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ANALYSIS OF THE RECULTIVATION EFFECTIVITY PERFORMED AFTER GAS INDUSTRIAL COMPLEX ACCIDENTAL IMPACT

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The current state of the agro-industrial complex of Ukraine is characterized by the increase of technogenic impact on the environment, especially in emergency situations. The state of soil and groundwater was determined for the terrain affected by technogenic disaster and where subsequent recultivation took place. A comparison with the state of the soil and water of the "ecologically clean" settlement of the same district was carried out. Conclusions on the effectiveness of the recultivation measures have been made.
Keywords: *soil, groundwater, decentralized water supply.*

The current state of the agro-industrial complex of Ukraine is characterized by the increase of anthropogenic impact on the environment, the main components of which are soil, water and air. They are closely related and are in a state of dynamic ecological balance. Because of this, any pollution introduced into one of the components immediately affects the system as a whole. The energy complex of Ukraine increases the intensity of extraction of natural resources, especially oil and gas. At the same time, environmental requirements and norms to the state of the environment are not always respected. The consequences of this are the pollution of soil and groundwater. Today, the oil and gas industry is the most common cause of disturbance of soil ecosystems. An analysis of the state of the environment with the compilation of forecasts of its further development is one of the main tasks of the present day.

A sharp increase in the morbidity and mortality of the population testifies to the consequences of environmental pollution caused by chemicals, in particular heavy metals, pesticides, radionuclides. The fact that the population of Ukraine is declining is known. In this case, according to statistics, the mortality of rural population is 3.5 times higher than urban [1].

There are 147 stable sources of groundwater pollution on the territory of Ukraine. Also, 93 large water withdrawals of underground waters are also operated (productivity is more than 5000 m^3/day), which quality has deteriorated due to anthropogenic influence [2].

The state of the water resources of the region by the integral ecological index is estimated as bad [3]. The first place among the causes of mortality in the rural population of the Poltava region is the disease of the cardiovascular system, the main reasons of which are the use of unsatisfactory water [1]. First of all, the reason for this state of water is the large amount of waste that has accumulated in the area. Also the reason is the excessive use of nitrogen fertilizers. All salts of nitrate and nitrite acids (nitrates and nitrites, respectively) are highly soluble in water. Thus, they migrate across aquifers over considerable distances and accumulate in agricultural products. [1, 4]. By the number of cases and the mass character of poisonings in the world, plants with elevated levels of nitrates, as an etiological factor, occupy a leading position [4]. In addition, the systematic use of products with high levels of nitrates causes so-called asymptomatic methemoglobinemia [5]. The problem of water contamination of decentralized water supply by nitrate ions is extremely relevant for rural areas, both in the Poltava district and in the Poltava region, because there is no one settlement with drinking water of proper quality [1, 6, 7].

A serious source of contamination of the soil and aquifers in Poltava region is the oil and gas producing complex, where nitrate and nitrite-containing compounds are used for drilling and intensification of wells. More than 85% of oil and gas condensate contaminants enter into the hydrosphere under "normal" non-emergency situations [8-10]. There are 9720 wells in Ukraine according to state accounting of oil and gas wells [11]. Poltava region is the second in the country for oil and gas production. During the last decades in areas of intensive oil and gas production, environmental degradation has occurred. In particular this is due to the degradation of soils. The soil degradation map of Ukraine [12] demonstrates the obvious unsatisfactory state of the soil in the Poltava region. Significant salinity of soils attracts special attention. This occurs due to soil contamination, which takes place practically at all stages of the process of oil production as a result of spills of oil and oil-containing products, highly mineralized ground waters, chemical reagents, emissions of combustion products. As a result of pollution and mechanical disruption of the structure and texture of soils during construction and mining, large areas of fertile land are lost, which causes significant damage to the country's economy and the environment.

According to statistics, the number of emergencies in the oil and gas industry in Ukraine reached 1.5 thousand per year [13]. One of the accidents occurred in the Poltava region in the village Kachanove in the late 70s of the 20th century. During the drilling of the gas well, an uncontrolled ejection of a gas with a height of more than 60 m took place. According to eyewitnesses "at night it was visible as in the daytime". Since the drilling rig was situated on a raised platform, the technical solution flowed to the village, which led to the death of the gardens, the contamination of household plots and partially fields. Pollutants also entered the Artopolot river, the main ones being oil, mentaglio powder, caustic, soda ash, lignosulfate, potassium chloride, LFR stabilizer, CMC glue, PBC solvent, lubricants, polymers and other impurities. Reclamation work was carried out, but the locals could not obtain any information. Moreover, the centralized water supply was built in the village only about ten years ago. All this time, the use of soil and groundwater by residents of nearby settlements occurs.

The purpose of the study was to determine the main physical and chemical parameters of soil and groundwater in the first and second aquifers to estimate the effectiveness of the reclamation works performed after an emergency ejection at the gas production complex of the village Kachanove in Hadyatskyi District of the Poltava region and to carry out a comparative analysis with the state of the soil and water of the centralized water supply in the same area (control samples), which is listed as an "ecologically clean area" - village Lyutenka in Hadyatskyi District of the Poltava region. In this area there are equipped places for rest of the population, children's camps for recreation, etc.

