

REVIEW

by Eng. Nevena Stoyanova Mileva, PhD, professor at Plovdiv University
"Paisii Hilendarski"

of a dissertation for the award of the educational and scientific degree "Doctor"

in: field of higher education 5. Technical sciences

Professional field 5.3. Communication and computer technology

doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)".

Author: Hristo Anastasov Kanevski

Topic: "Application of computer technologies to improve environmental performance in road transport"

Scientific supervisor: Prof. Eng. Slavi Lyubomirov, Phd, Plovdiv University "Paisiy Hilendarski"

1. General description of the materials presented

By order No. RD-22-93 of 17.01.2025 of the Rector of Plovdiv University "Paisii Hilendarski" (PU), I am appointed as a member of the scientific jury for ensuring a procedure for the defense of a dissertation on the topic "*Application of computer technologies to improve environmental performance in road transport*" for the acquisition of the educational and scientific degree "doctor" in the field of higher education 5. Technical sciences, professional field 5.3. Communication and computer technology, doctoral program Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.).

The author of the dissertation is M.Eng. Hristo Anastasov Kanevski – PhD student in full-time study at the Department of Electronics, Communications and Information Technologies (ECIT) with scientific supervisor Prof. Eng. Slavi Lyubomirov, Phd from Plovdiv University "Paisii Hilendarski". The training of PhD student Hristo Anastasov Kanevski was conducted in full-time study at the Department of Electronics, Communications and Information Technologies (ECIT) at Plovdiv University "Paisii Hilendarski".

The set of materials on paper submitted by M.Eng. Hristo Anastasov Kanevski is in accordance with Art. 36 (1) of the Regulations for the Development of the Academic Staff of the University of Plovdiv, and includes the following documents: a request to the Rector of the University of Plovdiv for the opening of the procedure for the defense of a dissertation; a curriculum vitae in European

format; a transcript-extract from the minutes of the Department Council of the Department of ECIT (PU), related to reporting the readiness to open the procedure and to a preliminary discussion of the dissertation; a dissertation in a volume of 155 pages; an abstract in a volume of 32 pages; a list of scientific publications on the topic of the dissertation - 6 issues; copies of the 6 scientific publications submitted under the procedure; a declaration of originality and authenticity of the attached documents; a certificate of compliance with the minimum national requirements for the award of the educational and scientific degree "doctor".

The doctoral student has submitted 6 publications, based on which he has a total score of 61.32 points, which meets the minimum national requirements for awarding the educational and scientific degree "doctor" in the relevant field.

2. Brief biographical data about the doctoral student

M.Eng. Hristo Kanevski graduated from the Vocational High School of Engineering and Technology in Smolyan in 2011. In 2019, he graduated from the Faculty of Physics and Technology of Plovdiv University "Paisii Hilendarski", majoring in "Automotive Engineering", with a Bachelor's degree. In 2020, he graduated from the same faculty with a Master's degree in "Automotive Engineering". Since 2020, he has been working at the Faculty of Physics and Technology of Plovdiv University "Paisii Hilendarski", majoring in "Mechanical Engineering and Transport" as an assistant professor. He has been working as an assistant professor at the aforementioned university to this day.

In 2021, he was enrolled in doctoral studies by order of the Rector of Plovdiv University "Paisiy Hilendarski" and held the position of assistant professor.

Possesses technical skills and competencies in the field of electronic systems in the car, technical diagnostics and work with specialized software products in the field of automotive technology.

3. Relevance of the topic and appropriateness of the set goals and objectives

The topic of this dissertation is relevant because it addresses a problem that has been actively studied worldwide in recent years, it is related to the development of new computer technologies to improve environmental performance in road transport. This topic makes many researchers look for solutions to carry out research and concepts applied in internal combustion engines. The dissertation focuses on methods and systems for reducing the toxicity of exhaust gases. The research carried out is relevant both now and in the foreseeable future in the direction of improving the environmental performance of vehicles.

The doctoral student worked in a relatively new field aimed at improving the efficiency and reducing emissions of internal combustion engines through the use of electronic control systems.

4. Knowing the problem

In developing his dissertation, M.Eng. Hristo Anastasov Kanevski referred to 131 literary sources. From the reference made, it is evident that a large part of the literary sources are from recent years. This shows good literary awareness by correctly citing the sources. The large number of literary sources suggests a good knowledge of the problem by the doctoral student and his handling of the tasks set. The reference to these sources and the achieved results speak of a good knowledge of the problem and its creative solution.

5. Research methodology

To achieve the goal of the dissertation "Application of computer technologies to improve environmental performance in road transport" five tasks have been set. They are well formulated and their solution would lead to the achievement of the set goal. The research methodology chosen by the doctoral student Hristo Kanevski allows the achievement of the set goal. In this context, it provides an adequate answer to the tasks solved in the dissertation.

