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VERBESSERUNG DES CHEMIEKURS AUF DER GRUNDLAGE MODERNER PÄDAGOGISCHER TECHNOLOGIEN AM BEISPIEL NICHT-CHEMISCHER HOCHSCHULRICHTUNGEN

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Zusammenfassung: Der Artikel fasst die Erfahrungen aus langjähriger Forschungs- und Produktionstätigkeit der Autoren auf den Gebieten der physikalischen Chemie und der chemischen Technologie des Glaszustandes zusammen. Die Ergebnisse der Analyse zeigen, dass Umweltprobleme nicht nur durch die Wissenschaft der Chemie erzeugt werden, sondern auch durch die Verwendung ihrer Ergebnisse in einer ökologisch ungebildeten Person. Es wird darauf hingewiesen, dass die Menschheit ohne Chemie nicht bequem existieren und vor allem die angehäuften Umweltprobleme nicht lösen kann. Zur Untermauerung des Vorstehenden einige Beispiele für die Entwicklungen der Autoren im Energiesektor, Hochtemperaturtechnik, Glastechnik, dem Bereich der glasartigen phosphorhaltigen Düngemittel, der Schaffung abfallfreier Industrien und einer umfassenden Studie der physikalisch-chemische Gesetze zur Gewinnung von glasigen Düngemitteln sind durch Ölsorbentien anorganischer und organischer Natur gegeben.

Schlüsselwörter: Umweltsicherheit im Energiesektor, nicht standardisierte wärmetechnische Einheiten, Glastechnologie, glasige phosphorhaltige Düngemittel, abfallfreie Produktion, glasige Ölsorptionsmittel anorganischer und organischer Natur**.**

IMPROVEMENT OF CHEMISTRY COURSE ON THE BASIS OF MODERN PEDAGOGICAL TECHNOLOGIES

On the example of nonchemical directions of higher education

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Abstract: The article summarizes the experience of many years of research and production activities of the authors in the areas of physical chemistry and chemical technology of the glassy state of matter. The results of the analysis show that environmental problems are generated not only by the science of chemistry but also by the use of its results in an ecologically illiterate person. It is noted that without chemistry humanity cannot exist comfortably and, most importantly, solve the accumulated environmental problems. In support of the above, some examples of the developments of the authors in the energy sector, high-temperature technology, glass

technology, and the field of glassy phosphorus-containing fertilizers, the creation of waste-free industries, and a comprehensive study of the physicochemical laws of obtaining glassy fertilizers are given by oil sorbents of inorganic and organic nature.
Keywords: environmental safety in the energy sector, non-standard heat engineering units, glass technology, glassy phosphorus-containing fertilizers, non-waste production, glassy oil sorbents of inorganic and organic nature**.**

Introduction. Today's global challenge is to transform natural systems and develop natural resources without damaging the ecosystem. On the importance of questions of achievement of the purity of the ecosystem is clearly evidenced. At present, the protection of the environment is facing humanity it has become one of the important issues. Water and air temperature control chemistry is of great importance in science when it comes to solving problems such as making, creating technology Without Waste, Etc [19]. Many of today's environmental problems are based on a variety of chemical processes. Therefore, chemistry is often seen only as the cause of the violation of the ecological balance in nature. However, without chemistry, humanity cannot comfortably exist, and that especially important - to solve the accumulated environmental problems. This article is aimed at reviewing some of the developments of the authors who are the result of their more than forty years of research and production activities in the field of physical chemistry and chemical technology of the glassy state of matter, which are convincing confirmation of the above.

Research results and discussion. Operational safety of the energy equipment is the main criterion that determines the possibility of power generation. Emergencies have a significant negative impact on the environment, therefore, they can be attributed to the problems of environmental safety. The reliability of power transmission lines is largely ensured by the quality insulation of electrical systems and equipment, in particular, the correct choice of the type of insulators on the designed line. The practice of building the Aswan hydroelectric power station, which gave electricity back in the summer of 1967, showed that glass is an indispensable material capable of operating simultaneously under conditions of high mechanical and electrical loads, as well as in aggressive environments. However, the composition of glasses used for the production of electrical products for mass use, including high-voltage insulators, remains very limited until today.

The development of glass compositions for high-voltage insulators was started by the authors of this articles from the early 1970s of the last century, i.e. they are at the very root of the problem. These developments, based on complex physicochemical and technological studies of glasses, have always been aimed not only at the operational reliability of products made from them, which, in turn, ensures environmental safety in the energy sector, but also at achieving an economic effect. The latter was ensured, in particular, by the wide use of natural raw materials in the form of rock in the synthesis of glasses, rocks (quartz sand, perlite sand, limestone), ore materials (manganese ore II varieties) and products of their enrichment, as well as production wastes (barite sludge from dumps).

