OPINION

From: **Prof. Dr. Eng. Krasimir Todorov Krastanov**
Member of the Scientific Jury appointed by Order No. 753/13.11.2025
of the Rector of the Technical University of Varna

Subject: Dissertation for awarding an educational and scientific degree **"Doctor"** in the scientific field 5. "Technical Sciences", professional field 5.1 "Mechanical Engineering", PhD program "Internal Combustion Engines"

Author of the dissertation: **Stoyan Nedelchev Stoyanov**

Topic of the dissertation: **„Characteristics of Gaseous Fuel Injectors for Engines** "

Supervisors: **Prof. Dr. Eng. Zdravko Dinchev Ivanov**
Assoc. Dr. Eng. Sergey Georgiev Belchev

The opinion was prepared on the basis of a decision of the first meeting of the scientific jury, appointed by order of the Rector of the Technical University of Varna.

1. Relevance of the problem developed in the dissertation.

The dissertation examines a topical issue related to the environmental safety of road transport and the growing demands for reducing carbon emissions. One of the main trends in this direction is the use of fuels with improved environmental performance, low-carbon gas and carbon-neutral fuels by engines. The transition to the use of fuels other than traditional liquid fuels, especially in cases with different specific energy densities, requires significant changes to the combustion control systems in the engines. Research on the actual behavior of the elements of the control systems is of utmost importance for the development and improvement of construction, as well as for ensuring a sustainable transition to the operation of gaseous fuel engines.

The aim of the development is to determine the actual flow characteristics of one of the main elements of the combustion engine combustion engines, such as gas injectors, as well as to investigate the main factors influencing the fuel supply characteristics.

To achieve the main goal, adequate models for research and simulations have been developed, as well as methodologies for verification and determination of the characteristics of injectors in simulated operating conditions. For the purposes of the experimental study, a specialized bench has been designed and manufactured, providing high accuracy of registration of the necessary data to determine the actual fuel supply characteristics of the injector under study.

The results obtained during the study show that one of the main factors influencing the amount of fuel delivered per cycle is the change in the behavior of the injector needle under different operating conditions. The obtained dependencies on the influence of the parameters of the control pulse and the initial conditions on the displacement represent current and useful results. The obtained characteristics can be used both to adjust the operation of engine control systems and to improve the design of gas injectors

2. Scientific and Applied Contributions of the Dissertation

The dissertation has an original contribution to science, thanks to the achieved scientific and applied results, realized through the introduction of effective methods that correspond to the modern achievements in the field under study.

The scientific and applied contributions presented in the dissertation can be summarized as follows:

- A hydrodynamic model of a gas injector has been created, showing the nonlinear influence of the nozzle diameter on the mass flow rate, and at larger diameters there is a redistribution of pressure drops between the valve area and the nozzle;
- The values of the leakage coefficient for different diameters of the nozzle are determined, establishing a tendency to decrease with increasing diameter due to the changing ratio between the structural resistance and the nozzle;
- Dependencies for the time-sections at different duration of the control pulse are derived, and their linear increase of more than 5 ms and the relationship with the resistance of the coil are proved;
- The influence of various factors such as injector temperature, different coil resistance value, differential pressure and nozzle diameter has been studied. It has been found that sustained flow performance results are obtained after injector tempering and a minimum electrical pulse duration exceeding the injector opening time;
- The influence of oscillatory processes in the pressure values in the fuel leakage zone has been determined and it has been found that with a longer duration of the control pulse and engine crankshaft rotation speed, the injector is opened in conditions of undamped pressure fluctuations.
- A specialized bench for studying the flow characteristics and dynamics of gas injectors has been designed and built, accompanied by operating methodologies and safety instructions. The developed methodology and the bench are applicable for calibration and optimization of fuel supply systems in engines with alternative fuels;
- The results obtained have the potential for environmentally friendly applications through more precise control of the fuel, delivered per cycle of fuel and reduction of toxic emissions.

I believe that the achievements of the dissertation will be useful for science and practice. No plagiarism was noticed in the dissertation.

3.Opinions, recommendations and comments.

The main results of the dissertation were reported and discussed at scientific conferences, thus becoming known in the scientific community. The publications submitted to the dissertation are four in number, one of which is independent, and the other three are jointly developed with the supervisor and other authors. Two of them have been published in indexed and refereed editions. A total of 6 citations are registered in the Scopus databases for these two publications. All presented publications are directly related to the dissertation and reflect in an indisputable way the results achieved by the dissertation. The publication of the results of the study in scientific journals contributes to their visibility and recognition in the scientific field.

The abstract corresponds to the requirements set by the Technical University of Varna and indicates the objectives of the scientific work and the research methods. It reflects the content of the dissertation, briefly and clearly summarizing the scientific work done and the results achieved.

The dissertation is complete scientific research with formulated problems, developed methods

and means of research, grounded theoretical basis, research of real objects, analysis of the results obtained and conclusions.

CONCLUSION

The dissertation in its structure, volume and content meets all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its implementation for awarding the educational and scientific degree "DOCTOR", and it contains the necessary scientific-applied and applied contributions.

As a result of all the above, I propose to the Honorable Jury to award to Eng. Stoyan Nedelchev Stoyanov, the educational and scientific degree "DOCTOR" in the doctoral program "Internal Combustion Engines", field of higher education 5. "Technical Sciences", professional field 5.1 "Mechanical Engineering".

Date: 08.01.2026 **JURY MEMBER: .....**

/prof. Dr. Eng. Krasimir Krastanov/