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**ECOLOGICAL PSYCHOLOGY**

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# ECOLOGY OF PROFESSIONAL SELF-AWARENESS FORMATION OF FUTURE PSYCHOLOGISTS

The article elucidates the peculiarities of the professional self-awareness formation of future psychologists in the professional training process in a higher education institution (hereinafter, HEI). On the basis of the conducted empirical research, it was clarified such peculiarities of the formation of professional self-awareness structural components of future psychologists as cognitive, emotional, motivational, and operational during training in HEI. The materials present the main results of mathematical and statistical analysis and interpretation of research results. The revealed trends indicate that the normative process of professional development in HEI is characterized by qualitative and gradual changes in the professional self-awareness of higher education students. In particular, motivational and empathic components are identified as the main components of the studied phenomenon.

Moreover, to the presented results of empirical research, in the context of the ecological approach, the problem of social and psychological determinants of the formation of future psychologists' professional self-awareness is highlighted. The identification and inclusion of such determinants in the educational process organization will contribute to the actualization of ecological and psychological mechanisms of students' professional and personal formation. Among the general recommendations for the environmentalization of the professional educational environment in the HEI, the article proposed the practice of mentoring junior students by senior students on the basis of the "equal to equal" principle, as well as providing intervision and supervisory support for future psychologists at the stage of higher professional education.

***Key words:*** self-awareness, professional self-awareness, the structure of professional self-awareness, professional self-concept, the self-image of a psychologist, future psychologists, ecological approach.

**Formulation of the problem.** Research in the field of environmental psychology is gaining special relevance today in connection with the search for effective ways out of the environmental crisis, which brings the following problems to the fore: 1) research on environmental awareness, in particular, professional awareness and self-awareness, by identifying the peculiarities of human perception of the environment and selection of factors significant for the subject of its unfavorable development; 2) identifying the motivation of environmental behavior, which reveals the reasons for persons' actions responsible for causing damage to the environment; 3) analysis of patterns of psychological consequences of the environmental crisis (mental health disorders, increase in crime, demographic changes, etc.).

We are most interested in the first aspect of research in the field of ecological psychology. Modern transformational changes in society and traumatic challenges exacerbate the problem of

professional formation and development of specialists in socionomic professions. Particular attention is drawn to the issue of the ecological friendliness of the psychologists' work, in particular, such aspects as the observance of high ethical standards and continuous professional improvement, the prevention of emotional and professional burnout in the conditions of intensive work with clients' traumatic experience. In this context, it is appropriate to single out the ecological problem of the professional self-awareness formation of future psychologists as a key link in their professionalization.

**Analysis of recent research and publications.** The problem of self-awareness has always attracted considerable interest from representatives of well-known foreign and domestic scientific currents and approaches. Therefore, the development of personal self-awareness is one of the key ideas of the psychoanalytic theory of S. Freud, who looked at it in the context of the identification and introspection of the parental self-identity; identity (E. Erikson); regulation, control, and efficiency (A. Bandura); independence of thinking and behavioral self-regulation (G. Hall); striving for self-expression and self-realization (R. Khevihkhepst); the development of cognitive processes (J. Piaget); the inner potential of the personality, its ability to purposefully interpret the present, which includes both the future and the past (F. Perls); formation of the "I-concept" (R. Burns, C. Rogers) [2][6][10][11][12].

Problems of professional self-awareness are presented in the works of such domestic scientists as V. Haluziak, O. Moskalenko, V. Rybalka, V. Petrenko, E. Pomytkin, Yu. Shvalb, V. Yurchenko, and others. Most researchers tend to see this phenomenon as self-awareness in the professional activity course. Professional self-awareness is, on the one hand, a process by which a person recognizes themselves and relates to themselves as a representative of the relevant profession, on the other hand, it is the result of self-awareness - a formed relatively persistent complex of ideas about oneself as a specialist, professional "Self-concept".

Other scientific researches are directly devoted to the study of the professional self-awareness development in student life, where the subject of analysis is the influence of educational and professional activities on future specialists' professional and personal development in socionomic professions (I. Bulakh, L. Holovei, O. Kokun, L. Dolynska, L. Orban-Lembryk, and others).

A. Derkach and O. Moskalenko in their studies singled out such professional self-awareness functional and structural components as 1) cognitive, which is realized in self-knowledge; 2) motivational, realized in self-actualization; 3) emotional, realized in self-understanding; 4) operational, implemented in self-regulation.

In modern psychological and pedagogical science, the issue of developing future psychologists' professional self-awareness is mostly considered in the context of their general professional formation (O. Akimova [**Error! Reference source not found.**], V. Haluziak [3], V. Pedorenko, V. Shtyfurak [9], Z. Karpenko [4], A. Kolomiiets [5], N. Lazarenko [7], O. Meshko & H. Meshko [8], and others). At the same time, there is a need to clarify the peculiarities of the structural components and socio-psychological determinants of the professional self-awareness formation of future psychologists, the identification and consideration of which in the professional higher education organization will contribute to the actualization of the ecological and psychological mechanisms of students' professional and personal formation.

**The purpose of the article** is to clarify the peculiarities of the formation of the professional self-awareness structural components of future psychologists in the ecological approach context.

**Outline of the main material**. After conducting a theoretical analysis of the phenomenon of professional self-awareness, we proceeded to diagnose the formation of its key structural components during the process of professional training in higher educational institutions (hereinafter, HEI).

An empirical study of the psychological characteristics of the formation dynamics of the professional self-awareness structural components was conducted with students of the first and fourth courses in the field of Psychology at Vinnytsia Mykhailo Kotsiubynsky State Pedagogical University. The research was carried out with students from 2016 to 2022. The final sample consisted of 360 respondents, with 90 individuals from each course, including 242 females and 118 males.

Analyzing the degree of discrepancy between the Ideal Self and the Real Self using N. Kolmogortseva's technique "Psychologist's self-image", which indicates the level of development of the professional self-awareness cognitive component among future psychologists, we obtained the following results, as depicted in Fig 1.

For the convenience of data processing, we have identified three main levels to determine the indicator: low, moderate, and high levels.

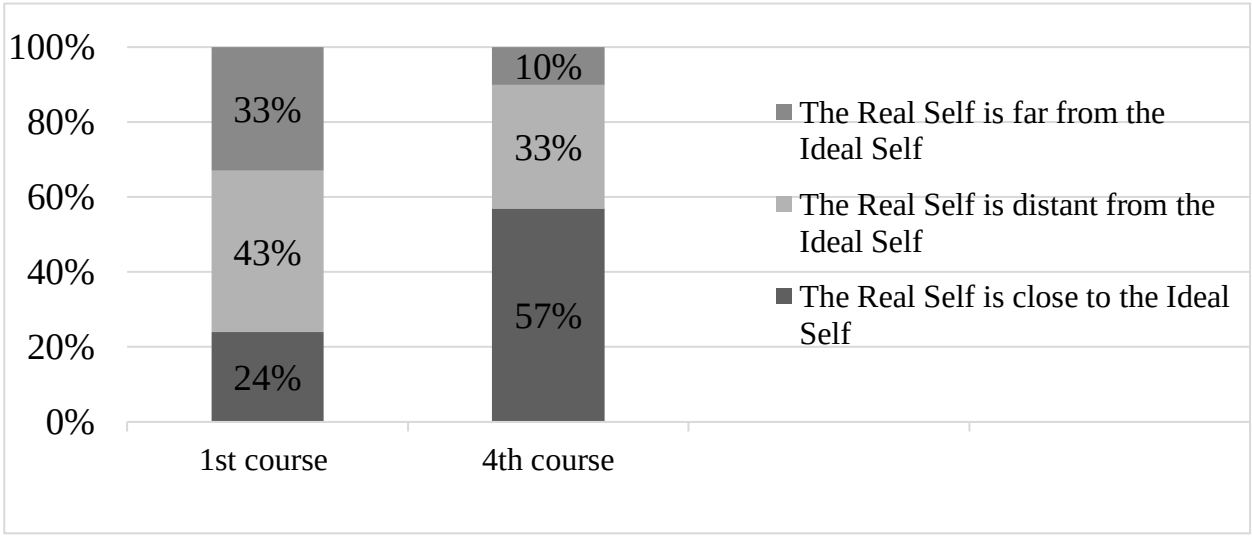


**Fig. 1.** The level of development of the professional self-awareness cognitive component among future psychologists in the first and fourth courses (according to N. Kolmogortseva's "Psychologist's self-image" technique).

According to the diagnostic results, it was found that in the first year, 33% of the respondents - future psychologists, have a low level of cognitive component development (Real Self is significantly distant from Ideal Self), 43% have an average level (Real Self is distant from Ideal Self), which constitutes the majority. A high level of cognitive component development of professional self-awareness is observed in 24% of students. Consequently, among fourth-year students, a high level predominates (Real Self approaching Ideal Self in 57%), 33% of students have an average level (Real Self is distant from Ideal Self), and only 10% of students have a low level of cognitive component development where Real Self is far from Ideal Self. These results are confirmed by the "Awareness" scale results using another diagnostic method, "Professional Readiness" by A. Cherniavska, in which 63% of first-year students and 47% of fourth-year students have a predominance of average level development, highly developed awareness in 10% and 47% of first and fourth-year students respectively.

The average level of cognitive component development of professional self-awareness among first-year future psychologists indicates the formation of a positive attitude towards professional activities. However, there is still insufficient understanding of their role functions and their place in the profession. Therefore, the "Professional Real Self" is in a constant process of formation and self-understanding as a future professional. The ideal self-image of a professional may be more attainable, as first-year students tend to overestimate their competence, as evidenced by a significant percentage of students with a Real Self approaching the Ideal Self (24%). The professional knowledge itself remains primarily theoretical and has not become personally meaningful. Students have an average level of formation of the mentioned properties necessary for solving specific educational and professional tasks.

However, fourth-year students predominantly have a high level of cognitive component development of professional self-awareness, characterized by an adequate assessment of their professional Real Self and Ideal Self, as well as a tendency to reduce the discrepancy between them. This is achieved through the presence of knowledge among future psychologists about the purpose, role, and place of the profession in modern society, as well as the necessary professional knowledge.

Analyzing the operational component of professional self-awareness among future psychologists using A. Cherniavska's "Professional Readiness" technique, we obtained the following results, presented in Fig. 2 and 3.

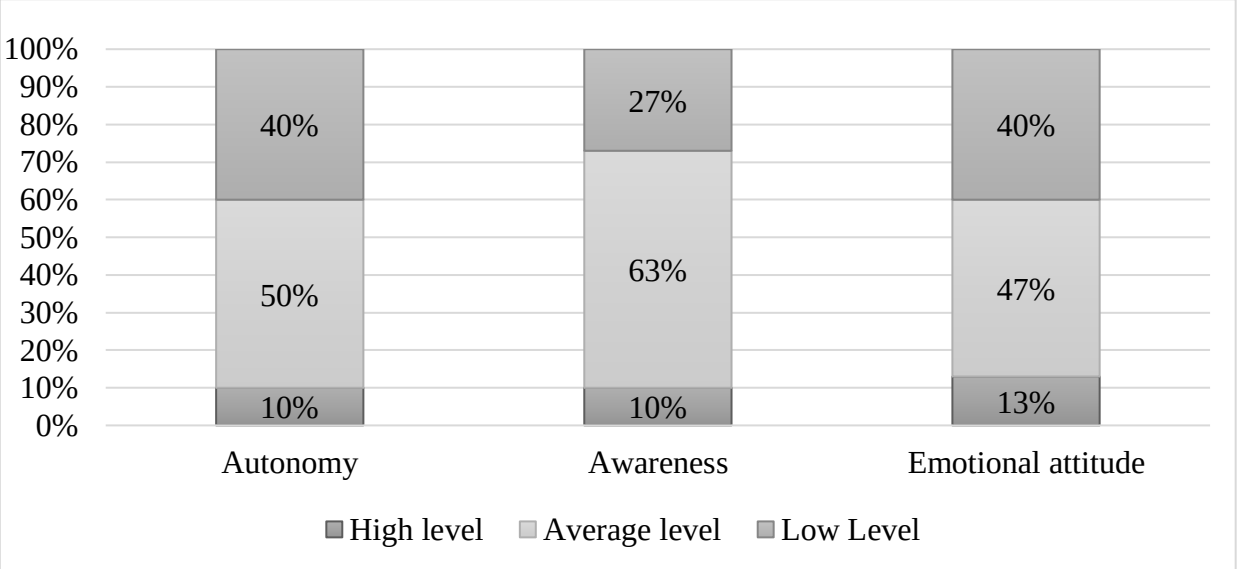


**Fig. 2.** Levels of formation of the professional readiness components as an indicator of the professional self-awareness operational component among 1st-course future psychologists (according to A. Cherniavska's «Professional readiness» technique)

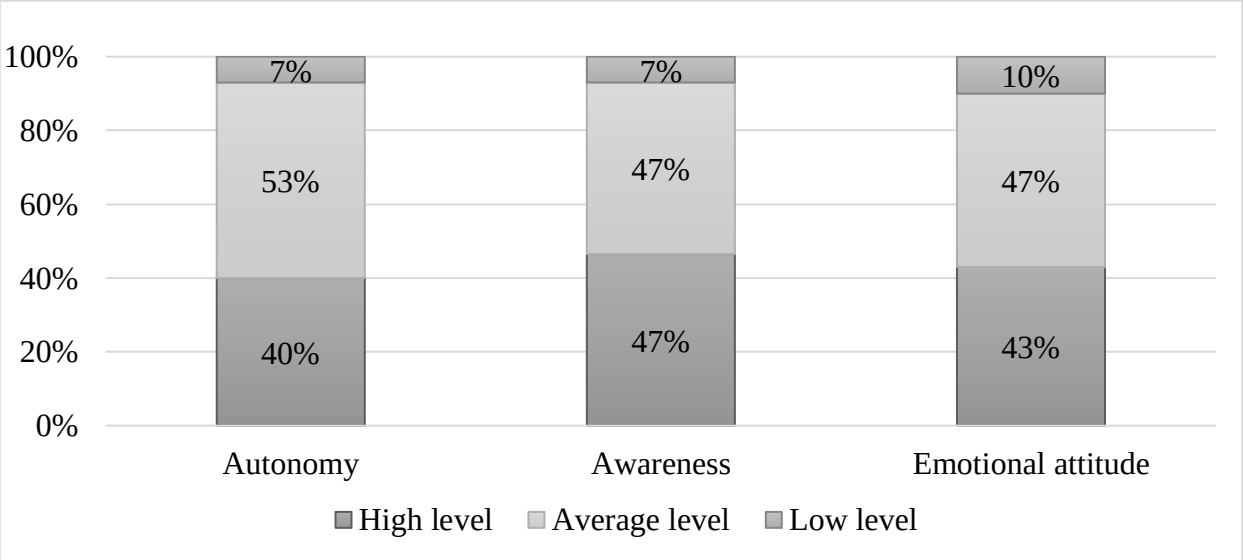


**Fig. 3.** Levels of formation of the professional readiness components as an indicator of the professional self-awareness operational component among 4th-course future psychologists (according to A. Cherniavska's «Professional readiness» technique).

