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DEVELOPMENT OF THE MOBILE DISASSEMBLY TEST BENCH FOR EXPERIMENTAL STUDY OF THE ECOLOGICAL SAFETY LEVEL OF EXPLOITATION OF FIREFIGHTING AND EMERGENCY-RESCUE EQUIPMENT WITH RECIPROCATING ICE AND THE PERFORMANCE CHARACTERISTICS OF THE EXECUTIVE DEVICES OF EPT

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Abstract

In the article, which shows the results of the authors' own research, the purpose of which was to improve the ES indicators of PP with RICE exploitation process, particularly for FERV of departments of SES of Ukraine and other institutions of security and defense sector, by developing the portable disassembly test bench for experimental studying the technical-economical and ecological characteristics of such PP with RICE, including FERV, and the performance indicators of executive devices of ETP during the times of armed aggression and in the post-war reconstruction of the country's economy and infrastructure. Following tasks were consistently solved: analysis of scientific and technical, reference, normative, and patent literature about design of test equipment for experimental researches of technical-economic and ecological indicators of PP with RICE and efficiency and performance indicators of executive devices of EPT; developing of design and geometric model of MDTB; manufacturing of MDTB; analysis of metrology parameters of mobile disassembly test bench. Problem of the study. The absence of a mobile disassembly complex of measurement equipment suitable for experimental studying the technical-economical and ecological characteristics of PP with RICE, including FERV of SES of Ukraine divisions, and the performance indicators of executive devices of ETP in remote and conflict-affected areas. Idea of the study. Developing of the mobile quickly deployable and universal test bench with all necessary instruments for direct and indirect measurement of RICE of PP, including FERV, ES of its exploitation process indicators and EPT executive devices efficiency indicators usable for providing of complex criteria-based assessment and verification of mathematical models of its operation processes which is can by made of non-deficient materials and is distinguished by its simplicity of design and high manufacturability and is suitable for use in remote and conflict-affected areas. Object of the study. Complex of technical-economical and ES factors of exploitation process of PP with RICE, including FERV of units of subdivisions of SES of Ukraine, in both regular conditions and in remote and conflict-affected areas, as well as efficiency and performance indicators of executive devices of EPT, as factors for complex criteria-based assessment of ES level and verification of mathematical models of this processes. Subject of the study. Design, metrology and performance parameters of mobile disassembly test bench for experimentally determining the physical quantities of the object of the study. Scientific novelty of the research results – the concept of design and method of application of mobile disassembly complex of measuring devices for experimental researching of technical-economic and ecological indicators of exploitation process of PP with RICE, as well as efficiency and performance indicators of executive devices of its EPT, as factors for complex criteria-based assessment of ES level and verification of mathematical models of such processes has gained further development, in terms of adaptation for FERV units of the SES of Ukraine remote departments affected by armed aggression. Practical significance of the research results – developed MDTB is suitable for performing of experimental researching of worded above indicators of FERV units which are both in regular exploitation process and in conditions of remote departments in conflict-affected areas with ensuring compliance with the «Regulations on Environmental Safety for the State Emergency Service of Ukraine» approved by Order № 618 on 20/09/2013 during armed aggression and during the period of post-war reconstruction of the country's economy and infrastructure.

Key words: environmental protection technologies, executive devices, ecological safety, power plants, firefighting and emergency-rescue equipment, reciprocating internal combustion engines, firefighting and emergency-rescue vehicles, mobile disassembly test bench, armed aggression, post war reconstruction.

