

THE SYSTEMATIC APPROACH TO SOLVING THE PROBLEM OF MANAGEMENT OF ECOLOGICAL SAFETY DURING PROCESS OF BIOWASTE PRODUCTS UTILIZATION

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Purpose. To create a methodological basis for constructing a management system of ecological safety of process of utilization of biowaste products. **Methodology.** Using the systematic approach and principle of multilevel decomposition, was proposed formalization of solution of the problem of management of ecological safety during process of biowaste products utilization. **Results.** Presented and illustrated the General and Detailed structural and organizational schemes of management of ecological safety of utilization process of biowaste products, which developed by authors. Functions of technological system of biowaste products utilization in general and for each of its structural parts was analyzed, described by formulas and verbally. Proposed hierarchic structure implies formalization of solution of the assigned task just in strictly adhering to the basic principles of multilevel decomposition. This implies the following features: presents of vertical (between the levels) and horizontal (between the stages) communications; priority of action of levels and stages from bottom to top; interrelation of levels; varieties of choosing and solving of the tasks for each of levels. **Originality.** For the first time, we have constructing the hierarchic structure of management system of ecological safety of process of utilization of biowaste products and also described by formulas the functions of for each of its structural parts. **Practical value.** Application of that approach allows complex carrying out the problem of ecological safety of production, accumulation and utilization of industrial and domestic wastes with considering obtaining the useful products. *References 4, no tables, figures 5.*

Key words: systematic approach, management of ecological safety, biowaste products utilization.

СИСТЕМНИЙ ПІДХІД ДО ВИРІШЕННЯ ПРОБЛЕМИ УПРАВЛІННЯ ЕКОЛОГІЧНОЮ БЕЗПЕКОЮ ПРОЦЕСУ УТИЛІЗАЦІЇ ВІДХОДІВ ЖИТТЄДІЯЛЬНОСТІ

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Мета. Створити методологічні основи для побудови системи управління екологічною безпекою процесу утилізації відходів життєдіяльності. **Методологія.** Використовуючи системний підхід, принцип багаторівневої декомпозиції, була запропонована формалізація вирішення задачі управління екологічною безпекою при утилізації відходів життєдіяльності. **Результати.** Представлено і проілюстровано укрупнену та деталізовану структурно-організаційні схеми такої системи управління, розроблені авторами. Розглянуто функції технологічної системи утилізації відходів життєдіяльності в цілому та її окремих структурних складових зокрема, їх описано формулами і вербально. У запропонованій ієрархічній системі присутні наступні особливості: наявність вертикальних (міжрівневих) і горизонтальних (міжетапних) зв'язків; пріоритетність дії рівнів і етапів, що направлена вздовж відповідних зв'язків; взаємозалежність рівнів і етапів; варіантність вибору і вирішення задач кожного рівня. **Наукова новизна.** Вперше побудовано ієрархічну структуру системи управління екологічною безпекою процесу утилізації відходів життєдіяльності, а також описано формулами функції усіх її структурних елементів. **Практична цінність.** Застосований підхід дозволяє комплексно вирішувати проблему екологічної безпеки виробництва, накопичення і утилізації промислових і побутових відходів із врахуванням отримання продукції цільового призначення. *Бібліографія 4 найм., без табл., 5 рис.*

Ключові слова: системний підхід, управління екологічною безпекою, утилізація відходів.

PROBLEM STATEMENT. Significant negative impact on the balance of the natural environment, for

ecological safety have excessive concentration of ecologically dangerous manufactures imperfection of techno-

logical processes, technical systems and the unreliability of other human activities. Among the factors of ecological safety in the majority of regions is one of the dominant position occupied by waste. One of the reasons of occurrence of ecologically dangerous waste is a scientific and technological progress in the creation of new kinds of materials [1]. In accordance with the Law of Ukraine "Of Wastes" hazardous waste is waste that having such physical, chemical, biological or other dangerous properties that create or could create a significant risk to the environment and human health and which require special methods and means of handling them. An effective solution to the problem of generation and accumulation of dangerous waste is to create a system of ecological safety management at their utilization [2, 3]. In this case, it is reasonable to use a systematic approach to the development of organizational and technological solutions for utilization. The system approach allows rational formulate and solve the complex problems, by structuring and allocation of their individual tasks as relatively independent parts.