In chapter one of the dissertation work, an analysis of the state of the air pollution problem is presented. Based on the literature review, the features of the main sources of pollution, namely road transport, which has an impact on air pollution, are specified. The problems from the conducted literature study are analyzed.

The second chapter of the dissertation focuses on problems caused by carbon deposits in internal combustion engines. Their impact on their power and environmental characteristics is presented, as well as the symptoms that appear as a result of the accumulated deposits. The result of removing unwanted deposits on the internal parts of the engine is analyzed.

The doctoral student focuses on methods and systems for reducing exhaust gas toxicity. In turn, he presents a schematic diagram of an electronic fuel injection system with two oxygen sensors. He has examined schemes of EGR, SCR systems, etc. He conducted research using the ETU-2200e research equipment. A methodology for cleaning the engine from carbon deposits is given. In Table 2.3 he presented the results of the opacimeter after cleaning.

In the third chapter of the dissertation, the doctoral student presents simulations of various malfunctions in a car engine and their impact on the emissions emitted by the vehicle. An experimental methodology for studying various engine malfunctions has been implemented and tested. A total of 10 different malfunctions are presented. The doctoral student has presented graphical results that have been analyzed in order to provide information on the efficiency of motor vehicle emissions. The data he obtained is used to assess the effect of parameters such as engine load and ambient temperature on vehicle emissions. According to the research conducted, he comes to the conclusion that the concentration of carbon dioxide remains relatively stable, with the greatest influence being exerted by the

malfunction in the throttle valve mechanism. In this case, the values reach 14.872%. He establishes that the highest concentration of carbon monoxide is recorded in the event of a malfunction of the oxygen sensor with a constant voltage of 0.9 V, with the values reaching 3.06%. According to the results, the highest concentration of hydrocarbons is recorded when the oxygen sensor malfunctions with a constant voltage of 0.9V, with values reaching 429.51 ppm.

In chapter four, the doctoral student focuses on experimental studies of the influence of the fuel-air mixture ratio and ignition angle on harmful emissions from a gasoline engine. The experiments were conducted with a BMW 318 gasoline engine equipped with a MegaSquirt 3 electronic control unit, Tuner Studio MS software and a Kane AUTO plus gas analyzer. The concentrations of carbon monoxide (CO), carbon dioxide (CO₂) and unburned hydrocarbons (HC) were measured at different engine speeds, different fuel-air mixture ratios and different ignition angles. The data obtained were used to compile correlation equations describing the relationship between the fuel-air mixture ratio, ignition angle and harmful emissions levels.

A procedure for changing the fuel-air ratio is presented. Emission measurements were carried out at different engine speeds: 800, 1000, 1200, 1400, 1600, 1800, and 2000 rpm, recording the concentrations of CO, CO₂, and HC.

The obtained data were analyzed using statistical methods to determine the correlation between the fuel-air mixture ratio and the levels of harmful emissions. The correlation equations describe the relationship between the fuel-air mixture ratio and emissions at different engine speeds. The analysis of the results was visualized graphically, with specific conclusions presented after each study.

The study graphically shows the relationship between AFR (Air-Fuel Ratio) and CO emissions % at different revolutions per minute (RPM). Studies of harmful emissions from a gasoline engine depending on the ignition angle are presented.

Emission measurements are conducted at various engine speeds: 800, 1000, 1200, 1400, 1600, 1800, and 2000 rpm. The data is analyzed using statistical methods to determine the correlation between ignition angle and harmful emission levels.

CO diagrams are presented at different ignition angles and engine speeds. The simulation results are analyzed and presented in tables and graphs.

6. Characteristics and evaluation of the dissertation work

The dissertation submitted for review has a total volume of 155 pages and contains 81 figures (photos, diagrams, graphs), 12 tables and formulas. 131 literary sources were used. The dissertation consists of an introduction, four chapters, a summary of the results, contributions of the dissertation, a list of scientific works on the dissertation, citations and used literature. The dissertation is formatted

according to the requirements, the figures are clear and understandable with an appropriate size. The content and text are well structured.

7. Contributions and significance of the development for science and practice

As a reviewer, I have no objections to the doctoral student's claims for the contributions formulated in this way. I support the contributions of the dissertation, I accept that they are scientifically applied and applied.

Scientifically applied are:

1. Methods, techniques and the specifics of the composition of exhaust gases for the assessment of harmful emissions affecting the environment from an ecological perspective have been researched, systematized and analyzed.
2. An experimental setup and methods for studying various internal combustion engine malfunctions and their impact on harmful emissions have been implemented and tested.
3. Factors influencing harmful emissions from internal combustion engines using spark ignition and electronic control units have been studied. A comparative analysis of the results has been conducted.
4. Research and data analysis have been conducted on the influence of the fuel-air mixture ratio on the composition of the exhaust gases. The results obtained show that in the range of the ratio from 15:1 to 17:1, harmful emissions of CO₂, CO and HC have minimal environmental consequences.
5. Data on the influence of ignition angle correction on the quantity and composition of exhaust gases have been implemented, studied and analyzed. It has been experimentally proven that the minimal environmental consequences of harmful CO₂, CO and HC emissions are in the range of 15 to 25 degrees.