Statement of the problem and analysis of the sources

The development of the environmental protection technology (EPT) from the negative technogenic impact of power plants (PP) with reciprocating internal combustion engines (RICE) of firefighting and emergency-rescue vehicles (FERV) of the State Emergency Service (SES) of Ukraine and its main executive device [1] – the filter with a liquid working medium (liquid fluid) of combined synergistic action for the remouving and neutralization of legislative regulated pollutants (chemical pollution) in the exhaust gases (EG) flow (gaseous fluid) using their sudden expansion, impact on a free liquid`s free surface and simultaneous bubbling through liquid layer a solution of reagents in technical fresh water with ozone, as well as reducing environmental pollution by noise (acoustic pollution) and thermal energy (thermal pollution) factors [2] with taking into account its metrologycal features [3] is an relevant task in view of the need to ensure compliance with the requirements contained in the Order of the SES of Ukraine № 618 (on main activities) dated 20/09/2013 «On approval of the Regulations on the organization of environmental support of the State Emergency Service of Ukraine» [4], as well as the requirements of the UNECE Regulations No. 49 [5], both during times of armed aggression and during the post-war reconstruction of the country's critical infrastructure and economy in the historical perspective of ensuring the sustainable development goals defined in the Decree of

the President of Ukraine № 722/2019 of 30/09/2019 «On the Sustainable Development Goals of Ukraine for the period up to 2030» [6].

At the same time, both a working experimental sample of the filter and the mobile diassembly testing bench (MDTB) are being developed to study the indicators of technogenic and ecological safety (ES) level of the exploitation of FERV with RICE, the filter itself and similar executive devices of such environmental protection technology (EPT), as well as to obtain sets of initial data for physical and mathematical modeling of processes in the filter and verification of these models [7, 8].

In order to fully take into account the effectiveness of the complex and synergistic action of the developed executive device, a mathematical apparatus will be developed to carry out a complex criteria-based assessment [9] with taking into account the decarbonization issues as it was described in study [10].

This state of the problem determines the **relevance of the study** – development of a mobile disassembly test bench (MDTB), which enables experimental studies of the performance indicators of PP with RICE, as well as the efficiency of various executive devices in EPT aimed at protecting the environment from technogenic impacts of such mobile sources of environment pollution. These PP units with RICE may include FERV used by the SES of Ukraine, especially in remote areas and frontline zones. This is crucial both during armed aggression and for post-war reconstruction of critical infrastructure.

This area of research is fully characterized by the following 4 main points of justification of relevance.

1) In accordance with the Order of the SES of Ukraine № 618 dated 20/09/2013 «On Approval of the Regulations on the Organization of Ecological Support of the State Emergency Service of Ukraine» [4]: the results of research allow achieving the goal of ecological support of the SES of Ukraine as a set of organizational and technical measures, including those carried out by higher educational institutions, namely, achieving ecological safety of all types of activities of bodies and units of the SES of Ukraine, protection of personnel and employees, material and technical means under the influence of environmentally unfavorable anthropogenic and natural factors, as well as environmental protection in the places of deployment and location of bodies and units of the SES of Ukraine, in terms of fulfilling the task of scientific support of the main tasks of ecological support of the SES of Ukraine, providing an assessment of environmental damage from the activities of bodies and units of the SES of Ukraine, implementing measures to restore the environment, complying with maximum permissible standards for emissions of harmful substances into the atmosphere, implementing measures to reduce them, reducing the toxicity of exhaust gases from equipment.

2) In accordance with the Decree of the President of Ukraine № 722/2019 dated 30/09/2019 «On the Sustainable Development Goals of Ukraine for the period up to 2030» [6]: the results of research correspond to:

– Goal № 3 «ensure a healthy lifestyle and promote well-being for all at all ages»,

– Goal № 7 «ensure access to affordable, reliable, sustainable and modern energy sources for all»,

– Goal № 11 «ensure openness, security, liveability and environmental sustainability of cities and other settlements»,

– Goal № 13 «take urgent measures to combat climate change and its consequences».