Based on the obtained results, we can conclude that for the majority of students, both in the first and fourth years (56% and 50% respectively), a general average level of professional readiness is observed. This indicates an average development of the operational component of professional self-awareness among students in these courses.

The indicator of the "Autonomy" scale shows that 50% of first-year students and 53% of fourth-year students have an average level of development. In the first year, 40% of students have a low level of autonomy, but in the fourth year, it is observed in only 7% of students. Additionally, only 10% of first-year students exhibit a high level of autonomy, compared to 40% of fourth-year students who demonstrate a high level of autonomy.

The results of the study on the "Autonomy" scale are supported by the data obtained from the A. Rean's questionnaire "Motivation for Success and Fear of Failure." In the first year, 43% of future psychologists exhibit "Fear of Failure" and 33% have "Hope for Success" motivation. In the fourth year, 40% of students are motivated by "Hope for Success," and another 40% of students have an undefined motivational pole.

Therefore, the average level of autonomy development among first-year students may indicate a lack of independence in their actions and behaviors. Students may not yet demonstrate sufficient initiative and proactivity in realizing their potential, as well as a sustained professional interest. Their desire to fulfill their professional duties primarily arises in situations that do not carry the risk of failure.

Students in the fourth course are characterized by a higher level of aspiration toward realizing their life potential, self-improvement, and self-development. In other words, 4th-year future psychologists are becoming aware of the significance of personal qualities for successful professional activity.

On the "Awareness" scale, 63% of 1st-year students and 47% of 4th-year students have an average level of development. Highly developed awareness is present in 10% of 1st-year students and 47% of 4th-year students. Additionally, 27% of 1st-year students and 7% of 4th-year students have a low level of awareness as a component of professional readiness.

The mentioned data can be compared to the indicator of the professional self-discrepancy between the Real Self and Ideal Self according to N. Kolmogortseva's " Psychologist's self-image" technique. According to this methodology, in the 1st year, 43% of students have a Real Self that is distant from their Ideal Self, while among 4th-year students, the Real Self is predominantly close to the Ideal Self (57%).

Accordingly, we can conclude that the awareness of 1st-year students is limited by their perception capabilities. At an average level, students are merely accumulating information about the future profession of a psychologist, but they have very few opportunities to actively participate in psychological work. They are faced with the pressing question of finding reliable and practical sources of knowledge that will allow them to obtain accurate and practical information about professional activities, which will ultimately enable them to realize themselves as psychologists.

We can also observe a positive trend among 4th-year students, where awareness regarding the profession is found at high and average levels. This indicates that to attain professional maturity, future psychologists are not only accumulating professionally relevant information but also actively seeking it to align the specificity of their personality with the demands of the professional field. In other words, by the 4th year, students are capable of more adequately assessing their chosen profession and correlating their personal qualities with its requirements.

According to the "Emotional Attitude" scale, an average level is observed among both 1st-year and 4th-year students (47% each). A low level is present in 40% of 1st-year students and 10% of 4th-year students, while a high level is found in 13% of 1st-year students and 43% of 4th-year students.

The corresponding results among students from both courses can be observed by comparing them with the results of the "Anxiety" scale of H. Eysenck’s "Self-Assessment of Mental States" questionnaire. It indicates that the average level of anxiety predominates among both 1st-year and 4th-year students, with percentages of 57% and 70% respectively. Additionally, the results from the "Emotional Attitude" scale can be correlated with the results of the "Frustration" scale of the same H. Eysenck’s questionnaire. The results indicate that 50% of 1st-year students have an average level of frustration, 33% have a high level, and 17% have a low level. Among 4th-year students, there is an equal expression of low and average levels of frustration (40% each), while 20% exhibit a high level.

Emotional attitude plays an important role in the process of making various crucial life choices for future psychologists, especially regarding their further professional path, psychological orientation, and so on. At the average level, this component is manifested in a generally positive attitude towards professional activity, and life optimism tends to be more resilient than pessimistic tendencies. Despite difficulties, students are capable of overcoming negative and frustrating situations. At a high level of development, this component becomes one of the most significant indicators of internal professional maturity.

Summarizing the results obtained using the "Professional Readiness" methodology (by A. Cherniavska), which allowed us to explore the operational component of professional self-awareness, we can observe an average level of development among 1st-year future psychologists and a significant portion of high-level development among 4th-year future psychologists.

The analysis of the professional self-awareness motivational component in future psychologists of the 1st and 4th year (according to A. Rean’s questionnaire "Motivation of success and fear of failure") showed the following results, presented in Fig. 4.

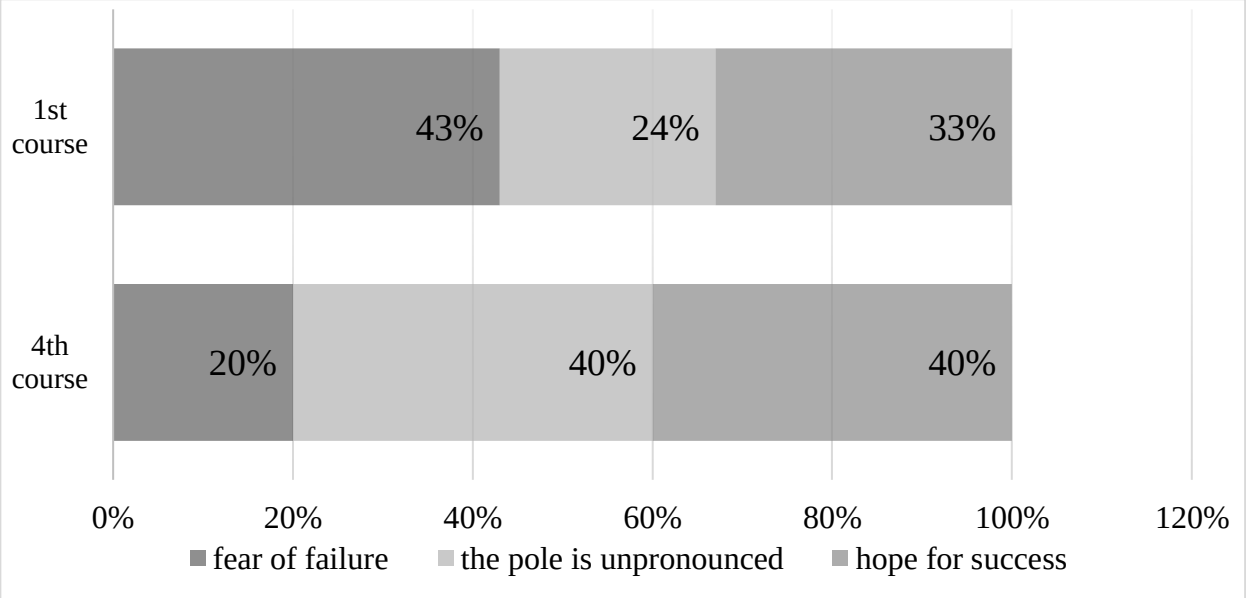


**Fig. 4.** The level of formation of the professional self-awareness motivational component in 1st- and 4th-year future psychologists (according to A. Rean's «Motivation for success and fear of failure» questionnaire).

As we can observe from the histogram of the "Fear of Failure" scale, which reflects the low level of development of the professional self-awareness motivational component, such manifestation is present in 43% of 1st-year students and 20% of 4th-year students. In 24% of 1st-year students and 40% of 4th-year students, the motivational pole is unpronounced and indicates an average level of the motivational component. A high level, expressed by the "Hope for Success" scale, is observed in 33% of 1st-year students and 40% of 4th-year students.

The results obtained for the "Fear of Failure" scale are consistent with the results of the "Frustration" scale from H. Eysenck's "Self-Assessment of Mental States" questionnaire. Among 1st-year students, the average level is observed at 50%, a high level at 33%, and a low level at 17%. Among 4th-year students, both low and average levels of frustration are equally expressed (40% each). According to the results of the "Anxiety" scale from H. Eysenck's questionnaire, the average level prevails in both 1st and 4th-year students, with 57% and 70% respectively. The results of the "Motivation for Success" scale are consistent with the results of the "Autonomy" scale from A. Cherniavska's "Professional Readiness" methodology. Thus, 50% of 1st-year students and 53% of 4th-year students exhibit an average level of development, while 40% of 1st-year students have a low level, which is only observed in 7% of 4th-year students. However, 10% of 1st-year students show a high level of autonomy development, compared to 40% of 4th-year students.

The study of the professional self-awareness motivational component revealed a low level of its development in 1st-year students, which is manifested in the predominance of the "Fear of failure" motivation among future psychologists, i.e., they try, first of all, to avoid punishment, condemnation of classmates and teachers. Even at the beginning of their work, future psychologists are characterized by a certain apprehension about the results. They show increased anxiety and a lack of confidence in their own capabilities. At the same time, they are quite responsible for the performance of activities and try to do everything correctly and rationally.

Most 4th-year future psychologists are characterized by the "Motivation to achieve success" tendency, that is, in general, they are directed to achieve constructive, significant, and positive results in their studies. The basis of individual activity is the hope for success and the need to achieve success. Such future psychologists are characterized by self-confidence, purposefulness, and activity.

In the process of researching the professional self-awareness emotional component in future psychologists according to the questionnaire of H. Eysenck's "Self-assessment of mental states", we obtained the results shown in Fig. 5 and 6.

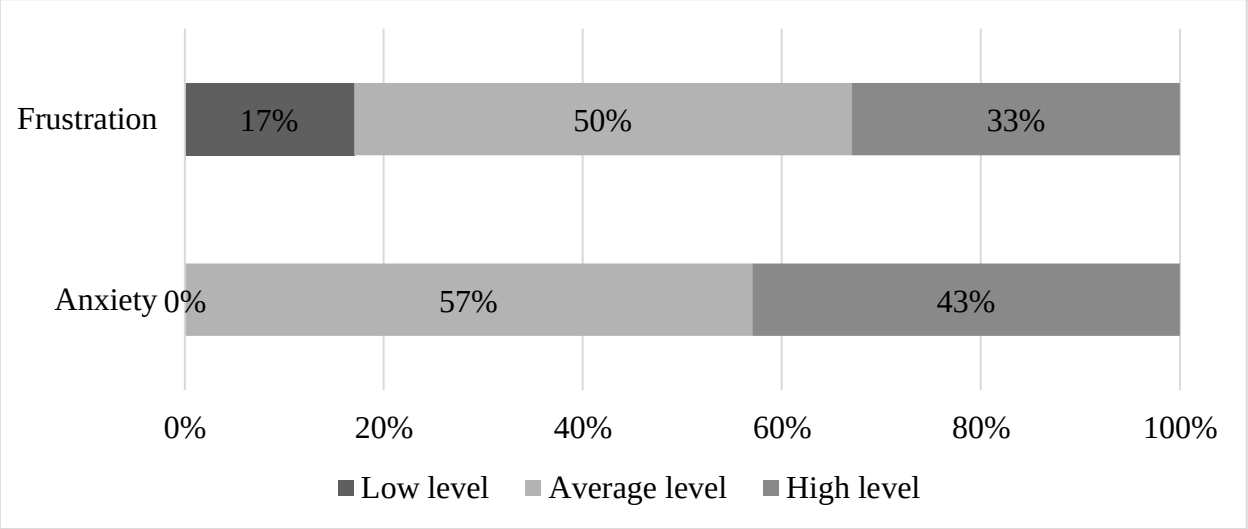


**Fig. 5.** The level of formation of the professional self-awareness emotional component in the 1st-year future psychologists (according to H. Eysenck's «Self-assessment of mental states» questionnaire)

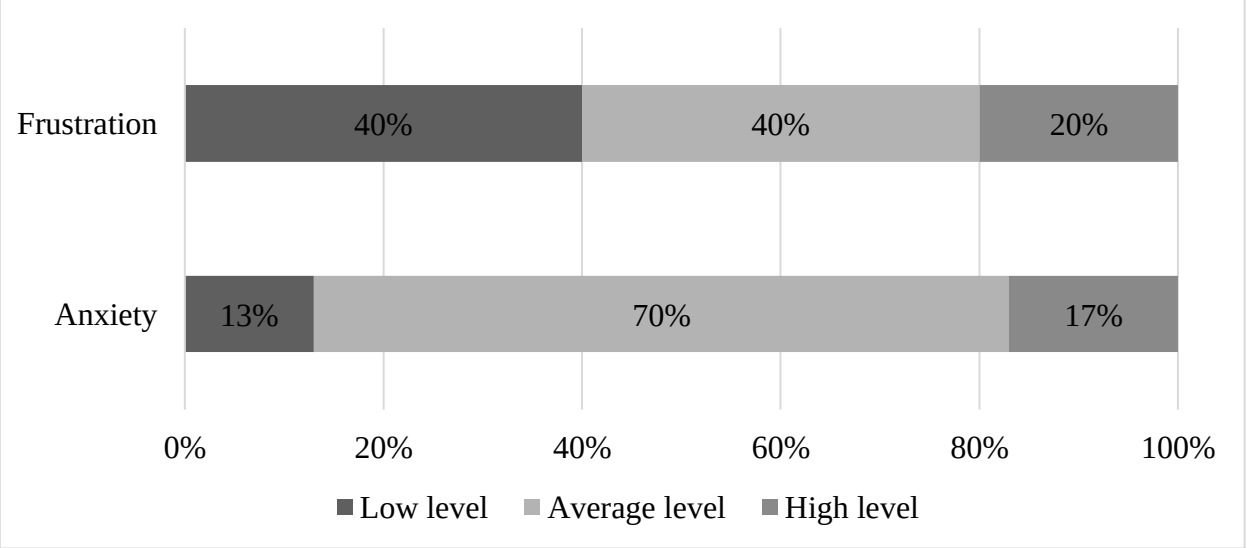


**Fig. 6.** The level of formation of the professional self-awareness emotional component in the 4th-year future psychologists (according to H. Eysenck's «Self-assessment of mental states» questionnaire)

According to the data presented in Figures 5 and 6, it can be observed that the average level of anxiety prevails in both 1st and 4th-year students, with 57% and 70% respectively. Among 1st-year students, there are no students with low anxiety (0%), while among 4th-year students, 13% exhibit low anxiety. High anxiety is observed in nearly half of the 1st-year students (43%) and in 17% of the 4th-year students. Anxiety is an expression of emotional distress associated with a sense of danger or failure anticipation. Any instability or disruption in the normal course of events can lead to the development of anxiety.