An example of such a development is glass of composition PP-80, which is considered in detail [7]. It is noted that this glass has high production rates. Somewhat inferior to the glass of the Lviv composition used for industrial production electrical insulators by volume electrical resistivity at 20 °C, glass PP-80 composition surpasses it in breakdown strength and has much lower values of the dielectric loss tangent, which has a significant impact on reducing the overall dimensions, weight, and, consequently, the cost of electrical insulators. A distinctive feature of glass composition PP-80 is its increased corrosion resistance, expanding scope. For traditional electrically insulating silicate materials (glass, porcelain, etc.), the most vulnerable is their low heat resistance, as well as the impossibility of machining with an ordinary graphite-cutting tool. Therefore, the practical purpose of our developments, begun back in 1975, was the creation of materials characterized simultaneously by high dielectric and mechanical properties, thermal stability (including cyclic loads) and machinability (cutting, drilling, milling, threading, etc.) with conventional graphite cutting tools. Our studies, which were considered in detail [15], lead, in particular, to the development of glass-mica-crystalline compositions obtained by glass technology from melts liquid-crystal segregated. These materials have a high compressive strength (up to 314 MPa), increased thermal resistance to cyclic loads (up to 100 cycles 0 - 500 - 0 °C), specific volume electrical resistance 104 -109, operating temperature of at least 850 °C in aggressive environments, zero porosity and machinability with a graphite-cutting tool (processing speed reaches 20 mm/s).

These materials are successfully used for the manufacture of special-purpose electrical insulators, resistive elements, assemblies for glass melting furnaces and furnaces for secondary thermal treatment of optical glasses, microcircuit substrates, as well as chlorinators for chlorination of manganese-containing raw materials in a manganese chloride melt. Their usage provides trouble-free operation of the relevant units, and therefore contributes to solving problems of environmental safety. The deterioration of the environmental situation is significantly contributed by the waste of various production, accumulating from year to year in dumps. The main way for solving this problem is to find areas of their use (creation of non-waste technologies). An example of such a solution has already been noted above - this is the use in the synthesis of glass PP-80 barite sludge from dumps. Another, but by no means the last example of the creation waste-free technology is the method developed by us for obtaining monofocones from quartz glass, considered in detail [1,7], based on the interaction quartz glass with melts and solutions of fluorides. When working with a cadmium fluoride melt, the spent melt was used both to obtain a glass-ceramic material mechanically processed with a graphite-cutting tool, and photochromic glass, the issue of non-waste production was resolved.

All the examples discussed above relate to the production of glass and composite materials, including glass, and are associated with the implementation of high-temperature processes. The glass industry is one of the most environmentally disadvantaged industries, which ranks second in terms of specific energy intensity per unit of output after aluminum production. Therefore, any new developments in this

industry should be aimed at achieving environmental cleanliness of processes and solving issues related to energy saving. At the present level, an effective solution of issues related to the implementation of high-temperature processes should include a set of tasks, among which it should be noted at least the following three aspects:

- ecological cleanliness;
- energy saving;
- versatility - the ability to use for the production of the vast majority of the range of the industry and applications in other industries.

The work in this direction, which we have been conducting for more than 30 years, allows us to conclude that the most effective results are achieved in the development of non-traditional heat engineering units, which make it possible to put into practice the whole complex of the above formulated tasks without compromising product quality. One of such heat engineering units is the glass-melting furnace developed by us, a furnace with the advertising name IK-1 and a number of its modifications, which are most detailed in work [8]. The design of the glass melting furnace IK-1 and its modifications guarantee the implementation environmental cleanliness of the process, in particular due to sharp (up to tenfold) reductions in the volatility of the components and energy intensity (up to tenfold) high-temperature processes, as well as several processes within the same furnace. Designed designs are versatile and multifunctional. Another non-traditional heat engineering unit developed by us is the heating chamber considered in [14] for drawing cylindrical glass blanks to obtain self-focusing optical elements and fibres. As sources of radiant energy in the heating chamber, in particular, incandescent infrared radiation lamps and ultraviolet heaters with an emission wavelength corresponding to the absorption wavelength of the glass used, which ensures the environmental friendliness of the process. One of the main factors that ensure the transformation of natural systems and the development of natural resources without damaging the ecosystem is the rational use of natural resources. Consideration of this issue was reflected in the monograph [5], in which, in particular, the development of an environmentally friendly glassy fertilizer with a prolonged action that restores natural resources, its industrial implementation and a very wide agrochemical application.