3) In accordance with the Resolution of the Cabinet of Ministers of Ukraine № 476 dated 04/30/2024 «On approval of the list of priority thematic areas of scientific research and scientific and technical developments for the period until December 31 of the year following the termination or abolition of martial law in Ukraine» [11]: the results of research correspond to the direction of:

– the section «Rational environmental management», namely «Modeling and forecasting of the state of the environment, technologies for overcoming negative impacts on it»,

– the section «Energy and energy efficiency», namely «Systems of generation and transportation of electric and thermal energy» and «Technologies for the development and use of new types of fuel, renewable and alternative energy sources and types of fuel»,

– the section «National security and defense», namely «Ecologically balanced energy security» and «Intelligent information and control technologies for diagnostics, operation and repair of military and special equipment».

4) According to the Specialty Passport 21.06.01 «Ecological Safety», approved by the Resolution of the Presidium of the Higher Attestation Commission of Ukraine № 33-07/7 dated 04.07.2001 [12]: the results of research correspond to the directions:

– «Development of scientific methods for research of complex assessment and forecasting of the impact of technogenic pollution on the environment and humans»;

– «Improvement of existing, creation of new, environmentally safe technological processes and equipment that ensure the rational use of natural resources, compliance with the standards of harmful effects on the environment. Environmental audit, environmental management».

Purpose of the study. To improve the ES indicators of PP with RICE exploitation process, particularly for FERV of departments of SES of Ukraine and other institutions of security and defense sector, by developing the portable disassembly test bench for experimental studying the technical-economical and ecological characteristics of such PP with RICE, including FERV, and the performance indicators of executive devices of ETP during the times of armed aggression and in the post-war reconstruction of the country's economy and infrastructure.

Problem of the study. The absence of a mobile disassembly complex of measurement equipment suitable for experimental studying the technical-economical and ecological characteristics of PP with RICE, including FERV of SES of Ukraine divisions, and the performance indicators of executive devices of ETP in remote and conflict-affected areas.

Idea of the study. Developing of the mobile quickly deployable and universal test bench with all necessary instruments for direct and indirect measurement of RICE of PP, including FERV, ES of its exploitation process indicators and EPT executive devices efficiency indicators usable for providing of complex criteria-based assessment and verification of mathematical models of its operation processes which is can by made of non-deficient materials and is distinguished by its simplicity of design and high manufacturability and is suitable for use in remote and conflict-affected areas.

Object of the study. Complex of technical-economical and ES factors of exploitation process of PP with RICE, including FERV of units of subdivisions of SES of Ukraine, in both regular conditions and in remote and conflict-affected areas, as well as efficiency and performance indicators of executive devices of EPT, as factors for complex criteria-based assessment of ES level and verification of mathematical models of this processes.

Subject of the study. Design, metrology and performance parameters of mobile disassembly test bench for experimentally determining the physical quantities of the object of the study.

During the implementation of this scientific research, the following **methods of the study** have been used: the analysis of scientific and technical, reference, normative, and patent literature, designing, metrology analysis.

Tasks of the study are as follows.

1) analysis of scientific and technical, reference, normative, and patent literature about design of test equipment for experimental researches of technical-economic and ecological indicators of PP with RICE and efficiency and performance indicators of executive devices of EPT;

2) developing of design and geometric model of MDTB;

3) manufacturing of MDTB;

4) analysis of metrology parameters of mobile disassembly test bench.

In this study described the results of performing of tasks 1, 2 and partially 3.

Analysis of the results of the conducted research allows us to highlight the following aspects of their **scientific novelty**. The concept of design and method of application of mobile disassembly complex of measuring devices for experimental researching of technical-economic and ecological indicators of exploitation process of PP with RICE, as well as efficiency and performance indicators of executive devices of its EPT, as factors for complex criteria-based assessment of ES level and verification of mathematical models of such processes has gained further development, in terms of adaptation for FERV units of the SES of Ukraine remote departments affected by armed aggression.

The results of the performed research can be of the following **practical significants**. Developed MDTB is suitable for performing of experimental researching of worded above indicators of FERV units which are both in regular exploitation process and in conditions of remote departments in conflict-affected areas with ensuring compliance with the «Regulations on Environmental Safety for the State Emergency Service of Ukraine» approved by Order № 618 on 20/09/2013 during armed aggression and during the period of post-war reconstruction of the country's economy and infrastructure.