The level of frustration according to the "Frustration" scale among 1st-year students is average (50%), 33% – high, and 17% – low. Fouth-year students have an equally expressed low and medium level of frustration (40% each), and 20% have a high level of frustration. In students, frustration manifests itself in oppressive tension, anxiety, a sense of hopelessness, and despair that arise in situations that an individual perceives as an inevitable threat to the goal achievement that is important to them, the realization of a certain need. The strength of frustration depends both on the degree of significance of the blocked action and on its proximity to the defined goal. The reaction to the state of frustration can be the following main types of actions: "withdrawal" from the real situation into the realm of fantasies, delusions, and daydreams; the emergence of an internal tendency to aggressiveness, which is either

delayed, appearing in the form of irritability, or openly breaking out in the form of anger; general "regression" of behavior, i.e., the transition to easier and more primitive ways of acting, frequent change of occupations, etc. As a result of frustration, residual self-doubt is often observed, as well as a fixation on the methods of action used in the situation of frustration.

The given results on the scales were also confirmed by the results of the "Fear of failure" scale (A. Rean's "Motivation of success and fear of failure" questionnaire), which expresses a low level of development of the professional self-awareness motivational component among 1st-year students (43%) and the "Emotional Attitude" scale (A. Cherniavska's «Professional readiness» methodology), according to which the average level of its development was found in students of the first and fourth years (47% each), low – in 40% of students of the 1st and 10% of students of the 4th year, and high – in 13% and 43% of students of the 1st and 4th courses.

**Results.** The research results allowed us to identify different levels of professional self-awareness formation among future psychologists of 1st and 4th courses. A statistical analysis of the obtained results was also carried out using the SPSS Statistics 24 computer program for statistical data processing. The data obtained during the calculations indicate the presence of a correlation between the selected scales. The results of the pairwise correlation of the 1st-year students' sample indicators revealed the following significant relationships: the value of the scale "difference between the Professional Ideal Self and the Real Self" according to the method " Psychologist's self-image" by N. Kolmogortseva has a direct correlation with the scales "Autonomy" (empirical = 0.596980**, with $p < 0.01$), "Information" (empirical = 0.899213**, with $p < 0.01$), "general level of professional readiness" (empirical = 0.939888** , with $p < 0.01$) according to the "Professional Readiness" technique by A. Cherniavska, the "Emotional Attitude" scale according to the same technique with the "Anxiety" scales (empirical = 0,906878**, at $p < 0.01$), "Frustration" (empirical = 0.780300**, at $p < 0.01$) according to H. Eysenck's «Self-assessment of mental states» questionnaire and the scale of "Motivation" (empirical = -0.405240 **, at $p < 0.01$) according to A. Rean's "Motivation for success and fear of failure" questionnaire. A direct correlation indicates that 1st-year future psychologists have a low and average level of professional self-awareness development as a whole, as well as its individual components. Such results are, first of all, connected with the formation of guidelines for professional activity, but with insufficient awareness among students of those properties of a psychologist's personality, which are professionally significant; do not clearly record their presence in themselves, have an average level of formation of the named properties; in solving specific educational and professional tasks, they occasionally show a tendency to reflection and empathy; motives of self-improvement are not always have professional nature.

The results of the correlation of the fourth-year students' sample indicators revealed the following significant relationships: the value of the scale "difference between the Professional Ideal Self and Real Self" according to the "Psychologist's self-image" technique has a direct correlation according to the "Autonomy" scales (empirical = 0.881604 **, at $p < 0.01$), "Information" (empirical = 0.842262 **, at $p < 0.01$), "general level of professional readiness" (empirical = 0.900430 **, at $p < 0$ .01) according to the "Professional Readiness" technique, the "Emotional Attitude" scale according to the "Professional Readiness" technique with the "Anxiety" scales (empirical = 0.906878**, with $p < 0.01$), "Frustration" (empirical = 0,780300**, with $p < 0.01$) according to the questionnaire of H. Eysenck's «Self-assessment of mental states» questionnaire and the scale of "Motivation" (empirical = -0.456753 **, with $p < 0.01$) according to the "Motivation for success and fear of failure" questionnaire by A. Rean. A direct correlation indicates that fourth-year future psychologists have a high and average level of professional self-awareness development both in general and in its individual components, in particular.

**Conclusions.** On the basis of the conducted empirical research, we can state that the low level of professional self-awareness in first-year students is caused by the lack of adequate guidance on professional activity; future psychologists are able to identify personality traits that are professionally significant but are not able to connect them with personal characteristics, and have a low level of these traits formation; they do not show a tendency to reflection and empathy while solving educational and professional tasks; self-improvement motives of first-year students are weakly related to their professional self-awareness.

The level of professional self-awareness development among fourth-year students is much higher since they already have a more clearly formed guideline for professional activity. They are aware of certain properties that arise on the basis of professional knowledge about the professional self-awareness components, in particular, the critical assessment of their presence in themselves and its implementation in the process of professional activity is more pronounced. Most fourth-year students are characterized by a tendency to reflection and empathy and a positive professional self-concept. The leading motive for

self-improvement is an understanding of the importance of personality traits for future professional activity.

The identified trends indicate that during the normative professional development in HEI, there is a gradual qualitative development of future psychologists' professional self-awareness. The most significant components of this integrated phenomenon are determined by the features of the motivational sphere of higher education seekers and the manifestation of empathy, which is also a key professionally important quality for future psychologists.

Among the ecological factors in the educational environment of HEI that should be strengthened in the professional training of first-year psychology students, the following are noteworthy. First is the involvement of first-year students in a greater number of practical and goal-oriented activities. Second, is the organization of interaction between junior and senior courses of study, which would be beneficial through the practice of mentoring junior students by senior students. This, in turn, would contribute to the formation of a more objective self-image in future professional activities. In this context, creating a cooperative space based on the principle of "equal to equal" is ecologically significant, where students from different courses of study can collaboratively solve problem tasks, engage in scientific research activities, and acquire practical skills and abilities.

Particularly relevant is the organization of supervisory and intervision student groups, which will ensure the ecological development of future psychologists in general and foster an atmosphere of cooperation and exchange of experience not only among students but also among HEI faculty members.

**Prospects for further research in this direction**. The development and implementation of ecological techniques and methods for providing psychological support in the development of professional self-awareness among future psychologists is the subject of our further scientific research.

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# A STRUCTURAL-FUNCTIONAL MODEL OF THE IMPACT OF ANTHROPOGENIC POLLUTION ON THE PERSONALITY

Because of the combat actions on the territory of Ukraine, the risk of man-made disasters, the consequences of which will affect the entire population of the planet, has increased significantly. Constant missiles attacks, destruction of hydroelectric power plants, thermal power plants, constant threats of damage of nuclear power plants – put at risk not only the physical health of people, but also mental and psychological health. The researches of domestic scientists demonstrate the consequences of the impact of the Chernobyl nuclear disaster on the mental health of the population: L. Kryzhanivska, A. Chuprikov, E. Horban, E. Khomska, V. Krasnov and others.

This scientific article presented a structural-functional model of the impact of anthropogenic pollution on the personality. It is revealed in the interaction of the human-nature system. The core structures of the designed model were: the structure of the socio-ecosystem by H. Bachynskyi, the four-dimensional structure of personality by Rybalka-Shevtsov and the structural-functional model of the psychological mechanisms of social adaptation of youth with the musculoskeletal system disorders by I. Chukhrii, A. Shevtsov.

The central component of the specified model is socio-ecosystems, as a territorial socio-natural self-regulatory system, which dynamic balance must be ensured by human society. It is an extremely complex system consisting of subsystems: socio-economic and natural subsystems.

For its part, the socio-economic subsystem consists of lower level subsystems: the population and economy ones, the natural subsystem consists of abiotic and biotic ones. The socio-economic subsystem contains components - human population, industrial, residential, engineering, communication, economic and other anthropogenic objects.

The population can make a negative impact on nature, and the consequences of this impact are manifested in the emergence of health disorders, in particular, human mental and psychological health.

In the man and nature relationships, it is the social community of people that is of great importance. A person's entry into human society is accompanied by the development of social adaptation of the individual, or its violation – maladaptation. Social adaptation is carried out with the help of social adaptation mechanisms

It is important to note that the ascending construct in the presented model is a personality with a personal core – the Self-concept. The structure of personality itself is presented by the following way: social-psychological-individual dimension, activity dimension, nosological dimension (differentiated into characteristics of developmental disorders or post-traumatic mental state of a person), age, genetic dimension.

The suggested model presents the vectors of influence not only of the population, in particular of individual social groups and individuals, on the socio-economic subsystem of the socio-ecosystem, but

also of the results of this influence - anthropogenic pollution on the population, in particular on the individual and his social-psychological-individual, nosological (as there is high risk of physical and mental health disorders), activity, age, genetic dimensions.

***Key words:*** *socio-ecosystem, population, social adaptation, mechanisms of social adaptation, personality structure, anthropogenic pollution.*

**Formulation of the problem.** The war on the territory of Ukraine has a devastating effect on its ecosystem. The consequences of military actions affect all ecological factors of the environment and significantly reduce the tolerance of living organisms to the devastating effects of constant missile attacks, the emission of pollutants, the pollution of river systems, the destruction of soils, the consequences of the explosion of the Kakhovka HPP and other destructive effects.

Considering the fact that the socio-ecosystem is a territorial socio-natural self-regulated system, the dynamic balance of which is ensured by human society, it is human civilization that is responsible for the consequences of irreversible destruction and pollution.

It is worth understanding that there is always a limit, a limit of tolerance, which is a set of environmental conditions within which an organism can exist. A significant part of adverse environmental factors are factors that limit the life of organisms during crisis periods, especially during reproduction.

**Analysis of recent research and publications.** Basic scientific provisions for designing a structural-functional model of the impact of anthropogenic pollution on a person are: the structure of the socio-ecosystem by G. Bachynskii, the four-dimensional structure of personality by Rybalka-Shevtsov and the structural-functional model of the psychological mechanisms of social adaptation of young people with musculoskeletal disorders I. Chukhrii, A. Shevtsov.

**The purpose of the article:** to design a structural and functional model of the influence of anthropogenic pollution on the individual based on the theoretical and methodological analysis.

**Outline of the main material.** The devastating ecological consequences of military actions can directly affect the mental health of the population of Ukraine. For a more detailed review, we suggest considering the following categories: mental trauma, war, psychological trauma.

War is a traumatic event for military personnel and civilians who are in the war zone.

Mental trauma is an internal condition characterized by a violation of adaptation due to an imbalance of the individual's mental capabilities (O. Stepanov).

Psychological trauma is a deep individual reaction to a tragic event, which causes excessive psychological stress and subsequent negative experience, which cannot be overcome unassisted and which causes permanent changes in a person's condition and behavior (L. Tsarenko) [4].

It is worth noting that the trauma experienced during the war always has a polyfunctional nature, that is, there is a combination of psychological (or mental) trauma with the physical injury (in cases of wounds), accompanied by physical pain and loss of functions, with mental trauma (trauma imprinted in history of human development and breaks through the "layers" of the mental apparatus and causes powerful regressive and defensive reactions). The specified multifunctionality of trauma includes the trauma of combat actions, which is complex in nature and consequences.

Psychologists identified the main types of events that can cause mental and psychological trauma to an individual: war and forced displacement as a result of it, acts of terrorism, man-made disasters with many victims, natural disasters, death of beloved one, sexual or physical violence, serious illness and others. That is, taking into account the main causes of mental trauma, we can again assume that war is a sufficiently polytraumatic phenomenon, since all the outlined signs are included in the consideration of the consequences of combat actions [4].

For a detailed consideration of the impact of military actions, in particular, anthropogenic pollution on the personality, we designed the Structural and functional model of the impact of anthropogenic pollution on the personality (Figure 1.). That is, in the proposed model, we reveal the nature of the impact on the personality (i.e., psychological changes) of the consequences of the disruption of the interaction between man and nature, which is a component of the global problem of the planet's ecosystem.

The core structures of the projected model were: the structure of the socio-ecosystem by G. Bachynskyi [2], the four-dimensional structure of personality by Rybalka-Shevtsov and the structural-functional model of the psychological mechanisms of social adaptation of youth with the musculoskeletal system disorders by I. Chukhriy, A. Shevtsov [8].

