

АКТУАЛЬНІ ПИТАННЯ РОЗРОБКИ ТА ВПРОВАДЖЕННЯ ТЕХНОЛОГІЙ ЗАХИСТУ НАВКОЛИШНЬОГО СЕРЕДОВИЩА

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PREREQUISITES FOR THE DEVELOPMENT OF A COMPLEX TECHNOLOGY FOR ATMOSPHERIC AIR PROTECTION DURING THE OPERATION OF POWER PLANT WITH RECIPROCATING INTERNAL COMBUSTION ENGINE WITH HIGH LEVEL OF MORAL AND PHYSICAL WEAR

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Introduction and formulation of research problem. From the analysis of scientific and technical literature and works of the main scientists in technogenic and ecological safety area [1-5] is known that power plants (PP) that are equipped with reciprocating internal combustion engine (RICE), namely diesel engine as the source of mechanical energy to drive (i.e. vehicles) and/or performing their main function (i.e. special equipment, including units of fire and emergency rescue equipment that are on operational duty in units of the State Emergency Service of Ukraine) are a powerful source of factors of environmental hazard (EH) of different origins. Which means that PP with RICE performs permanent, intensive and diverse by its physical origin, the negative impact of technogenic nature on the components of the environment, especially on atmospheric air.

Purpose of the study. Determination and description of the prerequisites for the development of complex environmental protection technology (EPT), in particular atmospheric air, from the negative technogenic impact of physical and chemical EH factors, the source of which is diesel RICE as a part of PP, both new and with a significant degree of moral and physical wear, during its accident-free exploitation. **Object of the study.** Ecological safety of atmospheric air in the places of PP with RICE exploitation both new and with significant moral and physical wear. **Subject of the study.** The EPT, which complexly ensures the legally established values of indicators of the level of the object of the study.

Presentation of the main material of the research. In monograph [1] based on the hierarchical principle, a classifier of EH factors was built. Classifier contains EH factors which are inherent in accident-free exploitation as part of the life cycle of an PP with RICE, which at the same time are in a different technical condition, degree of moral and physical wear, consume different types of motor fuel, while the exploitation process itself can be implemented according to different models (that is, a set of operational regimes presses and corresponding weight factors). In that case in building of the EPT and development of their executive devices the rational and perspective decision would be to fix the attention in research on the total influence on environment components: a) chemical EH factors: emission of gaseous and aerosol pollutants – exhaust gas (EG),

vapors of motor fuel and motor oil, crankcase gases; b) physical EH factors: energetic pollution of environment components with thermal energy as well as noise and vibration. Herewith other chemical EH factors (liquid pollutants spilling and solid waste) are shown only in accident by performing care and renovation and by disposal of equipment units after the resource has been exhausted. The monograph [4] sets out the scientific and methodological foundations of the construction of EPT against the negative technogenic impact of PP with RICE with a significant degree of moral and physical wear during their accident-free exploitation.

At the same time the EPT functioning which is performed to fulfill legally established level of environmental safety (ES) indicators of such process that is based on the appropriate methodological basis, in particular on the environmental safety management system (ESMS) (developed and described in the monograph [4]), and the executive devices of EPT in relation to the ESMS act as its material basis.

Functioning efficiency evaluation of that ESMS and corresponding EPT should be done with the appropriate criteria-based mathematical apparatus – the integrative indicator of the ES level of the exploitation process of PP with RICE D_{RICE} (developed in the dissertation [5]) which contains separate components that characterize the efficiency of the diesel particulate matter filter (DPF) as the executive device of the EPT – the index of efficiency of exploitation of the DPF as the executive device of the EPT I_{DPF} (described in the article [7]), as well as individual components characterizing the level of ecological perfection of the RICE – the complex fuel and ecological criterion of prof. Igor Parsadanov K_{fe} (developed in the monograph [2], improved in the monographs [3, 4], became the basis of the structure of the new criterial apparatus in the dissertation [5] and was used to evaluate the efficiency of the implementation of innovative elements of EPT (renewable energy resource consumption and the use of a hybrid engine) for the RICE in articles [8,9]). At the same time, in the hierarchical classifier there are the EH factors, which are collectively taken into account by the mathematical apparatus of the K_{fe} criterion, EH factors that are not taken into account by this criterial apparatus, but are intensively manifested in the process of accident-free exploitation of the PP with RICE and EH factors, which are not taken into account by this criterial apparatus, but do not appear in the such exploitation process (but only in an emergency situation, during maintenance and repair, when disposing of equipment units after the resource has been exhausted).