EXPERIMENTAL PART AND RESULTS OBTAINED. Like any complex system, the management of ecological safety consists of many components that form the basis of their functional characteristics and relationships in the operation of the whole system. This allows presenting the system in the form of model

suitable for analytical research and synthesis of components-subsystems of systems as itself and environment. The starting point for the development of such a system is proposed the differentiation of production process on the specific stages.

Each of the components of management system of ecological safety during waste utilization is a very complicated and a large target subsystem and characterized by certain functions, methods and means of their implementation.

The main tasks for management system of ecological safety are to prevent (or substantially reduce) the negative impact on the natural environment, mitigate the effects of manifestations of sources of danger, the weakening of the intensity of the action of hazards. In this case the priority management technical solutions are the use of schemes of joint processing of waste of different economic systems.

Using the principle of multilevel decomposition [4], we have to go to the formalization of solution of the problem of rational management of ecological safety during utilization process of biowaste products. The process of designing of the system is due to the division into hierarchical levels of functionally completed stages of the solution of the complex of subtasks of that level (Fig.1).

Initial data for creation of management system of ecological safety		Improved and new technologies, which using management system of ecological safety		Organization and executing the processes, which using management system of ecological safety		Results of using of which using management system of ecological safety	
1st level Identification of wastes	2nd level Identification of hazards dependently of principals of the formation	3rd level Preparing processes	4th level Equipment	5th level Organization and controlling of management system of ecological safety	6th level Manufacturing processes	7th level Output results of using of management system of ecological safety	8th level Control system

Figure 1 – General scheme of multilevel decomposition (without excessive detailed elaboration)

Formation of the initial data (Fig. 2) includes two levels defining the approaches to the identification of wastes and hazards. At the first level are determined by the

types of waste for utilization technological process. In this case especially allocated groups promoting the formation of highly toxic substances.

1st level Identification of wastes	2nd level Identification of hazards dependently of principals of the formation
Consuming wastes	Regionalization of hazards
Industrial wastes	Space and time structuring
Domestic wastes	Quantitative structuring of hazard sources
Subsystem of initial data for developing of management system of ecological safety	

Figure 2 – Scheme of initial data formation stage

3rd level Preparing processes	4th level Equipment
Technological process of thermal processing of wastes	Equipment for preventing formation of highly toxic substances in exhaust gasses
Technological process, which prevent formation of highly toxic substances	
Technological process, which prevent the secondary formation of highly toxic substances	Equipment for preventing formation of highly toxic substances in solid residue
The new and improving ecological safety technologies of utilization	

Figure 3 – Scheme of new and improving technologies stage

The second level involves detection and identification of hazards with taking into account the characteristic features of the region (each of regions have its own priorities and hierarchy of structures of accumulation of biowaste products and manufacturing), space and time structuring of hazard (set of ecological dangerous wastes of any kind of genesis, which because of interaction and mutually influence are hazard generators), quantitative structuring (involves amiability of statistic data of each of types of biowaste products). That level is finalizing by development of variants of principle technological schemes of utilization with taking into account ensuring of ecological safety.

The stage of new and improving technologies as well as the previous consists of two serial levels (Fig. 3) The third level covers the preparatory processes of creating of technological system of utilization, which taking into account ecological safety. It includes the technological process of thermal processing of wastes, pyrolysis; creating the necessary thermochemical process, which prevents formation of highly toxic substances and the process of following possible formation of highly toxic compounds.

On the fourth stage produced technical requirements and developed equipment necessary for utilization process that ensured ecological safety (in gaseous and solid residue). By these we mean servicing of technological processes by main, auxiliary and additional equipment with taking into account safety of staff. The character feature of that level is taking into account volumes and nomenclature of production processes and also dates of performances.