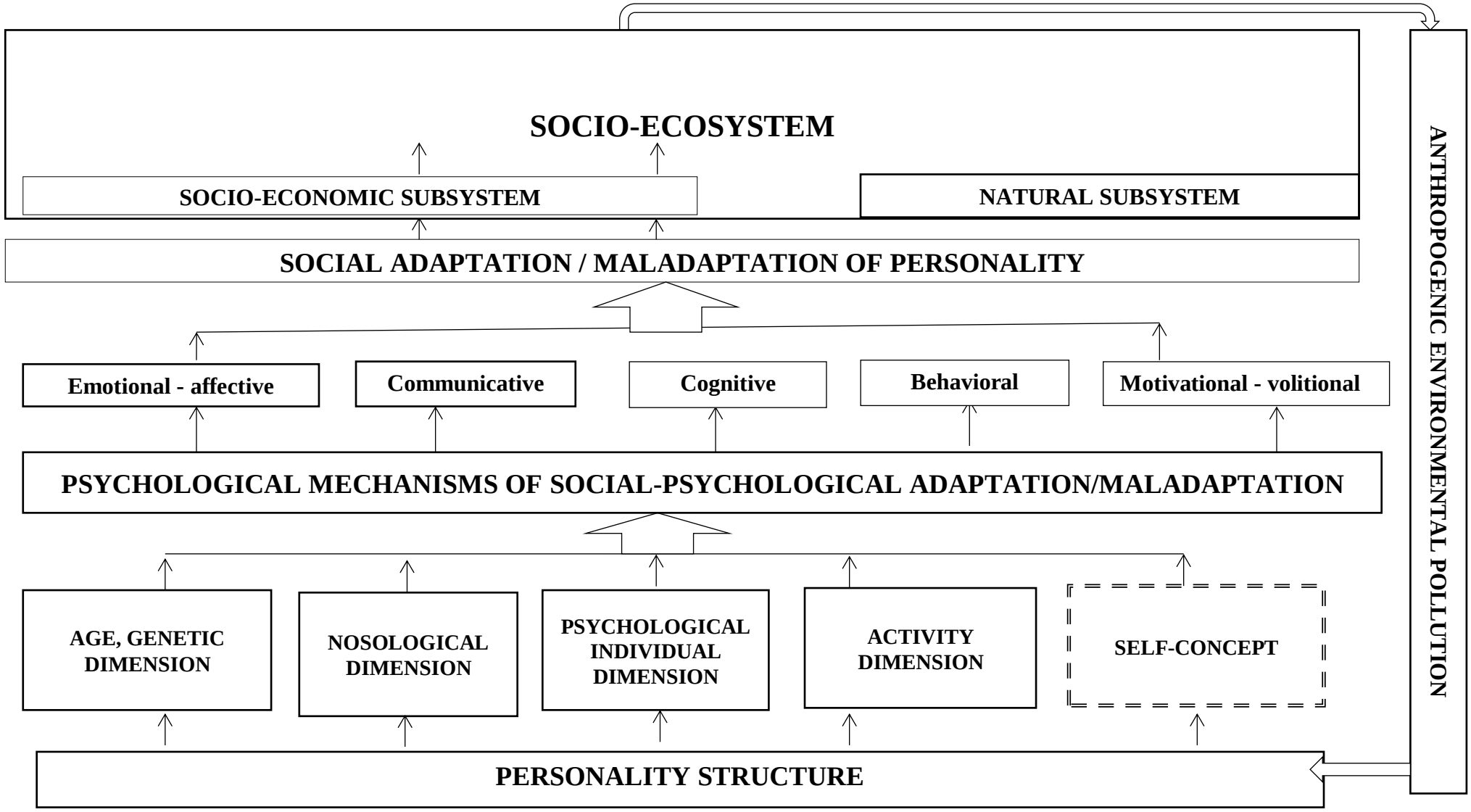


Fig. 1. Structural and functional model of the influence of anthropogenic pollution on the personality

The central component of the specified model are socio-ecosystems, as a territorial socio-natural self-regulatory system, the dynamic balance of which must be ensured by human society. This is an extremely complex system consisting of subsystems: socio-economic and natural subsystems [2].

For its part, the socio-economic subsystem consists of lower level subsystems: the population and economy, the natural subsystem consists of abiotic and biotic ones. The named subsystems contain components: socio-economic – human population, industrial, residential, engineering, communication, economic and other anthropogenic objects; natural – geography of the earth surface, rocks, vegetation, animal world, surface and underground waters, atmospheric air [2].

It is important to realize that all these components are interconnected and complex dynamic systems. And the self-regulation of socio-ecosystems is carried out as a result of their social component, namely the population [2].

It happens with the help of having its own controlling center that manages the development of the socio-ecosystem (good or bad). It is the opposite to natural systems, which are polycentric rather than monocentric as the socio-ecosystem.

The nature and man relationships are of great importance in the global ecosystem. These relationships gained significant momentum with the development of scientific and technical progress, in particular machine production. Humanity has turned into a powerful geological force that exerts influence on most natural processes. The result of it turns to physical, chemical, biological pollution, and the radioactive pollution, which deserves special attention.

Domestic scientists researched the problem of the impact of the Chernobyl nuclear disaster on the mental health of the population: clinical and psychological characteristics of non-psychotic disorders (L. Kryzhanivska, A. Chuprikov, E. Gorban), mental health disorders (E. Khomska, V. Krasnov ). Children were particularly affected, the effect of small doses of radiation on the physical development of children was researched (N. Sinchuk, Z. Paramonov, V. Shatylo, V. Pavlyuk) [1; 5; 6].

Domestic scientists also worked on the scientific and practical problems: psychological assistance to the population affected by disasters (S. Yakovenko), psychological correction of psycho-emotional states of victims of the consequences of the Chernobyl disaster (V. Lysenko) and others [3; 7].

The population can make a negative impact on nature, and the consequences of this impact are manifested in the emergence of health disorders, in particular, human mental and psychological health.In the relationship between human and nature, it is the social community of people that is of great importance. A person's entry into human society is accompanied by the development of social adaptation of the individual, or its violation – maladaptation.

Social adaptation of an individual is a process of active adaptation to the social environment where a person is in, it has a continuous character, it is most evident during interaction with the social environment and during working activities. Complication of the individual's behavior in the social environment as a result of incorrectly formed ideas about oneself leads to the formation of social and psychological maladaptation.

At the current stage of global scientific research, the problem of social adaptation is described in many scientific achievements, in particular, its features are highlighted in the works of G.Yu. Aizenk, A. Bandura, K. Levin, L. Phillips and others, the structure and component composition were described by G.O. Bal, J. Piaget, and others.

Social adaptation is carried out with the help of mechanisms of social adaptation, which are grouped in the following way:

Cognitive mechanism (social-psychological-individual and activity dimensions):

adaptive strategies - forms of behavior aimed at analyzing the difficulties that arise and possible ways to overcome them, learning and gaining adaptive individual experience, increasing self-esteem and self-control, realizing one's own value as an personality, believing in one's own resources for overcoming difficult situations, developing skills and strategies solving psychological problems related to social adaptation, knowing one's activity in the context of the psychosocial activity of others;

maladaptive strategies – passive forms of behavior with refusal to overcome obstacles, despair in one's own strength and intellectual potential, deliberate underestimation of the situation, negative personal experience.

Behavioral mechanism (activity dimension):

adaptive strategies - behavior of an individual during which he cooperates with experienced people, seeks support in the nearest social environment or offers it to others in overcoming difficulties, compromise and cooperation, acceptance of "struggle";

maladaptive strategies - behavior that includes avoiding unpleasant situations, passivity, solitude,

isolation, the desire to avoid active interpersonal contacts, refusal to solve problems, rivalry, avoidance.

Emotional-affective mechanism (social-psychological-individual and activity dimensions):

adaptive strategies – an emotional state with active protest in relation to difficulties and confidence in the existence of a solution to any, even difficult, situation;

maladaptive strategies - behavior with a depressed emotional state, a state of hopelessness, susceptibility, experiencing anger and guilt toward oneself and others, lack of positive experiences.

Communicative mechanism (social-psychological-individual dimension):

adaptive strategies – strategies, forms and methods of communication leading to social adaptation;

maladaptive communicative strategies – inadequate and conflictual forms of communication that lead to social maladaptation and interpersonal and group conflicts.

Motivational - volitional mechanism (social-psychological-individual and activity dimensions):

adaptive strategies – internal motivational strategies and controlling - volitional qualities that lead to social adaptation;

maladaptive strategies – maladaptive motivations, in particular motivational strategies to avoid failure and external locus of control [8].

It is important to note that the ascending construct in the presented model is a personality with a personal core - the Self-concept.

The structure of the personality is presented in the following way:

The social-psychological-individual dimension consists of the following basic personality substructures: 1.1. Ability to communicate. 1.2. Orientation. 1.3. Character. 1.4. Self-awareness. 1.5. Experience. 1.6. Intellectual processes. 1.7. Psychophysiological personality qualities.

Activity dimension: 2.1. Need-motivational component. 2.2. Informational and cognitive component. 2.3. Goal-setting component. 2.4. Operational-resultative component. 2.5. Emotional and sensory component of activity.

The nosological dimension of the conventional personal space is differentiated into the characteristics of developmental disorders or the post-traumatic mental state of a person.

Age, genetic dimension, which determines the temporal quality of the four-dimensional personal hyperspace and characterizes the level of development of personality qualities, aptitudes, abilities, and mental properties [8].

The proposed model presents not only the vectors of influence of the population, in particular of individual social groups and individuals, on the socio-economic subsystem of the socio-ecosystem, but also of the results of this influence - anthropogenic pollution on the population, in particular on the individual and his social-psychological-individual, nosological (as there is high risk of physical and mental health disorders), activity, age, genetic dimensions.

**Conclusions and Prospects for Further Research.** A socio-ecosystem is a territorial socio-natural self-regulatory system, the dynamic balance of which must be ensured by human society. Different types of anthropogenic pollution have a sociological nature, that is, they arise as a result of human activity. For its part, anthropogenic pollution itself affects a person both in the form of physical health disorders (disruption of vital activities) and mental health disorders of a person, which is determined by a violation of the functioning of the mechanisms of social adaptation of the individual.

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# FORMATION OF ENVIRONMENTAL CULTURE IN PRESCHOOL CHILDREN

**Abstract**. The article emphasizes the need for formation of the environmental culture in preschool children, which is the initial stage of formation of the human personality. It is during this period that the foundations of interaction with the nature are laid, with the help of adults, a child begins to realize it as a common value for all people.

The role of the educator in formation of the environmental culture in preschool children is revealed. It is emphasized that the main priority in the educational process of a preschool educational institution should be ensuring the proper environmental culture. The educator must organize the educational process in such a way that it becomes environmentally favorable for children. The main task that the teacher should implement in the process of environmental education of preschool children is characterized. The task of the educator is to educate the younger generation in the tradition of the harmonious coexistence with nature, rational use and reproduction of its resources, in the psychological readiness to protect natural values.

In the course of the research, we specified the concept of "environmental culture". Features of the formation of the environmental culture in preschool children are distinguished and described.

It was found that the basis of the environmental culture includes elementary knowledge about nature: orientation in the nearest natural environment; awareness of the vital needs of living beings in the conditions of existence; familiarization with the elementary information about the interrelationships of living nature, its importance in human life. Children's knowledge of nature occurs during vigorous activities, when they master the skills of caring for its objects, preserving and creating conditions for their normal coexistence. In order to educate children in the humane attitude towards nature, not only knowledge is important, but also the education of humane feelings, positive experience in communicating with nature.

**Key words:** children of preschool age, environmental education, environmental culture, environmental consciousness, environmental attitude.

**Statement of the problem.** A person enters into a certain relationship with nature. He/she adapts to the natural environment, changing himself/herself under its influence, and, of course, transforms this natural environment with his/her activities. Therefore, the problem of the relationship between man and nature is not new, it has always existed. But now, at the present time, the environmental problem of the interaction of man and nature, as well as the interaction of human society on the environment, has become very acute and has taken huge scale.

The planet can be saved only by the activities of people, which are based on the deep understanding of the laws of nature, taking into account the numerous interactions in natural communities, and realizing that man is only a part of nature. This means that the environmental problem appears today not only as a problem of preserving the environment from pollution and other negative effects of human economic activity on Earth. It grows into a problem of preventing the natural impact of

people on nature, consciously, purposefully, systematically developing interaction with it. To realize this, an exceptional role is played by environmental education (instilling the moral, humane attitude towards nature).

Preschool childhood is the initial stage of formation of a human personality. Formation of the environmental culture is the most important task of a preschool institution at present. The components of a preschooler's environmental culture are knowledge about nature and its environmental orientation, the ability to use it in real life, in behavior, in various activities (in games, work, in everyday life).

The self-worth of preschool childhood is obvious: the first seven years of a child's life are a period of rapid growth and intensive development. It is during this period that the foundations of interaction with nature are laid, with the help of adults, a child begins to realize it as a common value for all people. This determines the relevance of the problem under consideration. Thus, the contradiction between the requirements of children's educational institution and the society with the insufficient level of the environmental culture in preschool children.

**Analysis of the latest research and publications** proves that at the current stage psychologists pay attention to the study of certain aspects of the outlined problem, in particular, formation of the environmental culture in preschool children.

The psychological-pedagogical foundations of formation of the initial ecological ideas in preschool children are the ideas of leading scientists, including: N. Hlukhova, N. Kondratieva, N. Lysenko, Z. Plokhii, V. Skrebets, V. Fokina, N. Yarysheva, etc.

Analysis of the modern scientific research by H. Bielienka, N. Horopakha, N. Lysenko, Z. Plokhii, O. Polovina, N. Yarysheva, etc. convincingly shows that formation of the environmental worldview is formed gradually during a person's life. The beginning of this process falls on the period of preschool childhood, when the foundations of world understanding, environmental awareness and practical interaction with nature are laid in the process of educational activity [1; 3].

The ideas of O. Zaporozhets, L. Lupiiko, V. Marshytska, M. Poddiakova, etc., about the correspondence to the age characteristics of preschoolers, their visual representation, effectiveness and systematization of knowledge, are the psychological foundations of formation of the initial environmental ideas in preschool children [2].

**The purpose of the article** consists of the theoretically substantiation of the formation of the environmental culture in preschool children in the process of familiarization with the surrounding environment.