1 Analysis of scientific and technical, reference, normative, and patent literature

In previous studies of the authors of this article [13], issues were considered, including the development of new and improvement of existing complexes of measuring equipment for the experimental and computational studies specified in the purpose of this article. The results of the profile work [14] on the issues of experimental testing of technical-economic and ecological indicators of the PP with the RICE and their metrological features were also analyzed in detail there.

In modern researches, modeling is used in the development of engine test benches, for example, in the MATLAB/Simulink application [15], multi-parameter controllers are used as part of the bench [16], measurement of the RICE torque using an electronic control system for an electro-mechanical dynamometer [17] and a hydraulic dynamometer [18], analysis systems for nonlinear output feedback and periodic damping of disturbances [19], failure analysis systems for the bench control system [20], nonlinear observer and output feedback of the bench [21], a reference controller for a discrete-time model for the test bench [22], a nonlinear observer of the air-fuel ratio in a separate cylinder in real time [23], application of probabilistic cause-effect diagnostics [24], etc.

Some designs of engine test benches allow for specific studies, such as the aging processes of motor oil [25] and the effectiveness of additives in it [26], prediction of fuel efficiency indicators of RICE taking into account the consumption of motor oil for waste [27], aerodynamic indicators duringRICE testing [28], operating characteristics of solid-state catalytic converters [29], electrochemical sensors based on YSZ for RICE and engine bench [30].

There are studies comparing the results of experimental measurements of ecological excellence of RICE using on-board measuring equipment and an engine test bench [31], development of 1D Urea-SCR systems [32], ecological indicators of RICE of motor vehicles [33].

2 Developing of design and geometric model and and manufacturing of mobile disassembly testing bench

The proposed stand design includes the following measurement devices:

– five- or four-component gas analyzer to measure concentrations in exhaust gases (EG) flow of following pollutants and components:

– unburned hydrocarbons (C_nH_m),

– carbon monoxide CO,

– nitrogen oxides NO_x,

– carbon dioxide CO_2,

– oxygen O_2;

– opacimeter for EG opacity;

– two differential U-tube manometers for EG pressure drop measurements at the EPT actuator inlet and within the actuator;

– temperature measurement system for EG, the working medium, and solid EPT components at 6–10 points;

– sound level meter for noise pollution from the RICE and EPT actuator;

– environmental sensors, including:

– barometer-aneroid,

– mercury thermometer,

– anemometer,

– hygrometer.

Additionally, there is a foldable table for a mobile computer that processes signals from the stand's instruments using criterion-based mathematical analysis and a power supply with protection features.

The layout of the MDTB is shown in Fig. 1. The MDTB geometry and layout model was built in the free online geometric modeling application FreeCAD [34]. The appearance of the MDTB is shown in Fig. 2.

In Fig. 3 opacimeter META-01 for the MDTB is presented. In Fig. 4 its instrument verification document is shown.

In Fig. 5 the 4-component gas analyzer Autotest 02.02 for the MDTB is presented. In Fig. 6 its instrument verification document is shown.

The data obtained experimentally on MDTB will be used in the future as initial data for a complex criteria-based assessment of the indicators of the ES level of the exploitation process of the PP with the RICE, in particular the FERV units of the SES of Ukraine, for verification of the results of the application of mathematical models of work processes in the RICE, for example, obtained in the free online application Blitz-PRO [35], as well as for obtaining indicators of the efficiency of the EPT executive devices.