Directly executing of process of utilization of biowaste products presented the third stage (Fig. 4). Here is fifth level that characterized by the solution of tasks of

control and organization of technological process. If we considering of specificity of the tasks, these level characterized by presence follow components of: organization of sequence of process; organization of shop sections of executing of technological process; and also systems of dispatching and management. The complex solving of tasks of that level must be carried out jointly with solving of tasks of sixth level – manufacturing. That involves the organization of technological and manufacturing processes on Fig. 4, considering ensuring of ecological safety.

The final stage of this algorithm is control of results of application of management system of ecological safety (Fig. 5). The seventh level imply obtaining of following parameters of ensuring of ecological safety, which basis on executing utilization process: reducing of volume of wastes on facilities and polygons; obtaining the products of useful purpose (for example, combustible gas, industrial chemical compounds, heat energy, electrical energy, matter for building industry etc.). At the last, eighth level is necessary to organize the system of controlling that allows evaluating efficiency of works for ensuring of ecological safety.

Proposed hierarchic structure implies formalization of solution of the assigned task just in strictly adhering to the basic principles of multilevel decomposition. This implies the following features:

- presents of vertical (between the levels) and horizontal (between the stages) communications;
- priority of action of levels and stages from bottom to top;
- interrelation of levels;
- varieties of choosing and solving of the tasks for each of levels.

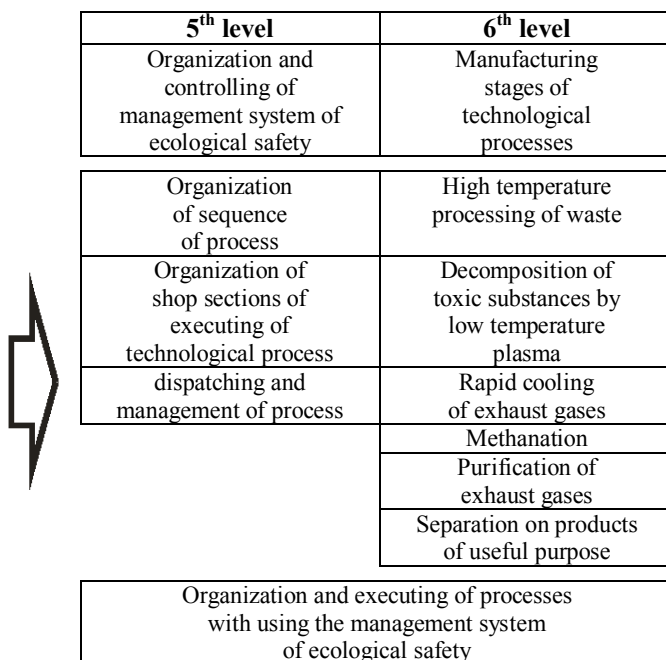


Figure 4 – Scheme of organization and executing stage

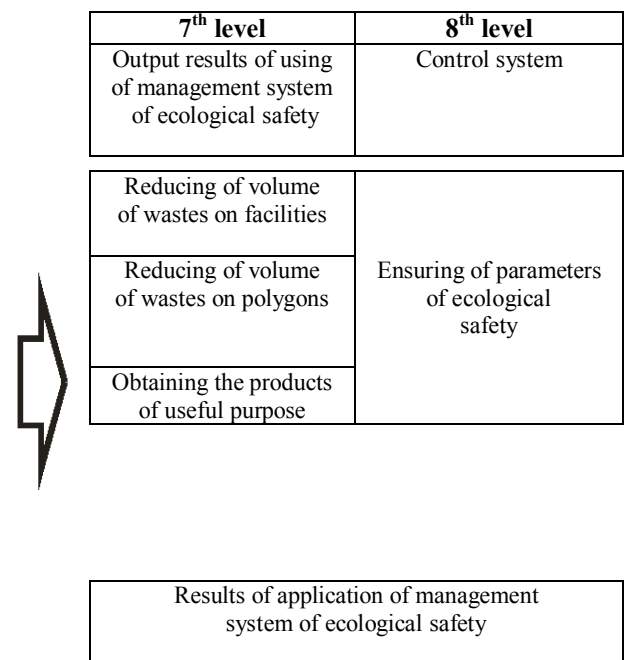


Figure 5 – Scheme of ensuring of executing stage

The functions of technological system of utilization of biowaste products. The foundation of existing of any system is basis and availability of specific purpose for its operating. It must be assumed that taken separately components of system perform their functions by subordinate its actions to final goal. At the same time, all of components of scheme are in benefiting interrelations and coordination in actions.