**Presentation of the main material**. Analyzing the content of the education of the environmental concept, it is possible to distinguish such concepts as: environmental culture, environmental consciousness, environmental attitude, etc. In different literature, authors give different definitions of these concepts.

V. Krysachenko, for example, gives the following definition of eco-culture: "Environmental culture is defined as one of the forms of culture, as a person's ability to feel the living being of the world, to adapt it to himself/herself, to harmonize the own needs and the structure of the natural environment" [6].

According to Z. Plokhii, environmental culture is aimed at overcoming the own limitations of a person as a natural being in relation to his/her adaptation in the biosphere in conditions of constant competition from certain living forms. Knowledge about nature offered to preschoolers should not represent a number of fragmented facts, but an interdependent, consistent chain of ideas revealing the most important connections and regularities of the natural world [10].

Environmental consciousness is the individual and collective (social) ability to realize the inseparable connection of human being with the nature, the dependence of people's well-being on the integrity of the natural environment, the ability and habit of acting without disrupting connections and cycles in nature [7].

If various and quite important connections that exist in nature are revealed, the theoretical level of the material increases, cognitive tasks become more difficult, and therefore, this contributes to the development of children's cognitive activity. As noted by the researchers [2; 4-7], without knowledge of the environmental relationships, it is difficult to predict the possible consequences of intervention in the natural processes.

A. Liovochkina defines environmental education as a purposeful systematic pedagogical activity aimed at the development of environmental education and upbringing of children; accumulation of the environmental knowledge, formation of the abilities and skills of activity in nature, awakening of high moral and aesthetic feelings, acquisition of high moral personal qualities and firm will in carrying out

environmental work [9].

Environmental education is the purposeful formation of the environmental thinking, environmental, moral, and legal views on nature and the place of man in it by people of different ages. Its goal is formation of a personality capable of freely navigating the environmental protection situation. Educators are faced with the task of educating the younger generation in the tradition of harmonious coexistence with nature, rational use and reproduction of its riches, in the psychological readiness to protect natural values. Environmental education of preschoolers, as is known, is based on children's assimilation of the system of knowledge about nature, about the connections and dependencies existing in it, on awareness of the impact of human activity on nature.

In fact, environmental education has two sides: environmental awareness, environmental behavior. Formation of the basics of the environmental awareness, as already noted, takes place mainly at the lessons on acquaintance with the surrounding world, while environmental behavior is formed over the years, and not so much at the lessons as in unregulated environmental activities.

The psychological aspect is of great importance, which includes the following:

1) development of the environmental awareness;

2) formation of appropriate (naturally expedient) needs, motives and attitudes of the individual;

3) development of the moral, aesthetic feelings, skills and habits;

4) education of a strong will.

Preschool age is the most important stage in the formation of a person's environmental worldview; it involves creation of the prerequisites for humane interaction with the natural environment.

Psychologists' research shows that at the stage of preschool childhood, the development of various forms of knowledge of the surrounding world and perception, figurative thinking, and imagination is of particular importance. The ability to see the world in its vivid colors and images in a childlike way is very necessary for people, because such an ability is a necessary component of their creativity. Direct perception of the objects of nature, their diversity, dynamics affect children emotionally, bring them joy, admiration, surprise, thereby improving the aesthetic feelings.

Scientists Bauer M.Y., Kuryk M.I., Lysenko N.V., Plokhii Z.P. testify that formation of the foundations of the environmental culture should be started from an early age of a child. The depth and truth of the environmental education of preschoolers is discussed in M.Y. Bauer's monograph "Methodology of the Environmental Education" [4]. In particular, the author singles out the most important features characteristic of the development of the environmental culture in children, which we aim to form both in ourselves and in our pupils:

- presence of worldview value orientations regarding a positive attitude towards nature;
- nature-appropriate environmental style of thinking and a corresponding attitude towards nature and the own health;
- skills and experience in solving the environmental problems;
- direct participation in the environmental protection activities;
- prediction of the possible negative remote consequences of nature-changing human activity [4, p. 84].

In N. Yarysheva's textbook "Methodology of Children's Acquaintance with the Nature" [12], from the standpoint of the modern pedagogical research, the technology of acquaintance of preschoolers with nature is covered quite widely, as well as various types of creative work on environmental education, the basis of which is the child's knowledge and activities.

Lysenko N.V. draws attention to the essence of the multifaceted value of nature in the educational and methodical guide "Eco-Eye: a Preschooler Explores the Natural World" [8]. The above-mentioned monograph and textbooks will help scientists and practitioners to determine the directions, forms and methods of conducting an experiment on formation of the foundations of the environmental culture in preschool children.

The pedagogical training and educational process should be aimed at formation of such psychological properties of the individual as the need to communicate with nature, interest in exploring its laws, motives for behavior and activities for the protection of nature, conviction in the social conditioning of the relationship of man to nature, in the need to manage natural phenomena.

The effectiveness of the influence of the environment on a child's personality in a preschool educational institution depends on the ability of the teaching staff to organize a comfortable ecological and developmental environment. In order to form a child's natural and environmental competence, an adult must focus on these problems (global, regional, local), have a formed sense of public responsibility for the state of nature, desire and effective readiness to preserve it.

In the studies of A. Bogush, N. Havrysh, they emphasize that a developmental space should be created in the preschool institution, which promotes the development of children's active existence in the natural environment, with the help of which it is possible to organize various types of activities: educational and cognitive, playful, productive, speech and communicative [5, p. 101]

The developmental environment for formation of the environmental culture in preschool children provides for creation of a complex of conditions necessary for assimilation of the environmental knowledge by children associated with their appropriate behavior. It is thanks to the developmental environment that a child gains the experience of communicating with nature, is faced with the need to observe certain laws of nature, learns to assess the state of the natural environment, to be responsible for the consequences of his/her own actions, that is, the environmental competence is formed by him/her [5, p. 101]

The basis for creating an educational program for preschool children is the Basic Component of Preschool Education. This document outlines optimally necessary, but sufficient knowledge and skills for preschool children in various spheres of social life. The pedagogical process should be aimed at formation of such psychological properties of the individual as the need to communicate with nature, interest in exploring its laws, motives of behavior and nature conservation activities.

The educator implements the following tasks of the environmental education:

- education of the humane attitude towards nature;
- formation of a system of environmental knowledge and ideas about nature;
- development of the ability to see and feel the beauty, attractiveness of each element of the environment, to enjoy and admire them;
- inclusion in the necessary environmentally focused activity.

"Do not harm nature" is an important conclusion that children should reach when communicating with the environment. Solving these tasks will ensure active communication of preschoolers with the natural environment and contribute to their socialization. In each age group, certain program tasks are implemented to acquaint children with nature. They involve the gradual assimilation of natural knowledge. 2- and 3-year-old children are introduced to plants, animals, and phenomena of inanimate nature, are taught to separate them in space, identify and correctly name some signs of plants, imitate the movements and voices of animals. At the same time, children improve their analyzers (visual, auditory), develop interest and attention to what they see, and develop a good attitude towards them [11].

Children of the 4th year of life form ideas about the objects and natural phenomena with which they constantly meet in life, they are lead to establish such connections that children can learn in the process of object-sensory activity in classes, games and reflect them in the form of specific ideas. In the process of assimilation of knowledge, higher forms of cognitive activity are formed in children. Children are taught to observe, to distinguish certain signs of plants and animals, to compare objects, to group them according to the external features. 4-year-old children can approach the establishment of cause-and-effect relationships.

Around the age of 5, children develop the higher form of visual thinking. They can master generalized knowledge. Children are taught to distinguish the peculiarities of the structure of plants and animals and to establish their dependence on living conditions. Before coming to school, children should develop observation, curiosity, love and care for nature, the ability to find beauty in it, interest in agricultural work. [1;2]

Acquaintance with the basics of the environmental culture of the individual in the conditions of the educational institution is impossible without the search and implementation of new pedagogical technologies of education, which provide for the improvement of the educational process by means of children's heuristics, the introduction of new cognitive and creative-exemplary forms of children's vigorous activities, a combination of preschool and family education of worldview values attitude orientations. But in order to educate children in a humane attitude towards nature, not only knowledge is important, but also the education of humane feelings, positive experience in communicating with nature. It is very important to use various forms, technologies, methods and techniques in working with children, to carry them out with the active interaction with children by parents and teachers. To acquaint them with interesting nature, creative, cognitive activities for children, to use more practical classes. And then, through acquaintance with nature, we raise sensual, kind, attentive and caring people, an environmentally literate person.

Thus, the basis of the environmental culture is elementary knowledge about nature: orientation in the nearest natural environment; awareness of the vital needs of living beings in the conditions of existence; acquaintance with the elementary information about the interrelationships of living nature, its

importance in human life. Children's knowledge of nature occurs during vigorous activities, when they master the skills of caring for its objects, preserving and creating conditions for their normal coexistence.

**Conclusions**. So, it is possible and necessary to instill in children love for the environment, the ability to protect "green friends" and increase wealth from preschool age. That is why environmental education and formation of the environmental culture in preschool children come to the fore. One of the conditions for optimizing the environmental education in a preschool education institution is formation of the foundations of the environmental culture of preschoolers, which involves acquisition of humane feelings towards living organisms, ideas about nature and its components, knowledge about the rules of behavior in the natural environment, the ability to admire nature and feel its beauty.

**Prospects for further exploration in this direction**. Issues related to the study of the development of the environmental culture at other age stages, in different learning conditions, and determination of teachers' readiness to implement psychological and pedagogical programs for formation of the environmental culture require further study.

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**PROBLEMS OF ENVIRONMENTAL PROTECTION AND BALANCED NATURE MANAGEMENT**

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# PERSISTENT ORGANIC POLLUTANTS OF ECOSYSTEMS

***Abstract.*** The development of synthetic organic chemistry is always determined by creating of new compounds and application in medicine (pharmaceutics), production of cleaning, cosmetic remedies and nutrient additives. The production and application of such compounds are of minimum harm for people and environment regarding to special toxicological and sanitary requirements are concerned. However, multi-tonnage production of lacquers, dyes, rubber, pesticides, disinfectors, plastics, mineral and synthetic lubricants and their stabilizers, industrial surfactants and detergents, fluorocarbons, organometallic compounds make a great harm to environment. In this article the physico-chemical and toxicological characteristics of the most important persistent organic pollutants (POP) have been described. The possible approaches and technologies of POP disposal have been considered in the framework of Stockholm Convention.

Research show that when determining the most appropriate method of POPs detoxification, it is necessary to take into account, in addition to technological, some more economic and social factors, pay attention to ensuring human health.

***Keywords:*** persistent organic pollutants, chlorine-containing pesticides, ecotoxicants, detoxification, waste disposal

***Introduction.*** The development of synthetic organic chemistry is always determined by creating of new compounds and application in medicine (pharmaceutics), production of cleaning, cosmetic remedies and nutrient additives. The production and application of such compounds are of minimum harm for people and environment regarding to special toxicological and sanitary requirements are concerned. However, multi-tonnage production of lacquers, dyes, rubber, pesticides, disinfectors, plastics, mineral and synthetic lubricants and their stabilizers, industrial surfactants and detergents, fluorocarbons, organometallic compounds make a great harm to environment. The main part of such negative influence is determined by existing in Ukraine residues of liquid rocket fuels (so-called "heptyl" – 5000 tons, "amyle", "melange" - 18000 tons), unused pesticides (~14000 tons), chlorine-containing wastes contain 1,2-dichloretane and vinyl chloride (at "Lukor", Kalush (Ukraine) only in 2004 was burned 6000 tons of such wastes), hexachlorobenzene (HCB) residues (at «Oriana», Kalush (Ukraine) there are ~ 11000 tons of HCB stored on the polygon of toxic wastes), acid oil tar from petrochemistry (only in 2002-2003 years it was brought ~20000 tons of such wastes into the territory of Lviv Region, Ukraine), millions $m^3$ of wastes from the uranium ore enrichment (Taromske, Dnipropetrovsk Region, Ukraine), multi-tonnage wastes of Ukrainian petroleum industry etc. The most toxic and dangerous are the chlorine-contained organic substances of so-called "dirty dozen" among the above mentioned chemical substances which pollute the environment.

***The aim of the work.*** In this work the authors tried to pick out and generalize the main physico-chemical and toxicological characteristics of POP in order to establish the safety conditions or treatment and possible ways of the extermination of such ecotoxicants. This work was carried out in accordance which has been adopted by 127 countries all over the world. Ukraine has adopted the Stockholm Convention for POP at 23.05.2001. Nowadays the project of Ukrainian Law concerning the Stockholm Convention ratification about POP in the Ministry Cabinet of Ukraine and later will be in Supreme Council for the ratification. In case of Stockholm Convention ratification Ukraine will accept finances including the finances of Global economic fond for the solution of the problems related to POP chemical

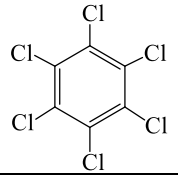
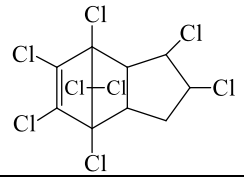
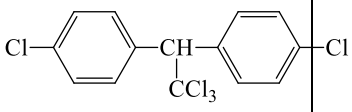
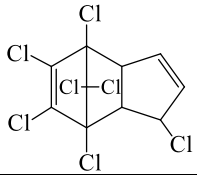
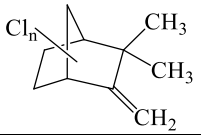
substances extermination for preventing release to the environment such highly toxic compounds due to modernization of the technologies of key industry branches.