This study was carried out within the framework of the implementation of the scientific component of the mastery of the educational and scientific program of higher education «Technogenic and ecological safety» for applicants for higher education of the third (educational and scientific) level in the specialty 183 «Environmental protection technologies» (corresponds to the Detailed branch according to the code of the International Standard Classification of Education ISCED-F 2013 0712 «Environmental Protection Technologies» in accordance with the Resolution of the Cabinet of Ministers of Ukraine dated July 7, 2021 No. 762 «On Amendments to the List of Fields of Knowledge and Specialties in Which Applicants for Higher Education Study», as well as the specialty G2 «Environmental Protection Technologies» in accordance with the Resolution of the Cabinet of Ministers of Ukraine No. 1021 dated August 30, 2024 «On Amendments to the List of Fields of Knowledge and Specialties in Which Applicants for Higher and Professional Pre-Higher Education are Trained education») in the field of knowledge 18 «Production and Technology» (G Engineering, Production and Construction), in accordance with the Higher Education Standard, approved and put into effect by Order of the Ministry of Education and Science of Ukraine No. 1427 dated 12/23/2021, as well as the Professional Standard for the group of professions «Teachers of Higher Education Institutions», approved by Order of the Ministry of Economic Development, Trade and Agriculture No. 610 dated 03/23/2021, namely the dissertation research of an adjunct of the 3rd year of full-time training on the topic «Technologies for protecting atmospheric air from the effects of power plants with a reciprocating internal combustion engine».

According to the individual training plan of the higher education applicant, the research materials will be included in the following elements of the dissertation work:

Section 1 «Analysis of the impact of PP with RICE on components of the environment»;

Section 2 «Development of a technology for protecting atmospheric air from the effects of chemical and physical factors during the operation of PP with RICE, taking into account the degree of its physical and moral wear and tear»;

Section 3 «Development of a rational design of an exhaust gas filter with a liquid working medium and a complex action for a physically and morally worn RICE»;

Section 4 «Study of work processes and performance indicators of the developed executive body of the atmospheric air protection technology»;

Section 5 «Criteria-based assessment of the efficiency of the developed atmospheric air protection technology and its executive device».

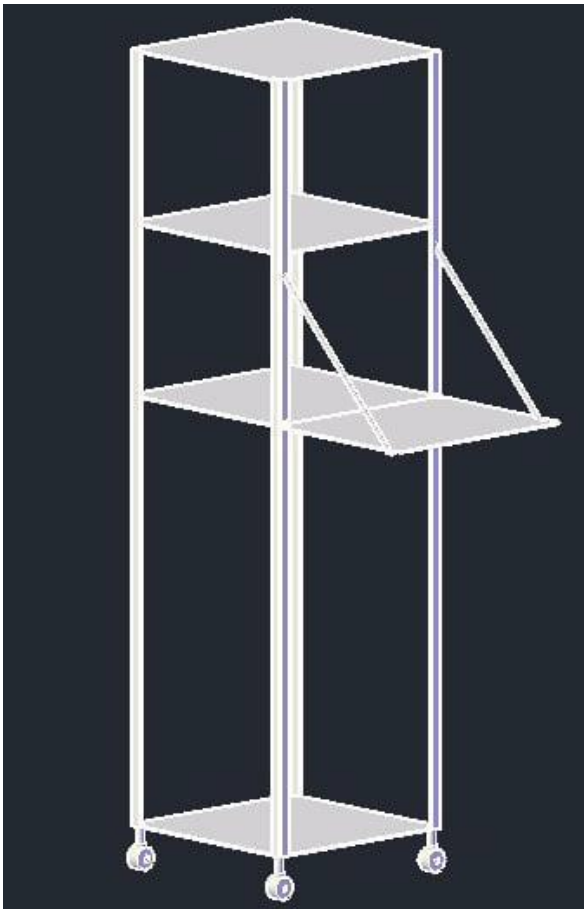

Figure 1 – Diagram of the designed and developed portable dismountable test bench

Figure 2 – Appearance of the designed and developed portable dismountable test bench

Figure 3 – Opacimeter META-01 for the mobile test bench

МІНІСТЕРСТВО ЕКОНОМІКИ УКРАЇНИ

ДЕРЖАВНЕ ПІДПРИЄМСТВО "ІВАНО-ФРАНКІВСЬКИЙ НАУКОВО-ВИРОБНИЧИЙ ЦЕНТР СТАНДАРТИЗАЦІЇ, МЕТРОЛОГІЇ ТА СЕРТИФІКАЦІЇ"