The monograph [4] gives the results of the analysis of the constructions and methods of operation of DPF in the form of appropriate classifiers built on a hierarchical principle. Filters with a liquid working body [4] should be especially noted among the well-known constructions of DPF. Due to a number of design features, such filters have not become widespread for vehicles, but are the promising technical solution for stationary PP (diesel generators, motor pumps, compressor stations, etc.). The main advantage of such DPFs is that the experimental working samples developed and tested, but not introduced into serial production, are structurally capable of comprehensively reducing the values of the following EH factors [6]: a) emission with the exhaust gases (EG) flow from RICE of particulate matters (PM), b) emission with the EG flow of unburned carbohydrates C_nH_m , c) emission with the EG flow of nitrogen oxides NO_x , and in addition: d) absorb the noise of the EG flow, e) extinguish sparks in the EG flow, f) reduce the temperature of the EG flow.

The schematic diagram of such two-stage DPF with a liquid working body, which explains the principle of its complex action, is shown in Fig. 1. Such design of the DPF proposed in work [6], the elements of which are protected by a patent USSR #1712636, is taken as a basis in this study for the purpose of further improvement and

improvement of operational efficiency. Figure 1 shows the following components: A – input EG flow; B – ozonized air; C – output EG flow; 1 – impact reservoir; 2, 3 – intake manifold with working nozzles; 4 – water-deflecting partitions; 5 – connecting channel; 6 – heat exchanger; 7 – bubbling reservoir; 8 – ring gas distributor; 9 – side nozzles; 10 – moisture separator; 11 – overflow device; 12 – bubbler.

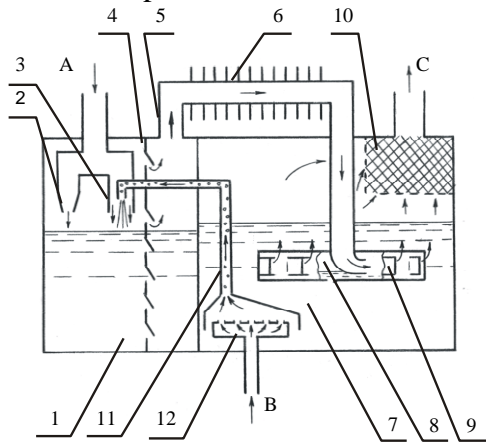


Figure 1 – Scheme of two-stage DPF with liquid working body [6]

Though, when analyzing the classification of working methods and their corresponding constructions of DPF, developed in the monograph [4], such DPF of complex action cannot be attributed to a specific item, since it is built on the use of different principles of action to neutralize various EH factors. The same applies to the place of this DPF in the classification of DPF according to the method of implementation of regeneration processes of the I and II kind, developed in [4], for the same reasons. Therefore, an equally important task

of developing an improved design of such type of DPF, a theoretical study of its working processes and experimental study of its performance indicators, as well as the implementation of the complex criteria-based assessment of the efficiency of its use as a complex executive device of the EPT, is the improvement specified classifications.

The use of special equipment with RICE during the post-war reconstruction of objects of housing stock, critical infrastructure, industry and so on will play a significant role. Therefore, the protection of atmospheric air from the negative impact of RICE of such PP, especially those characterized by a significant degree of physical and moral wear, which will work for a long time stationary in crowded places and in steady regimes of operation with high effective power, acquires the status of one of the priority tasks of ensuring of technogenic and environmental safety.

The expected number of units of such equipment and the predicted volume of restoration work necessitates the need for reliable, simple in design, technological and low-cost technical solutions. DPF with a liquid working body, the improvement of the principle of operation and design of which is proposed to achieve the purpose of this study, fully corresponds the specified need, which makes this study relevant both for the period of the country's post-war reconstruction and in the future peacetime, and the corresponding new scientific product must be appropriately protected [10].

Since it is assumed that such an executive device of the EPT has a complex effect, namely, it eliminates several EH factors at once, which at the same time have a different physical nature from each other, and the mathematical apparatus of the K_{fe} criterion does not take some of them into account, then a separate direction in the study is development of a specific structure of the mathematical apparatus of the D_{RICE} integrative indicator and the I_{DPF} index for the purpose of assessment the effectiveness of the operation of such a technical means of ES ensuring, as the DPF with a liquid working body. Therefore, it is promising to improve the prototype of the DPF with a liquid working body, described in articles [6,11], in order to eliminate some fundamental design flaws, based on a comprehensive theoretical study of the work processes in it and the results of bench motor tests.

Conclusions. Thus, on the basis of the analysis of scientific and technical, reference, patent and normative literature, it was found that study aimed at improving the scheme of the environment protection technology from the negative anthropogenic impact of the PP with RICE with a significant degree of moral and physical wear during their accident-free exploitation through the development of devices for cleaning the EG flow, which reduce several EH factors at once, the mathematical apparatus for criteria-based assessment of the efficiency of its operation are relevant, have signs of scientific novelty and significant practical value.

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