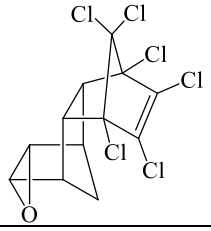
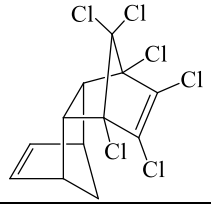
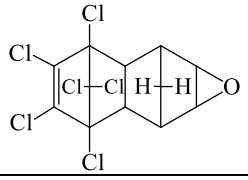
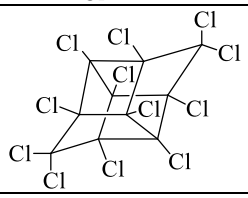
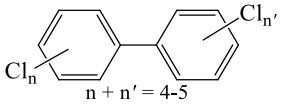
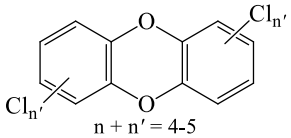
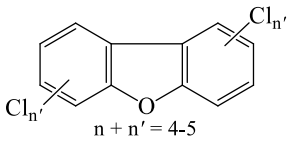
***Objects of the investigation.*** According to the Stockholm Convention (17.05.2004) the POP (table 1) are divided iпto 3 groups. The POP of 1st group contains highly toxic pesticides (DDT, Dieldrin, Aldrin, Heptachlor, Mirex, Toxaphene, Endrin, Chlordane, HCB). The POP of 2nd group contains the industrial polychlorinated biphenyls (PCB). The POP of 3rd group are not industrial produced, but high temperature processed on dust-burning factories and form waste which contains the chlorine. This group of over-toxic substances called «dioxins»: polychlorinated dibenzo-para-dioxins (PCDD), polychlorinated dibenzofurans (PCDF).

The physico-chemical properties of considered POP are listed in table 1. As a rule these substances are the polychlorinated compounds with large molecular weight and large chlorine content (50–78 %), large solubility in fat tissues of animals and human [8, 9]. Such compounds possess the cumulative properties and thermal stability, they are inert for the influence of the environment. That is why such POP can migrate in under-soil waters, crust, atmosphere during a long time. The POP of the II and Ill group are the most stable. These substances have aromatic structure with developed substituents (the dependence "structure-properties") [l0]. The attractive idea of studying fundamental dependence "structure-pesticide activity" by mathematical methods [11, 12] and making the total screening [13] is great stimulus for many investigations and publications in this field. It has been established the common requirements of "structure-activity" not only for polychlorinated aromatic systems [14], but also for iminoderivatives of sulfur [15], quaternary ammonium salts [16, 17], substituted ureas [18, 19], N-benzylacetamides [20], other chemical substances [21]. However, such investigations are auxiliary during the application and introducing the biological active compounds to the industry.

***Table 1***

**Physico-chemical properties of some POP**

| No | Structure | Trade name / CAS No / chemical name | m.p., °C | Chlorine content, % | Application field [2] |
|---|---|---|---|---|---|
| 1 |  | Hexachlorobenzene / 118-74-1 / Hexachlorobenzene | 231.0 | 74.69 | Fungicide, formerly used in a seed treatment |
| 2 |  | Chlordane / 57-74-9 / 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene | 175.0 (boil.) | 69.21 | Insecticide, against the thermites, rats |
| 3 |  | DDT / 50-29-3 / 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane | 108.5–109.0 | 50.01 | Insecticide, against the various insects, antimalarial and against typhus |
| 4 |  | Heptachlor / 76-44-8 / 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene | 95.0–96.0 | 66.48 | Insecticide, used in a combination with seeds |
| 5 |  | Toxaphene / 8001-35-2 / Polychlorocamphene | 65.0–90.0 | 68.54 | Insecticide, against the Colorado beetle |

| No | Structure | Trade name / CAS No / chemical name | m.p., °C | Chlorine content, % | Application field [2] |
|---|---|---|---|---|---|
| 6 |  | Dieldrin / 60-57-1 / 1,2,3,4,10,10-hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4,5,8-dimethanonaphthalene | 175–176 | 55.84 | Insecticide |
| 7 |  | Aldrin / 309-00-2 / 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene | 104–105 | 58.29 | Insecticide |
| 8 |  | Endrin / 72-20-8 / 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-endo-5,8-dimethanonaphthalene | 200.0 (decomp.) | 55.84 | Insecticide, against the pests |
| 9 |  | Mirex / 2385-85-5 / Dodecachloropentacyclo[5,2,1,02,6,03,9,05,8]decane | 485.0 | 77.98 | Insecticide, against the thermites. Polymer plasticizer |
| 10 |  | Sovol / Tetra- and pentachlorobiphenyls | 325–390 (boil.) | 54.30 (n + n′ = 5) | Plasticizer for lacquers and dyes, additive for transformer and condenser oils |
| 11 |  | PCDD / Tetra- and pentachlorodibenzo-*p*-dioxins | > 350.0 (decomp.) | 49.73 (n + n′ = 5) | The toxic wastes of the thermal disposal of chlorine-containing organic substances (COS) |
| 12 |  | PCDF / Tetra- and pentachlorodibenzofurans | > 350.0 (decomp.) | 52.07 (n + n′ = 5) | |

The toxicological properties of POP are listed in table 2. These compounds are xenobiotics. They are introduced to the environment as chemical products and technogenic pollutants. Above mentioned substances possess the carcinogenic, mutagenic, embriotoxic, neurotoxic, immunotoxic properties and kill all living organisms. They change the hormone system, cause the anemia, cancer, diseases of kidneys and human blood.

***Table 2***

**Toxicity, sanitary and hygienic parameters of POP**

| No | Trade name | Toxicity, sanitary and hygienic parameters | | | | Physiological influence of active substance on living organism |
|---|---|---|---|---|---|---|
| | | $LD_{50}$ mg/kg | $MPC_{w.z.}$ mg/m$^3$ | $MPC_w$ mg/l | $MPC_{PRQ}$ mg/kg | |
| 1 | Hexachlorobenzene | 1700 | 0.9 | – | – | Carcinogenic, teratogenic and immunotoxic |

| No | Trade name | Toxicity, sanitary and hygienic parameters | | | | Physiological influence of active substance on living organism |
|---|---|---|---|---|---|---|
| | | $LD_{50}$ mg/kg | $MPC_{w.z.}$ mg/m$^3$ | $MPC_w$ mg/l | $MPC_{PRQ}$ mg/kg | |
| | | | | | | substance. Affects the skin |
| 2 | Chlordane | 250 | 0.01 | – | – | Carcinogenic, mutagenic, neurotoxic substance. Affects the blood, liver, hormone system |
| 3 | DDT | 200 | 0.1 | 0.2 | – | Carcinogenic, mutagenic, embriotoxic, neurotoxic, immunotoxic substance. Affects the hormone system, liver, causes anemia |
| 4 | Heptachlor | 82 | 0.01 | 0.05 | 0.05 | Toxic substance for animals and human. It transforms into the very toxic heptachlor epoxide under the influence of ultraviolet radiation |
| 5 | Toxaphene | 60 | 0.2 | – | 0.5 | Strong toxicant for fish and animals. Carcinogenic, neurotoxic substance. Affects the blood, liver and kidneys |
| 6 | Dieldrin | 24 | 0.01 | – | – | According to the official data, there is no substance on the territory of Ukraine |
| 7 | Aldrin | 18 | 0.01 | 0.02 | – | According to the official data, there is no substance on the territory of Ukraine |
| 8 | Endrin | 5–12 | – | – | – | Carcinogenic, neurotoxic substance. Affects the hormone and reproductive system |
| 9 | Mirex | – | – | – | – | According to the official data, there is no substance on the territory of Ukraine |
| 10 | Sovol | – | 1.0 | – | – | Causes the Down syndrome. Affects the nervous system of children, increases the toxicity of other substances due to synergetic effect |
| 11 | PCDD | At one-moment influence: min: 0.5–1 mcg/kg max: 70 mcg/kg | – | – | EU: 4 pg/kg per day; USA: 1 pg/kg per day; RF: 10 pg/kg per day; | Extremely toxic substance. Carcinogenic for animals and human. Affects the immune system (direct analogues of HIV), causes immunodeficiency similar to AIDS |
| 12 | PCDF | | – | – | | |

*Note: $LD_{50}$ – dose of the product, that causes the death of 50 % of the experimental animals; $MPC_{w.z.}$ – maximum permissible concentration in the air of working zone; $MPC_w$ – maximum permissible concentration in the water; $MPC_{PRQ}$ – maximum permissible concentration (permissible residual quantity) in the nutrients; 1 mcg = $10^{-6}$ g; 1 pg = $10^{-12}$ g.*

Such conclusions have been made on the basis of numerous investigations. It has been made the investigations concerned with the influence of physical, chemical and biological factors on the decomposition of pesticides in soil [22, 23], its metabolism in plants and animals [24, 25]. Detailed investigations of the analysis of chlorine-containing pesticides [26], extraction and purification of pesticide metabolites [27] and elaboration of the universal methods of the micro-quantities determination of chlorine-containing pesticides [28] have been made. The key factor is the studying of the mechanism of POP biochemical action [29, 30]. For example, DDT and pyrethroids causes the Na-channel closing in the nervous cell membranes. DDT open and close the channels quickly and cause depolarization, -hexachlorocyclohexane, Dieldrin and other chlorine-containing insecticides increases the concentration of $Ca^{2+}$ due to disturbing the work of Ca-pump regulator or reducing the concentration of $Ca^{2+}$ by endoplasmic reticulum [31].So it may be seen that various disturbings of the biochemical xenobiotics lead to numerous above mentioned diseases.

***Technological aspects of POP detoxification***. According to the Stockholm Convention the

production of compounds No 4-8, 10 (table 1) is prohibited all over the world. The production of compounds No 1-3 (table I) should be allowed only according to the permission for participants which are enumerated in Register. This is explained by comparatively low toxicity values of last substances which is listed in table 2 ($LD_{50}$ = 200-1700 mg/kg). Nowadays, as exception the compounds No 2, 4, 9 can be used against thermites in buildings and compound No 3 can be used in Dicofol production. Other compounds must be exterminated.

The Convention spares the priority attention to the warding off the POP formation and release in the environment. It can be effectively reached by:

- using the low-waste technologies;
- using the less dangerous chemical substances;
- active using of the processes of recuperation and recycling the wastes and substances in framework of single technological process;
- using the principle of "industrial symbiosis" (waste and POP substances from first production can be detoxificated with the aid of POP substances from second production by the method of reagent processing [32, 33];
- reducing of elemental chlorine using or chemicals which generate the elemental chlorine as whitening agents;
- improvement of waste management in order to prevent open and uncontrolled burning of solid household waste, dust, medical and other waste. During the construction of new waste treatment factories it could be advisable to greatly reduce the formation of medical and household waste, use the renewal sources, re-using, recycling, separation of waste and promote the using of products which release less amounts of waste.

Besides the preventive measures there are lots of methods and technologies of the detoxification and extermination of chemical substances [34] including POP substances. The most popular are the methods of thermal [35], high-temperature pyrolysis [36], pyrometallurgical [37], oxidation (or direct burning), biotechnological, electrochemical, radioactive and photochemical dechlorination [6], reagent detoxification [6, 38, 39]. The application of super-high frequency (SHF) micro-wave chemical technologies is also perspective [40].

However, during the determination of the most advisable method of POP detoxification we must take into account, besides the technological, also some economic and social factors, and pay attention to the securing of human health.

***Conclusions.*** The physico-chemical and toxicological characteristics of the most important persistent organic pollutants (POP) have been described.The possible approaches and technologies of POP disposal have been considered in the framework of Stockholm Convention.

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# THE USE OF SPENT SORPTION MATERIALS FOR THE TREATMENT OF FOOD INDUSTRY WASTEWATER

*A significant number of sorbents used in the food industry are not reused due to the complexity of their regeneration and significant material costs. They are often stored on the territory of the enterprise or taken to landfills, usually without authorization. Today, it is important to study the regeneration and reuse of sorbents used in food production. It is promising to use sorbents previously used at the stage of water treatment or preparation of technological solutions and regenerated in wastewater treatment, in particular, in the same food production facilities and in other industries where wastewater contains organic substances.*

*The article investigates the reuse of a spent sorbent mixture consisting of activated carbon and kieselguhr for the treatment of wastewater from dairy processing enterprises. The results of experimental studies of the dynamics of ion exchange adsorption of lactic acid and alanine by mixed sorbent and spent sorbent under periodic conditions are given. According to the results of the study, the difference in cleaning efficiency for the two options is insignificant and amounts to about 3%, which is within the experimental error.*

*It is shown that the sorption of pollutant components of wastewater of milk processing enterprises by cheap sorbents, which include regenerated sorbents, is one of the most promising because of their high efficiency, low cost of treatment, and the possibility of further use of spent sorbents in agriculture.*

***Keywords:*** sorption, mixed sorbents, organic pollutants.

***Introduction.*** The food industry is one of the largest water consumers. The preparation of food and drinks is inextricably linked to the use of clean water. The quality of water used in the food industry is subject to careful monitoring. Moreover, each area of the industry must operate on the basis of both industry standards and specific regulations. This is the only way to ensure the required taste, odor, appearance, and internal content. Water treatment technologies that are relevant to the food industry include settling, coagulation, flocculation, flotation and biochemical treatment, disinfection, and electrodialysis. Water treatment in food production may involve several stages. Adsorption is often used for water treatment, in particular, water softening. For example, in the production of soft drinks, activated carbon filters are used to treat water, which can reduce the content of organic compounds and inorganic salts in drinking water. In beer production, water is softened by adsorption on zeolites.

A lot of food additives of synthetic origin (e.g., sodium benzoate, citric acid) cause undesirable coloration or turbidity of the product. The production process does not always allow for boiling to eliminate this drawback, as this often results in a loss of food value. In this case, activated carbon adsorption is most often used.

Sorption processes are widely used in the food industry. The quality of food products and technological schemes of their production always have special requirements, which are clearly regulated by the relevant documents. Accordingly, the sorption materials used in food production have the highest quality parameters, the content of impurities in them is minimal, and therefore the cost of such materials

is higher compared to adsorbents used in other industries.

The peculiarity of food production technologies is that the technological scheme always clearly stipulates not only the type of sorbent, but also its brand, dispersion, origin, and even the manufacturer. For example, sorbents are used to clarify sugar syrups, malt mixtures, refine edible oils, reduce acidity and eliminate unwanted color (Table 1). It is worth noting that activated carbon is most often used in food production, while a mixture of activated carbon and other, cheaper sorbents such as kieselguhr, zeolite, and glauconite is used to reduce the cost of the adsorption material.