(ДП "ІВАНО-ФРАНКІВСЬКСТАНДАРТМЕТРОЛОГІЯ")

вул.Оболоня, 4, м.Тернопіль, 46008, тел.(0352)52-62-07, 52-74-09, код ЄДРПОУ 02568176

свідоцтво про уповноваження № П-133-2024 від 03.06.2024

СВІДОЦТВО

про повірку

законодавчо регульованого засобу вимірювальної техніки

№ ТФ/1079/Ф Чинне до « 05 » 11. 2025 р.

Назва та умовне позначення Димомір портативний

META-01 Зав. № 1589

Виробник ПК «МЕТА»

За результатами повірки встановлено, що засіб вимірювальної техніки (далі – ЗВТ) відповідає вимогам Розділу ЕД

(назва нормативно-правового акта,

МПУ 146/11-2023

що містить вимоги до метрологічних характеристик і значення метрологічних

Діапазон виміру димності в одиницях коеф. ослаблення N 0-100 %

характеристик (клас точності, похибки, діапазон вимірювання), особливості застосування ЗВТ)

Додаток: на _____ стор. у _____ прим.

Провідний інженер (підпис) Наталія ПОДОЛЬСЬКА (ім'я, прізвище)

Місце відбитка повірочного тавра « 05 » 11. 2024 р.

Figure 4 – Instrument verification document of opacimeter META-01 for the mobile test bench

Figure 5 – The 4-component gas analyzer Autotest 02.02 for the mobile test bench

МІНЕКОНОМІКИ

ДЕРЖАВНЕ ПІДПРИЄМСТВО
«ВСЕУКРАЇНСЬКИЙ ДЕРЖАВНИЙ НАУКОВО-ВИРОБНИЧИЙ ЦЕНТР СТАНДАРТИЗАЦІЇ, МЕТРОЛОГІЇ, СЕРТИФІКАЦІЇ ТА ЗАХИСТУ ПРАВ СПОЖИВАЧІВ»
(ДП «УКРМЕТРТЕСТСТАНДАРТ»)

вул. Метрологічна, 4, м. Київ, 03143
Свідоцтво про уповноваження № П-9-2019 від 14 лютого 2019 р.

СВІДОЦТВО

про повірку законодавчо регульованого засобу вимірювальної техніки

№ 12-01/0967 Чинне до «20» 04 2023

Назва та умовне позначення Газоаналізатор Автотест-02.02

Зав. № 15754

Виробник НВП «МЕТА»

За результатами повірки встановлено, що засіб вимірювальної техніки (далі – ЗВТ) відповідає вимогам

(назва нормативно-правового акта,

Методика повірки М 047.000.00. МП

що містить вимоги до метрологічних характеристик і значення метрологічних

характеристик (клас точності, похибки, діапазон вимірювання), особливості застосування ЗВТ)

Додаток: на - стор. у - прим.

Повірник (підпис) П.В. Петрищин (ініціали, прізвище)

Місце відбитка повірочного тавра

«20» 04 2022

Figure 6 –Instrument verification document of 4-component gas analyzer Autotest 02.02 for the mobile test bench

Acknowledgement

This study was carried out as part of the scientific and research work of the Department of Applied Mechanics and Environmental Protection Technologies (now – Environmental Protection Technologies) of the Faculty (now – Educational and Scientific Institute) of Technogenic and Ecological Safety (now – Management and Population Protection) of the National University of Civil Protection of Ukraine of State Emergency Service of Ukraine «Development of a methodology for complex assessment of the impact of exploitation and application of special equipment on the environment in conditions of military aggression» (State Registration № 0124U000374, 01.2024–12.2026).