The population of our planet is growing steadily, and therefore more and more foodstuffs, including plant foods. However, to increase the sown area in the world lacks opportunities. Therefore, the main way out of this situation is a rapid and significant increase in yield, which is possible only with timely balanced plant nutrition. Along with the issue of increasing productivity, at least the question of a reasonable, science-based use of land resources is acute. This requires great attention to the problem of restoring lost soil fertility up to their complete agricultural unsuitability, leading to the need for complex, lengthy and expensive reclamation work. The solution of all the questions formulated above is clearly impossible without the use of fertilizers. Developers and manufacturers of fertilizers, both organic and mineral, should strive to solve a difficult, but, of course, solvable problem - to obtain a food additive for agricultural crops, which, to the maximum extent, excludes the shortcomings that exist today, inherent in fertilizers, regardless

of their origin. Finding ways and methods of prompt solution of this problem is of great socio-economic and environmental importance, should contribute to the discovery of a practically inexhaustible source with providing agricultural enterprises with technically and economically accessible products for restoring, preserving and improving soil fertility, as well as creating a favorable environmental situation. An objective assessment shows that the fundamental shortcomings of all the main types of mineral fertilizers produced by industry and used by the agrochemical complex are associated with their polycrystalline structure, leading to accelerated dissolution, leaching and weathering, and finally selective leaching by groundwater. Washout and weathering lead not only to the fact that the application of fertilizers does not always lead to plant nutrition, but also to the deterioration of the ecological state of water bodies. The author notes a cardinal way to overcome the formulated shortcomings, namely: the rejection of traditional polycrystalline fertilizers and the use of amorphous materials for the development of fundamentally new highly effective fertilizers, among which glass plays the leading role. Targeted development of glass compositions for use as mineral fertilizers, not to mention their industrial production [2, 9, 10], was practically not considered by anyone before the project implemented by the authors of [5]. The result of the project was the development of competitive domestic materials and technologies for the production of environmentally friendly long-acting glassy fertilizers , which restores natural resources, and its various modifications.

The consequence of the extraction of more and more oil is an increase in the volume of pollution in normal situations and, most dangerously, the cases of accidents during transportation become more frequent, oil products, among which the most severe in terms of scale and consequences are accidents during water transportation. It was noted that a new type of biosorbent was developed to clean water surfaces from oil pollution, which is an association of strains – destructors hydrocarbons immobilized on a porous sorbent - foam glass, obtained from the pulverized fraction of a glassy phosphorus fertilizer. Speaking about this biosorbent, as well as about biosorbents in general [13], its main disadvantages should be noted, which include insufficiently high buoyancy, the possibility of using only at temperatures above 8 °C, as well as a storage period not exceeding 2 years, and the impossibility of ensuring the necessary efficiency in the elimination of emergency oil spills. The issue of buoyancy of the biosorbent from the pulverized fraction of glassy phosphorus fertilizer has now been resolved, but all other shortcomings remain in force.

The comprehensive studies of the physical and chemical patterns of obtaining glassy oil sorbents of inorganic and organic nature and flow processes of absorption of oil and oil products by them. In particular, practically unsinkable oil sorbents based on type glass have been obtained. The results of these complex studies are reflected in a number of publications [3, 4, 11, 12]. In the aspect of the issue considered in this paper, it is worth emphasizing some of the results obtained. For the developed oil sorbents based on phosphate and silicate foam glasses, we proposed methods of regeneration, allowing to achieve a high multiplicity of their use with

partial return of absorbed oil. At the same time, spent sorbents are reused in the primary production cycle. Regeneration in the case of phosphate systems is based on the fact that their compositions lie in the range of compositions of glassy fertilizer [5]. For the foam glasses developed by us in this system that meet the requirements for oil sorbents [1], the question of their regeneration was solved by pouring the sorbent with oil onto the soil after the process of sorption and applying to it an association of strains - hydrocarbon destructors. After that, the sorbent can be reused for example, the multiplicity of its use is achieved, or applied as a fertilizer.