***Table 1***

**Characterization of individual adsorbents and their application in the food industry**

| Technological process | Adsorption material |
|---|---|
| Purification of water-sugar solutions in the beverage industry | Kieselguhr brands Bekogur 3500 and Bekogur 200 activated carbon, synthesized from wood (for example, Dekolar A) |
| Clarification of sugar syrup before concentration | Activated carbon synthesized from wood (for example, BAU-A) and thermally activated glauconite |
| Purification of edible oils | Activated carbon is synthesized from walnut shells (for example C WZ-22 ) |
| Reducing acidity of dairy products | Zeolite CPPS and thermally activated glauconite |
| Removal of unwanted color (whey, milk, low-alcohol beverages) | Activated carbon synthesized from coconut shells (for example, Norit DLC SUPER 30) |
| Softening of drinking water | Crushed stone and sand from natural zeolite of the Sokyrnytsky deposit |

Among the conventional treatment methods, adsorption processes are widely used to achieve effective removal of dyes from industrial wastewater [1-4].

Adsorption processes are widely used in food technology, not only in the preparation of raw materials and water, but also in the treatment of wastewater. These processes are among the most effective methods of cleaning water from organic matter pollution.

Solid sorbents are used for various processes which differ in certain patterns. Such processes include physical adsorption, chemisorption, ion exchange, chromatography, etc. Various synthetic and natural solids sorbents are used for adsorption processes. Choice sorbent is determined by its sorption capacity, selectivity, and cost. Recently, natural and modified sorbents - zeolites, bentonites, kieselguhr and activated carbon were widely used [1,3] for wastewater treatment.

An important advantage of these methods is possibility of regeneration of sorbents and their reuse [2].

The use of traditional activated carbon (AB) is the most common in adsorption processes, but it is quite expensive. Many studies have been conducted to investigate the adsorption properties of low-cost adsorbents such as peat, bentonite, steel mill slag, porcelain clay, corn residues, wood chips, and silica [1]. However, these inexpensive adsorbents usually have low adsorption capacity and require large amounts of adsorbent to effectively treat wastewater. To date, in order to reduce the cost of AB, it is most often used in a mixture with clay natural or modified sorbents, or food industry waste [4].

Wastewater from food processing plants is a highly concentrated microbiological contaminant. The technical solutions used today to treat them are ineffective due to their low technical level, or they are costly and lead to a significant increase in production costs.

Wastewater from dairy processing plants is characterized by a high content of dissolved organic matter, characterized by COD (chemical oxygen demand) in the range of 2000 - 60,000 mg $O_2/dm^3$. Law prohibits disposal of such wastewater into sewerage networks, and its accumulation on filtration fields leads to the formation of toxic substances.

Currently, adsorption methods using natural and synthetic sorbents are widely used for wastewater treatment, which makes it possible to regenerate and reuse them. The availability of natural porous materials in our region that have filtering properties and are able to adsorb suspended and dissolved components in water with the pore surface makes it possible to use them effectively for wastewater treatment of dairy processing plants, which confirms the relevance of certain studies [5]. At the same time, the use of activated carbon is considered the most effective for removing organic matter from wastewater, but due to the high cost of such an adsorbent, its use for wastewater treatment is limited. A significant number of sorbents used in the food industry are not reused, due to the complexity of their regeneration and significant material costs. In addition, the reuse of used sorbents requires their biological

treatment, which is due to the specifics of the adsorbed substances. Therefore, they are often stored on the territory of the enterprise or taken to landfills, usually without authorization. More promising is the use of such sorbents in wastewater treatment, in particular, in food production and other industries where wastewater contains organic substances.

**The purpose of the research** is to investigate the possibility of reusing a spent sorbent mixture for wastewater treatment at dairy processing plants.

***Experimental part.*** The regeneration of the spent mixed sorbent, consisting of activated carbon (BAU-A) and kieselguhr (K) of Bekogur 200 grade in a mass ratio of 1 : 3, was carried out as follows:

- At the first stage, the regeneration of the mixed sorbent was carried out in a hydrodynamic mode at a mass ratio (sorbent): $H_2O$ = 1 : 4, process temperature 50-60°C for 45-60 min.
- The mixed sorbent was boiled stepwise in a 1 % NaOH solution for 45-60 min and a 4 % HCl solution for 45-60 min, followed by filtration, washing with distilled water to pH = 7, and drying.

The efficiency of regeneration was determined by the ability of the spent sorbent to absorb the main pollutants of dairy wastewater.

The main pollutants of wastewater are:

- lactic acid (α-oxypropionic acid);
- milk proteins (mostly water-soluble, albumin)
- molasses;
- orphan;
- fats;
- lactose;
- synthetic organic substances that cause coloration of wastewater (sodium benzoate, salts of citric and malic acids, etc.);
- phosphorus half.

For the study, were used model solutions containing lactic acid at a concentration of 0.002 mg/dm$^3$ and alanine (modeling the content of water-soluble proteins) at a similar concentration. It was investigated the process of sorption of oxypropionic acid and alanine by regenerated mixed sorbent (variant 2), mixed sorbent consisting of activated carbon (BAU-A) and kieselguhr (K) of Bekogur 200 brand (variant 1). The study of the sorption process of α-oxypropionic acid and alanine by a mixed sorbent under dynamic conditions was carried out in a column-type apparatus. The work was carried out on an installation (Fig. 1), which operates according to the following scheme: the model solution flows from the separating funnel 1 into the adsorption column with zeolite filling 2. The sorbent is poured onto a grate 3 covered with low-density filter paper (black tape). The filtration rate is regulated by the tap 4 on the dividing funnel 1 and the tap of the column apparatus should be fully open. The filtrate was collected in a container 5 at regular intervals and analyzed. The minimum height of the sorbent layer was at least 7cm [6].

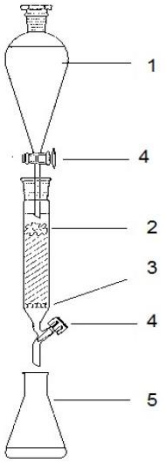


**Figure 1.** Schematic of the experimental setup:
1 – separating funnel with eluent;
2 – mixed sorbent;
3 – grate;
4 – faucet;
5 – receiver for collecting fractions

The lactic acid content was determined by potentiometric titration, and the amino acid content was determined by the photocolorimetric method based on the ability of peptide bonds (- CO-NH-), carboxyl and amino groups to form colored complex compounds with copper sulfate in alkaline medium. Solutions of amino acids and proteins give a blue-violet color [7].

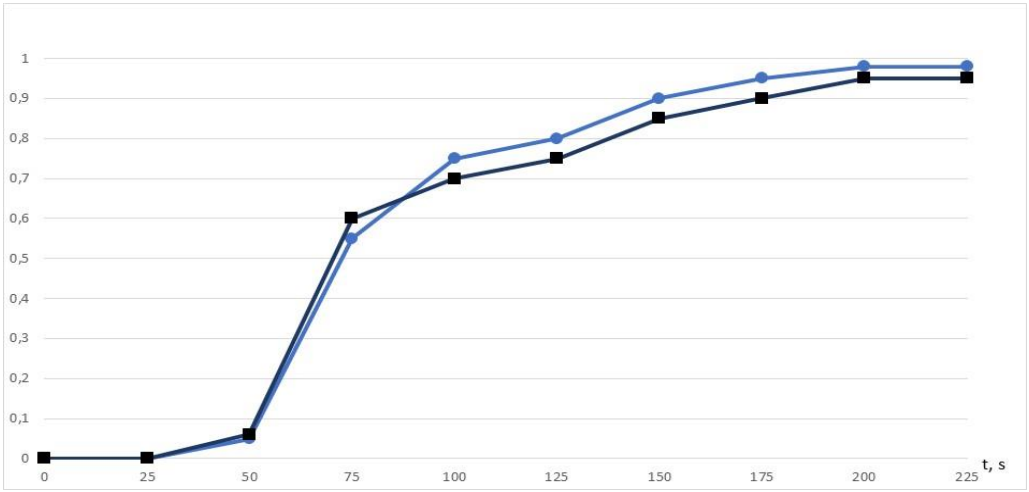


**Figure 2.** Sorption curves of α-oxypropionic acid depending on the sorbent:
● - fresh mixture of activated carbon and kieselguhr (variant 1)
■ - spent and regenerated mixture of activated carbon and kieselguhr (variant 2)

The curves of lactic acid sorption by the mixed sorbent are shown in Fig. 2. It is obvious from the data that under the conditions of this hydrodynamic regime of the adsorption process of α-oxypropionic acid on the selected sorbent, a mixed-diffusion adsorption mechanism takes place. We observe a plateau in the time space of 100-150 s. At the same time, the efficiency of the spent and regenerated sorbent practically does not differ from the fresh mixture of activated carbons of kieselguhr.

According to the results of the study, the maximum degree of purification for option 1 is somewhat higher; amounting to 98%, but the difference in the efficiency of purification for the two variants is insignificant, amounting to about 3%, which is within the error of the experiment. The maximum degree of purification for the home variants is achieved in the same time interval - in 200 seconds.

Experimental data on the kinetics of alanine adsorption are shown in Fig. 3. The plateauing at time >15 min of sorption indicates the transition of the adsorption process to the internal diffusion region and to the equilibrium state. At the same time, it is observed that the sorption efficiency is somewhat higher when using a fresh mixture of activated carbon and kieselguhr, but the difference in the purification efficiency for the two variants is insignificant (99% for variant 1 and 96% for variant 2), amounting to 3%, which is within the error of the experiment. The maximum degree of purification is achieved in the same time intervals for the home variants, it occurs after 175 seconds.

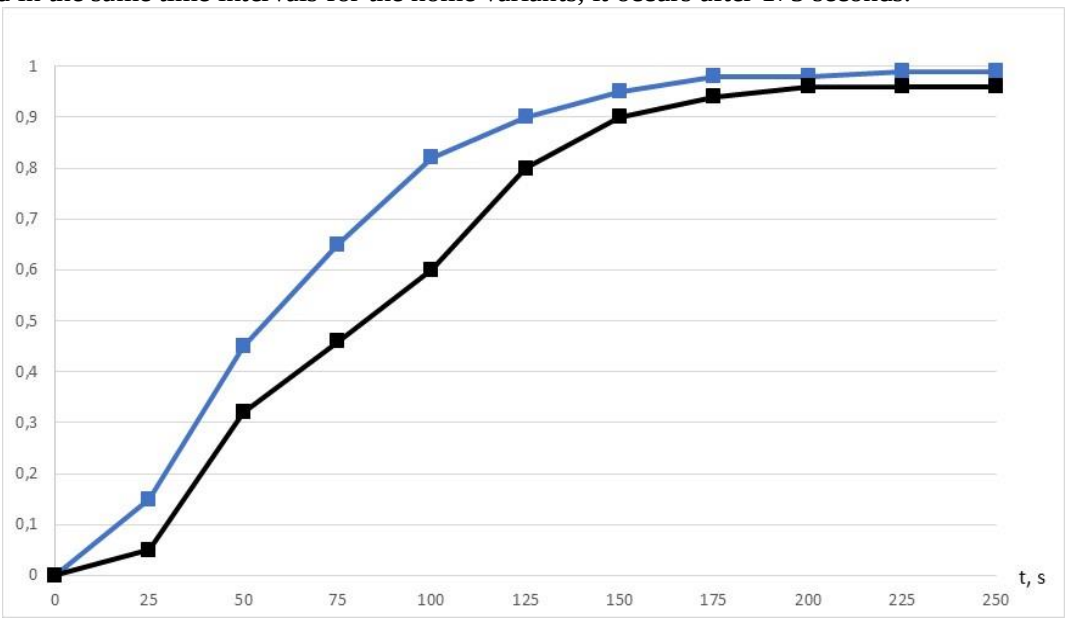


**Figure 3.** Sorption curves of alanine depending on the sorbent:
● - fresh mixture of activated carbon and kieselguhr (variant 1)
■ - spent and regenerated mixture of activated carbon and kieselguhr (variant 2)

Therefore, it can be argued that chemical regeneration of the spent sorbent mixture containing diatomaceous earth and activated carbon allows the use of waste materials at the stage of wastewater treatment of food production and provides the necessary extraction of pollutants of organic origin.

**Conclusions.** The effectiveness of regeneration of the spent mixed sorbent was determined, when it was sequentially purified from organic impurities after clarification of technological solutions by treating it with 1,25 % NaOH solution or sequential treatment with 1 % NaOH solution and 4 % HCl solution with the restoration of the sorption capacity of such a sorbent to 97-100 %. The activity of the regenerated mixed sorbent towards the main components of wastewater from dairy processing enterprises was investigated.

The research shows that the sorption of pollutant components of dairy processing enterprises by cheap sorbents, including regenerated sorbents, is one of the most promising due to their high efficiency, low cost of treatment, and the possibility of using spent mixed sorbents as fertilizers, soil structure improvers, and feed mixtures.