At the same time, materials from the VCU library system were used, including electronic versions of journals and other materials, databases, interlibrary subscription as part of participation in Non-Resident Academic Associates program co-sponsored by the College of Humanities and Sciences at Virginia Commonwealth University (VCU) and the Davis Center for Eurasian Studies at Harvard University in 202–2025 academic year.

Conclusion

Thus, based on the results of the research, reflected in the sections of this work, the following general conclusions can be drawn.

Analysis of scientific and technical, reference, normative, and patent literature about design of test equipment for experimental researches of technical-economic and ecological indicators of PP with RICE and efficiency and performance indicators of executive devices of EPT was performed.

Design and geometric model of MDTB was developed and manufactured.

Analysis of metrology parameters of MDTB was performed.

The concept of design and method of application of MDTB for experimental researching of technical-economic and ecological indicators of exploitation process of PP with RICE, as well as efficiency and performance indicators of executive devices of its EPT, as factors for complex criteria-based assessment of ES level and verification of mathematical models of such processes has gained further development, in terms of adaptation for FERV units of the SES of Ukraine remote departments affected by armed aggression.

Developed MDTB is suitable for performing of experimental researching of worded above indicators of FERV units which are both in regular exploitation process and in conditions of remote departments in conflict-affected areas with ensuring compliance with the «Regulations on Environmental Safety for the State Emergency Service of Ukraine» approved by Order № 618 on 20/09/2013 during armed aggression and during the period of post-war reconstruction of the country's economy and infrastructure

The results of the study have found the following practical implementation:

– in the production and economic activities of LLC «TELECOM COMPLEX», the results of the implementation in the strategic planning of the development directions of the LLC both during the armed aggression and during the post-war reconstruction of the critical infrastructure and economy of the country in the historical perspective of ensuring the goals of sustainable development, defined in the Decree of the President of Ukraine No. 722/2019 dated September 30, 2019 «On the Goals of Sustainable Development of Ukraine for the Period until 2030» in terms of bringing the indicators of the level of technogenic and ecological safety of LLC`s PP equipped with RICE to the current legislative requirements (certificate of use dated March 10, 2025);

– in the educational process of the Department of Environmental Protection Technologies of the Educational and Scientific Institute of Management and Population Safety of the NUCP of Ukraine of SES of Ukraine, the results of the implementation: increasing the efficiency of the educational process, namely when studying the topic «Environmental Quality Control System and its Connection with the Monitoring System» from the discipline «Technologies and Methods of Controlling Environmental Quality Indicators», the topic «Tasks, Methods and Modeling Process» from the discipline «Mathematical Modeling of Pollutant Distribution and Protection of Environmental Components» and the topic «The Concept of a Mathematical Model» from the discipline «Mathematical Modeling of Pollutant Distribution in Environmental Components» for full-time higher education students at the third (educational and scientific) level of higher education, studying in the specialty 183 (G2) «Environmental Protection Technologies" (ISCED-F 2013 0712 «Environmental Protection Technologies») in the field of knowledge 18 «Production and Technologies» (G «Engineering, Production and Construction») under the educational and scientific program «Technogenetic and Environmental Safety» at the NUCP of Ukraine of SES of Ukraine in 2024–2025 academic year.

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РОЗРОБКА МОБІЛЬНОГО РОЗБІРНОГО ВИПРОБУВАЛЬНОГО СТЕНДУ ДЛЯ ЕКСПЕРИМЕНТАЛЬНОГО ДОСЛІДЖЕННЯ ПОКАЗНИКІВ РІВНЯ ЕКОЛОГІЧНОЇ БЕЗПЕКИ ЕКСПЛУАТАЦІЇ ПОЖЕЖНОЇ ТА АВАРІЙНО-РЯТУВАЛЬНОЇ ТЕХНІКИ З ПОРШНЕВИМ ДВЗ ТА РОБОЧИХ ХАРАКТЕРИСТИК ВИКОНАВЧИХ ПРИСТРОЇВ ТЗНС