Regeneration of oil sorbents based on silicate systems is based on a low value coefficient of linear thermal expansion of base glass C52-1, which makes it heat resistant to cyclic loads. Marked allowed to use for regeneration sorbent oil burning process. As a result of regeneration, part of the oil was desorbed, and part burned down. Under laboratory conditions, the regenerated sorbent was tested at a multiplicity of use equal to 30. At the same time, no visible signs of destruction of the sorbent were observed after this multiplicity of use; given multiplicity is far from the limit. For the developed oil sorbent, there is no need to address the issue of disposal. Laboratory studies have shown that 40% of mass can be successfully used as a cullet when melting glass C52-1, as well as 10% by weight - in the manufacture of oil sorbent from C52-1 glass. Thus, developed oil sorbent allows us to implement a closed cycle, ensuring zero waste production. This fact helps to minimize the amount of oil sorbent, which facilities for possible oil spills, in particular oil tankers and ships, while equipping them with autonomous devices that ensure the regeneration of the sorbent directly at the spill site.

The optimal solution would be to study all chemical products separately, determine their content and behaviour in the environment, the study of the biological consequences of their impact. And when it comes to having environment, but a whole mixture of toxic substances, then only a competent chemist can determine and evaluate the total effect of the collective action of several poisonous substances, since there are such well-known effects only for chemists – synergistic or the antagonistic action of the mixture toxic substances. So the ecology especially ecotoxicology and chemistry again should help each other. Many environmental problems arise when they enter the ground, sea and river waters of oil emissions from tanker accidents or reckless oil drilling wells. This phenomenon is called in ecology, and it poses many new problems for chemists, the solution which requires the development of new technologies and methods for cleaning the surface of water from oil pollution. As a result of water pollution, a large number of fish died out in rivers and lakes. In connection with mass kills, specialists, including chemists, had problems assessing water quality, while resorting to additional chemical pollution. In such cases scientists - chemists resort to biological methods for assessing water quality, based on the analysis of fish species and other aquatic organisms inhabiting waters with varying degrees of pollution.

Thus, it is clear that the environment and ecotoxicology is closely related to chemistry, and rather, electrochemistry, biochemistry, analytical chemistry and other

chemical disciplines. At the same time, ecology and other ecological disciplines contribute to the further development of almost all chemical disciplines.
The work [1] emphasizes a very reasonable and original idea about the ecologization of natural sciences, for example, chemistry, physics, biology, etc. How this process has an end goal formation of students as future managers, environmental outlook, thanks to which a significant part of intellectuals and heads of enterprises will form environmental thinking. Otherwise, we will get famous technocrats with their technocratic thinking. It must be emphasized that the most pressing environmental issues of our time, such as pollution of the natural environment (aquatic environment, air environment and soil environment) [7, 9], acidification of the natural environment (caused by acid rain) and destruction of stratospheric ozone by chlorine-containing compounds (such as chlorofluorocarbons and compounds nitrogen [4]) can eventually be resolved on the basis of consideration of the chemical aspects of these problems. Furthermore, at the same time, there must be a great human desire, willpower and knowledge of the depth and the consequences of these problems. If we want to preserve the quality of the natural environment for future generations of humanity in good condition, then we should have an environmental strategy as a priority, and the financial side of the issue of solving environmental problems should give way to common sense meaning, because there is no more important health on the light of nothing. Moreover, chemists have proposed one method for assessing the level of contamination, determining the chemical oxygen demand for a wastewater sample. This method makes it possible to determine the degree of pollution even faster than the well-known BOD-5 method (biological oxygen demand for 5 days). The foregoing allows us to state that, fulfilling orders and environmental needs and ecotoxicology, chemistry at the same time and itself will certainly develop as in depth, as well as applied research. Along with the content of organic pollutants in water, of interest are the compounds of an ionic nature, which are also water pollutants (e.g. nitrates, sulfates, etc.). The content in water is determined by chemical, or rather, electrochemical methods based on measurements of the electrical conductivity of solutions (these methods have the general name of conductometric methods). To establish the nature of those present in wastewater, it is necessary to apply chemical (analytical) methods of determination. The environmental problem is also relevant in all corners of the Earth. Only its degree of tension is in the variety of countries and regions of the world [20].

Conclusion. Consideration of some developments of the authors, which are the result of their more than forty years of scientific and production activity in the field of physical chemistry and chemical technology of the glassy state of matter, clearly indicates that it is erroneous consider chemistry as the culprit of all environmental ills. Environmental problems generates not only the science of chemistry, but also the use of its results by an ecologically illiterate person. Without chemistry humanity cannot exist comfortably and, what is especially important, cannot solve the accumulated environmental problems, to solve almost all global environmental problems (elimination of environmental pollution, elimination of acidification of the natural environment, elimination of ozone holes in the atmosphere and others) a deep

ecologization of all chemical and other natural science disciplines is necessary. From this, as a whole, both ecology and chemical science itself will be benefit. Carrying out tasks of an ecological nature, chemistry, at the same time, itself develops and improves both in applied, as well as in theoretical aspects.

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