledge and professional skills in the field of the doctoral program (Ecology and Environmental Protection), demonstrating qualities, skills and competence for independent scientific research.

Based on the above, I give a positive assessment of the developed dissertation, abstract, results and contributions, and propose to the scientific jury to award the educational and scientific degree of "Doctor" to Mihai Petrov in the doctoral program "Ecology and Environmental Protection", in the professional field 4.2. Chemical Sciences.

Подпис заличен
Чл.2 от ЗЗЛД

Reviewer: 

assoc. prof. D. Toneva

16.09.2024