The main function of technological system of utilization is to create a technological process of utilization of biowaste products with taking into account ecological safety. We should also mention the ability of obtaining of products of useful purpose for following usage. Form of the function is formally represented as a complex of following three components:

$$F = (A, B, C), \quad (1)$$

Here, under our notation should be understood: A – action of system (component) which leads to necessary result; B – designation of object to which directed action; C – formulation of special conditions and limitations under which executed action of the system (components).

Assuming that description of function for proposed technological system of utilization can made by form of formula (1), components of that formula taking following meanings:

F (system of ensuring of ecological safety) = [ecological safety (A) in operating of technological process of utilization (B) with rational organization and technical parameters and application of improved technologies of ensured of safety (C)].

The general approach determines that each of components of the system (component-subsystem, component-element) also is determined by its own function. Functions of system components are dependent on their own properties and on its relations with other components. To formulate the main functions of components of the system we can use a proposed above General multilevel scheme (Fig. 1) and schemes of its individual levels (Fig. 2 – 5).

At the first level in subsystems we must allocate dangerous wastes by their types of formation and identify them by risk of possibility of formation of highly toxic substances in process of utilization.

In process of definition of main regularities of formation of ecological danger in subsystems of second level (Fig. 2) the components of Formula (1) taking the following meanings:

F^2_1 (regionalization of hazards) = [as a result of analysis industrial and social features of the region (A) allocate priorities of hazard structures (B) in depending on possible development of hazard (C)];

F^2_2 (space and time structuring of hazards) = [as a result of analysis ecological dangerous objects of any kind of genesis, which due to interaction and mutual influence between themselves are generated the hazard (A), positioning its sources (B) with taking into account not only spatial location of that sources in relation to various objects, but also nature of environment in which they are distributing (C)];

F^2_3 (quantitative structuring of sources of ecological danger) = [as a result of analysis of different variants of principal schemes of utilization of biowaste products (A) they classified with taking into account of disposable resources (B) and their kinds (C)].

The functions of subsystem of third level (Fig. 3) are following:

F^3_1 (technological process of heat processing) = [choosing of technological processes (A), which create thermodynamic conditions (B) necessary for decomposition of wastes on molecular components (C)];

F^3_2 (technological process, which prevents formation of highly toxic compounds, pyrolysis) = [choosing of technologies (A) for creation of process of pyrolysis (B) and its organization in area (C) where existing highly toxic compounds];

F^3_3 (technological process, which prevents secondary formation of highly toxic compounds) = [choosing of technologies (A) for creation and transportation multiphase structures for realizing of regime of rapid cooling of exhaust gases (B), which prevents secondary formation of highly toxic compounds (C)];

The functions of subsystem of fourth level (Fig. 3) are following:

F^4_1 (equipment for preventing formation of highly toxic compounds in atmosphere) = [designing, manufacturing and choosing (A) of equipment (B), which ensured ecological safety process of utilization of wastes that prevent formation of highly toxic compounds (C) at minimal cost of equipment];

F^4_2 (equipment for preventing formation of highly toxic compounds in solid residue) = [designing, manufacturing and choosing (A) of equipment (B), which ensured quality of implementation of technological process of pyrolysis (C) at minimal cost of equipment];

The functions of subsystem of fifth level (Fig. 3) are following:

F^5_1 (organization of sequence of process) = [developing (A) of cyclic schedule (B) of forming of thermal utilization, which ensured a minimal spending of resources for ensuring of industrial and ecological safety (C)];

F^5_2 (organization of shop sections of executing of technological process) = [designing and organization (A) of shop sections for realization of technological process of ecological safety utilization (B) with taking into account features of new and improving technologies (C)];

F^5_3 (management of the process) = [regulation and network planning in time (A) of cyclic schedules of using of technological processes of ecological safety utilization (B) for implementation of manufacturing cycles (C)].