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# THERMAL TREATMENT AS A METHOD OF REMEDIATION OF SOIL CONTAMINATED WITH PESTICIDES

*Thermal treatment of pesticide-contaminated soil is one of the effective methods of purifying soil from harmful pollution. Since pesticides have a harmful effect on humans and the environment, especially if they enter the body through food, there is a need to reduce their amount in the soil. Thermal treatment of soil contaminated with pesticides consists in raising the temperature of the soil to a certain level, which allows the destruction of pesticides and other harmful substances. The purpose of this work is to analyze the results of previously conducted studies using high-temperature processing and their conclusions regarding the effectiveness of the method.*

*The review of research was conducted on the basis of the criteria for the effectiveness of thermal treatment and its potential use for the remediation of pesticide-contaminated soils.*

*Recent research shows that thermal treatment of pesticide-contaminated soil can be a self-sufficient and simple method of soil purification. However, further research is needed in this area to improve methodology, techniques and environmental safety development regarding post-procedural soil behavior and waste disposal. All this can help in further work on solving the problems of soil pollution and help preserve the health of people and ecosystems.*

*It has been established that heat treatment is one of the most effective methods of remediation of soil contaminated with pesticides. It allows you to reduce the level of pollution by a significant amount after just one application of this method. However, before using the treatment, it is necessary to study in detail all possible factors affecting the effectiveness of the method, including temperature, duration of treatment, type of soil and others.*

*Various methods of heat treatment, their effectiveness and possibilities of use in real conditions were analyzed. The main factors affecting the effectiveness of the method, as well as various options for the application of heat treatment, depending on the type of soil and the level of contamination, were also investigated.*

***Keywords:*** soils, purification, pesticides, remediation, heat treatment.

***Introduction.*** Pesticides are substances designed to control pests of plants, animals, and other organisms that damage crops. However, their improper use and accumulation in the soil can lead to serious consequences for the environment and human health. One of the most serious problems associated with the use of pesticides is their accumulation in the soil. In the case of long-term use of pesticides, they can accumulate in the soil and transfer to plants and animals that feed on contaminated areas. This can lead to serious food contamination and affect the health of the people who consume it. In addition, pesticides can have a harmful effect on the environment, as they can enter groundwater and rivers, which can affect the diversity of ecosystems and lead to the death of fish and other aquatic organisms [1].

Thus, soil contamination with pesticides is a serious problem that requires immediate measures to solve it. Thermal soil treatment is one of the effective methods of remediation of pesticide-contaminated soils and can be used to restore soil quality and ensure food safety. Another problematic aspect of soil contamination with pesticides is that these substances can be transferred to different ecosystems and thereby affect human and animal health. Many of the pesticides are very persistent and can remain in the soil for decades. This means that even if the use of pesticides is stopped, their residues can affect insects

for a long time. Therefore, many researchers are looking for new technologies to remediate pesticide-contaminated soil. One of these methods is heat treatment of the soil. It consists in treating the soil with high temperatures, which reduce the concentration of pesticides in the soil by destroying them.

Although heat treatment is a fairly effective method of remediation, it has its advantages and disadvantages. One of the biggest disadvantages is that high temperatures can kill the beneficial microorganisms that live in the soil and are necessary for its fertility and is a rather expensive method, as it requires a lot of energy and time.

Therefore, it is necessary to continue research and develop new methods of remediation of pesticide-contaminated soil that are more effective and less harmful to the environment and human health.

**Analysis of research and publications.** A review of soil remediation methods for pesticide contamination examines several effective methods, such as phytoproduction, phytosenization, phytoremediation, bioremediation, and phytoextraction. However, all of these methods have their own peculiarities. Phytoproduction and phytosenization are very effective methods because they use natural processes to clean the soil but they usually require a lot of time and resources. Bioremediation, which uses microorganisms to break down pesticides, is effective but requires temperature and humidity control [1]. Phytoremediation and phytoextraction are the newest methods of soil remediation. Phytoremediation is the use of plants to break down pesticides and clean the soil. This method can be more effective than phytoproduction and phytosenization, because plants can produce enzymes that break down pesticides faster than natural processes [0]. Phytoextraction is the use of plant extracts to remove pesticides from the soil. This method can also be effective, but requires a large amount of plants and water to produce the extract [7].

It is important to consider all possible methods of soil remediation in order to choose the optimal and effective approach to solving the problem of pesticide contamination. One of the soil remediation methods is thermal soil treatment. It involves heating contaminated soil to high temperatures to destroy pollutants and can be applied to a variety of pesticides. In addition, thermal treatment is a relatively fast and effective method that can be applied at the site of contamination without the need to transport the soil to special sites . However, this method also has its limitations and disadvantages, in particular, the high cost and the need for large energy costs for heating the soil .

After analyzing various methods of soil remediation , thermal treatment was found to be the optimal method for remediation of pesticide-contaminated soil. This method allows for the destruction of pesticides in the soil by raising the temperature to high levels and is an environmentally acceptable method as it does not use chemicals to destroy pesticides.

***The purpose of research*** is to study the heat treatment as a potential method of remediation of soils contaminated with pesticides and the principle of action of heat treatment, its effectiveness and the possibility of application for practical purposes. Parameters affecting the reduction of the amount of pesticides in the soil are also analyzed.

Thermal treatment of soil is based on the use of high temperatures to break down pollutants into simpler components. As a result, pesticides break down into less toxic substances that can be safely removed from the soil or used as a source of nutrients for plants. One of the key elements of heat treatment is temperature, which is usually in the range of 300 - 700 $^0$C [2]. This method can be used to remove various types of pesticides, including organic insecticides, herbicides and fungicides. In addition, thermal treatment can be applied to different types of soil, such as sands, clays, and soils with a high humus content [5].

During heat treatment, the soil is exposed to a high temperature, which leads to the decomposition of pollutants into simpler components. This process occurs in two stages: desorption and degradation. During desorption, pesticides are released from the soil and enter a gaseous state, after which their degradation occurs due to thermal decomposition. However, it is worth noting that heat treatment can have some disadvantages, in particular, it can affect the structure of the soil and its physical properties, such as water permeability and gas permeability. In addition, the process can be quite complex and require a lot of energy. It is also important to consider that thermal treatment may not be effective in removing pesticides that are in hard-to-reach places, for example, in soil pores or in aqueous solution.

Heat treatment parameters such as temperature, duration and intensity are important for process efficiency. The temperature should be sufficient to destroy pesticides, but at the same time should not lead to damage to beneficial microorganisms in the soil. The most effective soil treatment temperature depends on the type and concentration of contamination. The duration of treatment is also an important parameter, as it is necessary to ensure sufficient time for the destruction of pesticides, but at the same time should not allow damage to beneficial microorganisms. The intensity of heat treatment affects the

speed of the process and ensures even distribution of heat in the soil. To achieve optimal results of soil treatment, it is necessary to balance all parameters well, taking into account the content of pesticides in the soil and their chemical properties.

The results of the study have shown that the optimal temperature for remediation of soil contaminated with pesticides is 250-300 $^0$C, while the duration of treatment should be at least 4 hours. It has been proven that when the temperature drops below 200 $^0$C, the effectiveness of remediation is significantly reduced, since the complete decomposition of pesticides does not occur. At the same time, when the temperature rises above 350 $^0$C, soil degradation and loss of nutrients can be observed, so it is necessary to choose the optimal temperature taking into account these factors [4].

Different methods can be used for thermal treatment of pesticide-contaminated soil, which differ in the type of thermal energy used for treatment. One such method is steam treatment, which can significantly reduce heat treatment time and increase process efficiency[5]. Another method is infrared heating, which uses infrared energy to heat the soil to high temperatures and break down pesticides and other pollutants in the soil. After that, the soil can be used again for crop production [6]. The method using water vapor is that the soil is first heated, after which it is moistened so that the water becomes saturated steam. The water then turns into steam, which penetrates the soil and helps remove pesticides. After that, heating is carried out again, which helps to evaporate water and reduce the level of moisture in the soil. There are also other thermal treatment methods, such as incineration and exothermic oxidation, but they are less efficient and may have a greater negative impact on the environment.

An overview analysis of the results of scientific research confirms that heat treatment can be an effective method of remediation of soil contaminated with pesticides. However, the success of this method depends on several interrelated factors, the most important of which are the treatment parameters and the properties of the contaminated soil.

It was established that different types of soil can affect the efficiency of heat treatment. It has been studied that heavy clay soils may be less amenable to heat treatment because their structure may prevent effective heating of the entire soil mass. Conversely, sandy soils may be more amenable to heat treatment due to greater heat permeability. In addition, the effect of temperature on pesticide decomposition may depend on its physical and chemical properties. For example, in acidic soils the decomposition of organic matter can be slow, while in alkaline soils it is fast. Also, the location of pesticides in the soil can affect the effectiveness of the treatment: the depth of their occurrence, their concentration, and the time they stay in the soil [7].

The mechanism of pesticide degradation during heat treatment also depends on the type of pesticide and the processing conditions. Usually, decomposition occurs through the processes of dehydration, disintegration, and oxidation [8].

Depending on the type of pesticide, the decomposition mechanism may differ. Pesticides containing fluorine, chlorine and bromine atoms can be decomposed at temperatures below 400 $^o$C, while pesticides containing phosphorus and sulfur atoms can be more resistant to thermal treatment. Organophosphates , on the other hand, have high thermal stability, so their degradation occurs at high temperatures (more than 500 °C).

Studies show that heat treatment can lead to changes in soil structure, depending on the type and duration of treatment. In addition, a change in soil pH is possible due to a decrease in the content of organic matter and water, as well as an effect on the content of organic matter and other elements that are important for plant development and human health [4,8].

For example, studies have shown that thermal treatment can contribute to a decrease in soil pH and an increase in its solubility, as well as to a change in the structure and composition of organic soil, which in turn affects the absorption of pesticides by the soil, its properties and general condition [4].

It is especially important to preserve soil structure after heat treatment, as soil structure is one of the main properties that determines the ecosystem functions of soil, such as interaction with plants and biodiversity. Studies have shown that high temperatures can cause a decrease in soil structural stability, which can lead to soil coagulation and reduced ventilation, as well as reduced water permeability and water content. However, temperature can have a positive effect on the effectiveness of pesticide remediation, as high temperatures increase the decomposition of pesticides in the soil.

Investigating the effect of thermal treatment on the microbiological composition of soil is an important step in studying the effectiveness of this method for remediation of soil contaminated with pesticides. During thermal treatment, the temperature of the soil is maintained at the level of 70-100°C, which can affect the microbiological composition of the soil. Thermal treatment can affect the composition of the bacterial and fungal population of the soil, reducing their number. However, at the

same time, heat treatment can reduce the number of pathogenic microorganisms and other undesirable microorganisms, which can be a positive effect. Thus, the study of the effect of high temperature on the microbiological composition of the soil is an important stage of researching the effectiveness of this method and taking this effect into account when planning remedial measures [7].

It is known that heat treatment can have a certain effect on the vegetation and ecosystems of the surrounding environment. However, the level of this effect may depend on several factors, such as the intensity of treatment, the type and time of heat treatment, and the type of soil.

Also, it is worth noting that during heat treatment, harmful substances can be formed, which can negatively affect plants and animals. For example, dioxins and furans can be formed , which are potentially carcinogenic [8].

**Comparison of advantages and disadvantages of thermal methods .** The advantages of the thermal treatment method for the remediation of soil contaminated with pesticides include:

1. Effectiveness: Heat treatment is an effective method for destroying pesticides in soil because it can reach high temperatures that ensure the decomposition of pesticides into safe substances.
2. No need to use chemical reagents: the treatment does not require the use of chemical reagents, which makes it safer for the environment.
3. Shorter turnaround time: Heat treatment can be completed within hours, which is significantly faster than some other remediation methods.
4. Preservation of soil quality: Heat treatment can preserve soil quality because it does not use chemical reagents that can damage the soil.
5. No residual products: after processing, no residual products remain that can negatively affect the environment or human health.
6. Suitable for a wide range of pesticides: High-temperature treatment can be applied to neutralize different types of pesticides, making it more versatile than other remediation methods.
7. Cost-effectiveness: the heat treatment method can be beneficial from an economic point of view, since it is not necessary to spend significant funds on the purchase of chemical reagents and other equipment.[4,5,7]

The disadvantages and limitations of the thermal treatment method for remediation of pesticide-contaminated soil are important issues to consider before using this method. One of the most serious disadvantages is the high energy consumption and costs for ensuring the required temperature conditions. There are also certain limitations associated with soil types where the application of thermal treatment may be less effective or even impossible.

Heat treatment can have a negative effect on the biological activity of the soil, as it can reduce the content of organic matter and destroy beneficial microorganisms. Also, there may be some problems with uniform heating of the soil, especially large volumes, which can lead to uneven distribution of heat and uneven decomposition of pesticides.

In addition, there is a risk of evaporation of toxic substances during heat treatment, which can lead to environmental air pollution. The consequences of such pollution can have a harmful effect on the health of people and animals, as well as on the natural environment.

Also, heat treatment can cause changes in the structure and properties of the soil, which can negatively affect the ecosystem. For example, an increase in temperature can lead to a decrease in organic matter in the soil, which can reduce its nutrient and moisture-holding capacity. A change in the structure and morphology of the soil cover, in turn, can reduce the microbiological activity of the soil and reduce its fertility [8].

When choosing a remediation method soil and pesticide disposal, it is necessary to take into account all shortcomings and limitations by selecting the optimal parameters of high-temperature treatment of the fertile soil layer, the area and depth of the soil cover; also, the processing method involves preliminary studies of the content of pesticides, their chemical composition, soil toxicity[2,4,7].

**Conclusions .** As a result of the analysis of research carried out by Ukrainian and foreign scientists, it was established that heat treatment can be an effective method for removing pesticides from the soil. It makes it possible to achieve more than 90% reduction in the concentration of pesticides in the soil, provided the procedure is performed correctly.

The effectiveness of heat treatment depends on such basic factors as the type of pesticides and the type of soil. At the same time, high temperature during heat treatment can lead to a decrease in the physical and chemical properties of the soil, such as pH and organic matter content. At the same time, heat treatment can have a negative effect on the microbiological composition of the soil and plant cover.

One of the biggest economic drawbacks is that heat treatment can be quite an expensive and

complex process that requires special equipment and skilled personnel.

In general, thermal treatment of soil is recognized as an effective method of pesticide remediation , however, some disadvantages and limitations must be taken into account, including limitations on the depth of treatment and the impact on the microbiological composition of the soil and the environment.

It is necessary to carry out preliminary additional research on certain areas of the soil cover to determine effective methods, techniques and frequency of heat treatment.

Considering the advantages and disadvantages of thermal soil treatment, such methods can be an effective choice for remediation of pesticides in soil, provided the necessary safety measures are observed and its limitations are taken into account. These results can be useful for farmers, scientists and representatives of government bodies dealing with soil pollution problems, remediation of the fertile soil layer and disposal of toxic wastes present in soils and groundwater.

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