У статті, в якій наведено результати власних досліджень авторів, метою яких було вдосконалення показників ЕБ процесу експлуатації ЕУ з ПДВЗ, зокрема для ПАРТ підрозділів ДСНС України та інших інституцій сектору безпеки і оборони, шляхом розробки мобільного розбірного стенду для експериментального дослідження техніко-економічних та екологічних характеристик таких ЕУ з ПДВЗ, у тому числі ПАРТ, і показників ефективності виконавчих пристроїв ТЗНС як за часів збройної агресії, так в період повоєнної відбудови економіки та інфраструктури країни. Послідовно вирішувалися наступні задачі: аналіз науково-технічної, довідкової, нормативної та патентної літератури щодо проектування випробувального обладнання для експериментальних досліджень техніко-економічних та екологічних показників ЕУ з ПДВЗ та показників ефективності та продуктивності виконавчих пристроїв ТЗНС; розробка конструкції та геометричної моделі МРВС; виготовлення МРВС; аналіз метрологічних параметрів МРВС. Проблема дослідження - відсутність мобільного розбірного комплексу вимірювальної техніки, придатного для експериментального дослідження техніко-економічних та екологічних характеристик ЕУ з ПДВЗ, у тому числі ПАРТ підрозділів ДСНС України, та показників роботи виконавчих пристроїв ТЗНС у віддалених та постраждалих від конфлікту районах. Ідея дослідження - розробка мобільного швидкорозгорнуваного універсального випробувального стенду з усіма необхідними приладами для прямого та непрямого вимірювання параметрів роботи ЕУ з ПДВЗ, включаючи ПАРТ, показників ЕБ процесу його експлуатації та показників ефективності виконавчих пристроїв ТЗНС, придатних для використання при здійснені комплексного критеріального оцінювання та верифікації математичних моделей процесів його функціонування, який може бути виготовлений з недефіцитних матеріалів і відрізняється простотою конструкції та високою технологічністю та придатний для використання у віддалених і постраждалих від конфлікту районах. Об'єкт дослідження - комплекс техніко-економічних та екобезпечних чинників процесу експлуатації ЕУ з ПДВЗ, у тому числі ПАРТ підрозділів підрозділів ДСНС України, як у штатних умовах експлуатації, так і на віддалених та постраждалих територіях від збройного конфлікту, а також показники ефективності та продуктивності виконавчих пристроїв ТЗНС, як чинники для здіснення комплексного критеріального оцінювання рівня ЕБ та верифікації математичних моделей цих процесів. Предмет дослідження - конструкційні, метрологічні та експлуатаційні параметри МРВС для експериментального визначення фізичних величин об’єкта дослідження. Наукова новизна результатів дослідження – набула подальшого розвитку концепція конструкції та методика застосування мобільного розбірного комплексу засобів вимірювальної техніки для експериментального дослідження техніко-економічних та екологічних показників процесу експлуатації ЕУ з ПДВЗ, а також показників ефективності та продуктивності виконавчих пристроїв його ТЗНС, як чинників для здіснення комплексного критеріального оцінювання рівня ЕБ та верифікації математичних моделей таких процесів, в частині адаптації для одиниць ПАРТ придатний для проведення експериментальних досліджень вказаних вище показників ЕУ з ПДВЗ, як у штатних умовах експлуатації, так і на віддалених та постраждалих територіях від збройного конфлікту, із забезпеченням дотримання «Положення про екологічну безпеку для ДСНС України», затвердженого наказом № 618 від 20.09.2013 р. як в умовах збройної агресії, так і в період післявоєнної відбудови економіки та інфраструктури країни.

Ключові слова: технології захисту навколишнього середовища, виконавчі пристрої, екологічна безпека, енергоустановки, пожежна та аварійно-рятувальна техніка, поршневі двигуни внутрішнього згоряння, пожежна та аварійно-рятувальна техніка, мобільний розбірно-випробувальний стенд, збройна агресія, повоєнна відбудова.

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