Applied, expressed in:

1. Studies of simulated malfunctions of a spark-ignition automobile engine, through laboratory tests and their impact on harmful emissions, have been conducted and presented;
2. Studies of electronically controlled gas nozzles that influence the levels of harmful emissions have been carried out and presented;
3. The change in unburned hydrocarbons (HC), carbon oxides (CO) and carbon dioxide (CO₂) depending on electronically programmable adjustments to the ignition angle and engine speed was studied;
4. A study of harmful emissions from a gasoline engine, depending on the air-fuel ratio, controlled by a microprocessor unit, has been conducted. Practical measurements have been carried

out at different engine speeds. Data on the air-fuel mixture ratio and the levels of harmful emissions have been presented and analyzed using statistical methods.

5. Experimental studies have been carried out on the harmful emissions emitted during the operation of a gasoline internal combustion engine - carbon dioxide (CO₂), carbon monoxide (CO) and hydrocarbons (HC), at different fuel-air mixture ratios, different ignition angle values and different engine speeds.

I believe that the doctoral student's contributions fully meet the purpose of the dissertation and I believe that they are sufficient in number and significance to obtain a doctorate degree.

8. Assessment of dissertation publications

In connection with the dissertation work, Mag. Hristo Kanevski has presented 6 (six) publications. The three articles are published in a collection of reports from the Scientific Papers of the Union of Scientists in Bulgaria-Smolyan. In all publications, Mag. Hristo Kanevski is in first place. One of the publications is the doctoral student's own. This is reason to believe that the results of the research on the dissertation are known to the scientific community.

The publications presented reflect the essence of the topic of the dissertation. No information on the citation of the publications is provided.

9. Personal participation of the doctoral student

From the dissertation submitted for review and the publications to it, it is evident that the doctoral student has independently conducted the experimental research. The topics and content of the publications are directly related to the dissertation, reflecting all its parts. This testifies to the significant contribution of the doctoral student to the results obtained. I have no common publications with the doctoral student and am not a related person, within the meaning of the law.

10. Autor's abstract

The abstract is presented in Bulgarian and English. It consists of 32 pages, including contributions and publications related to the dissertation. The review of the abstract of the dissertation shows full compliance with the requirements for its preparation, as well as the adequacy of reflecting the main results and contributions of the dissertation.

11. Critical remarks and recommendations

I have no critical remarks towards the doctoral student regarding the submitted documents and scientific papers.

I have the following questions for the doctoral student:

1. The dissertation states that electronic control of the fuel mixture and ignition significantly reduces emissions of harmful gases. To what extent can the results of your research be applied to different types of internal combustion engines (e.g. diesel and hybrid systems), and what challenges would you expect in such an implementation?

2. Experimental studies have shown that the optimal fuel-air ratio for minimal environmental impact is in the range of 15:1 to 17:1. How could this ratio be adapted to real-world operating conditions, such as urban and suburban driving, and what additional technologies could help with its automated regulation?

12. Personal impressions

I have known M.Eng. Hristo Anastasov Kanevski since he started working as an assistant in the Department of Mechanical Engineering and Transport of the Faculty of Physics and Technology at the Paisii Hilendarski University. My observation is that he approaches his teaching activities responsibly, updates the content of the teaching material in the disciplines he teaches and monitors innovations in this field.

13. Recommendations for future use of the dissertation contributions and results

In the dissertation, the doctoral student has not presented any guidelines for future development. Important prerequisites for future use of the dissertation contributions and results, in my opinion, are that the doctoral student must develop his research through participation in scientific research projects.

CONCLUSION

The presented dissertation represents a valuable scientific work in which the doctoral student has fulfilled the set goal and formulated tasks. The dissertation *contains scientific-applied and applied results that represent an original contribution to science* and meet all requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADSRB), the Regulations for the Implementation of the ADSRB and the relevant Regulations of the PAISII HILENDARSKY PU.

The dissertation shows that the doctoral student Hristo Anastasov Kanevski possesses in-depth theoretical knowledge and professional skills in the scientific specialty 5.3 Communication and Computer Engineering, demonstrating qualities and skills for independently conducting scientific research.

Due to the above, I categorically give my positive assessment of the research conducted, presented by the dissertation work, abstract, achieved results and contributions reviewed by me above, and I propose to the esteemed scientific jury to award the educational and scientific degree

"Doctor" of Hristo Anastasov Kanevski in the field of higher education: 5. Technical Sciences, professional field 5.3. Communication and Computer Engineering, doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)".

19.02. 2025

Reviewer:

(Prof. Eng. Nevena Mileva, PhD)