The basic regularities of subsystem of sixth level (Fig. 4) we can describe following functions:

F^6_1 (technological process of high temperature processing of wastes) = [regulation and network planning in time (A) of cyclic schedules of technological processes of burning of biowaste products (B) for implementation of predetermined manufacturing processes (C)];

F^6_2 (technological process of decomposition of toxic substances) = [regulation and network planning in time (A) of decomposition of highly toxic substances by low

temperature plasma (B) for implementation of predetermined task (C)];

F^6_3 (technological process of cooling of exhaust gases) = [regulation and network planning in time (A) of process of cooling of exhaust gases with using of multiphase dispersed structures (B) for implementation of predetermined task (C)];

F^6_4 (technological process of methanation) = [regulation and network planning in time (A) of process of methanation of exhaust gases (B) for implementation of predetermined task (C)];

F^6_5 (technological process of purification of exhaust gases) = [regulation and network planning in time (A) of process of purification of exhaust gases (B) for implementation of predetermined task (C)];

F^6_6 (technological process of separation of exhaust gases) = [regulation and network planning in time (A) of process of separation of exhaust gases on technological gasses and combustible methane (B) for implementation of predetermined task (C)];

The functional dependences for subsystems of seventh and eighth levels (Fig. 5) fit into general dependences for process of utilization of biowaste products with taking into accounts ecological safety.

F (system of ensuring of ecological safety) = [ecological safety (A) in process of operation of technological process of utilization (B) at rational organization and technical parameters with application of improved technologies of ensuring of safety (C)].

CONCLUSIONS. Consideration of management system of ecological safety in process of utilization of biowaste products as a complicated technological sys-

tem, allows complex carrying out the problem of ecological safety.

On basis of principle of multilevel decomposition was formalized the task of rational management in utilization biowaste products and described functions of technological system of utilization.

With taking into account of statements of systematic approach of solving of complicated problems and also specific features of creation of management system of ecological safety in utilization of biowaste products, was proposed the methodological scheme for solving of task of management of ecological safety considering obtaining the useful products.

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СИСТЕМНЫЙ ПОДХОД К РЕШЕНИЮ ЗАДАЧИ УПРАВЛЕНИЯ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТЬЮ ПРИ УТИЛИЗАЦИИ ОТХОДОВ ЖИЗНЕДЕЯТЕЛЬНОСТИ

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Цель. Создать методологические основы для построения системы управления экологической безопасностью процесса утилизации отходов жизнедеятельности. **Методология.** Используя системный подход, принцип многоуровневой декомпозиции, были предложена формализация решения задачи управления экологической безопасностью при утилизации отходов жизнедеятельности. **Результаты.** Представлены и проиллюстрированы укрупненная и детализированная структурно-организационные схемы такой системы управления, разработанной авторами. Рассмотрены функции технологической системы утилизации отходов жизнедеятельности в целом и ее отдельных структурных составляющих в частности, они описаны формулами и вербально. В предложенной иерархической системе присутствуют следующие особенности: наличие вертикальных (межуровневых) и горизонтальных (межэтапных) связей; приоритетность действия уровней и этапов, направленную вдоль соответствующих связей; взаимозависимость уровней и этапов; вариантность выбора и решения задач каждого уровня. **Научная новизна.** Впервые построена иерархическая структура системы управления экологической безопасностью процесса утилизации отходов жизнедеятельности, а также описаны формулами функции всех ее структурных элементов. **Практическая ценность.** Примененный подход позволяет комплексно решать проблему экологической безопасности производства, накопления и утилизации промышленных и бытовых отходов с учетом получения продукции целевого назначения. Библиография 4 наим., без табл., 5 рис.

Ключевые слова: системный подход, управления экологической безопасностью, утилизация отходов.