We have selected and experimentally investigated 20 soil samples on the household plots that the local population uses for agricultural purposes, and 20 samples of water from mine wells (depths of 18 m) in the village Kachanove in the Hadyatskyi District of the Poltava region. For control, we have selected the same number of samples of soil and water from the well (depth 20 m) in the village Lyutenka in Hadyatskyi District of the Poltava region.

The average results of experimental studies of soil samples are presented in Table 1.

Tab.1.

Basic physical and chemical parameters of soil samples v. Kachanove (Emergency zone after reclamation) and v. Lyutenka ("Environmentally friendly" zone)

№	Indicators	v. Kachanove	v. Lyutenka
1	Density, g/cm^3	2,57	2,22
2	Hygroscopic moisture, %	2,14	0,9
3	Water capacity of soil, %	48	27,8
4	Organic matter content, %	1,8	1,5
5	Humus content, %	1,7	1,3
6	pH of water extraction of soil	8,55	7,6
7	Exchange acidity, mmole-eqv/100 g soil	3,0	7,8
8	Mass loss of soil on calcination, %	11,32	31,60
9	Content of water-soluble salts of water extraction of soil, mg/100 g soil	644,0	479,5
10	Bicarbonate-ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	52,12 0,85	57,47 0,94
11	Chloride-ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	103,90 2,93	38,65 1,09
12	Calcium-ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	48,05 2,40	13,52 0,68
13	Magnesium -ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	16,19 1,35	13,20 1,10
14	Sulfate-ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	286,00 5,96	237,30 4,94
15	Sodium -ions content in water extraction of soil, mg/100 g soil and mmole-eqv/100 g soil	137,71 5,99	119,32 5,19

Source: Author's experimental research

Obviously, there are certain differences in the basic physicochemical parameters of the investigated soils. Soil affected by anthropogenic impact is more saline. Its water extraction is more alkaline. But reclamation work has increased its organic component and humus content. Differences in the macrocomponent composition of aqueous extracts are observed for the content of chloride ions and calcium ions. Obviously, measures of protection and improvement of soil state in the direction of accelerating the degradation of oil products and the elimination of soil salinity are constantly being carried out in the investigated territory.

The main measures for the optimization and protection of the humus state of sod-podzolic soils are the introduction of organic and mineral fertilizers, sideration, liming, regulation of the water regime, the introduction of grass-field crop rotations, etc. On chernozem soils it is necessary to introduce field-protective forest plantations, agrotechnical methods of erosion control, crop rotation with a percentage of perennial grasses and leguminous crops of at least 25%, and the introduction of organic and mineral fertilizers. These measures are effective.

Significant losses of mass during calcination for soil with low organic content and hygroscopic soil moisture are unexpected. This can mean the presence of impurities removed at the calcination temperature, and these are most likely organic contaminants. It can be concluded that such a soil cannot be considered as "environmentally friendly".

We have experimentally investigated the main physical and chemical properties of the quality of drinking water in the decentralized water supply of the above-mentioned settlements and the average indicators were presented in Table 2.

Tab. 2.

Basic physical and chemical parameters of water samples v. Kachanove (Emergency zone after reclamation) and v. Lyutenka ("Environmentally friendly" zone)

Indicators	Standard	v. Kachanove	v. Lyutenka
Colour, degrees	≤20(35)	8	10
The intensity of flavor, points	≤2(3)	0	0
The intensity of the odor, points	≤2(3)	0	0
pH	6,5-8,5	7,70	7,50
Total hardness, mEq/dm^3	≤7,0(10)	3,26	3,45
Ca hardness, mEq/dm^3	-	2,50	2,40
Mg hardness, mEq/dm^3	-	0,76	1,05
Aluminium-ions, mg/dm^3; mEq/dm^3	≤0,2(0,5) mg/dm^3	0,30; 0,022	0,30; 0,022
Total Fe-ions, mg/dm^3, mEq/dm^3	≤0,3(1,0) mg/dm^3	0,58; 0,03	1,03; 0,06
Sodium-ions, mq/dm^3;mEq/dm^3	-	306,69; 13,34	382,78; 16,65
Alkalinity, mq/dm^3;mEq/dm^3	1,5-6,5 mEq/dm^3	681,37; 11,17	274,58; 4,50
Sulphate-ions, mg/dm^3, mEq/dm^3	≤250(500) mg/dm^3	182,26; 3,86	589,61; 12,28
Chloride-ions, mg/dm^3;mEq/dm^3	≤250(350); mg/dm^3	55,54; 1,57	40,78; 1,15
Nitrate-ions, mg/dm^3, mEq/dm^3	≤50; mg/dm^3	3,01; 0,05	77,51; 1,25
WSS, mg/dm^3	≤1000(1500)	1272,00	1427,50

Source: Author's experimental research

On the basis of experimental studies, it can be concluded that the water in the village of Kachanove does not meet the quality standards for such indicators as alkalinity, the content of total iron and aluminum ions. The positive thing is that the content of nitrate ions is within normal limits. But the state of the water «ecologically clean» zone does not meet the norms for the indicators of the content of nitrate ions, which is extremely dangerous and indicates the presence of sources of contamination. In addition, there is an excess of the content of aluminum ions, total iron, sulfate ions. The content of water-soluble salts also approaches to the maximum possible level.

Conclusion:

1. Despite reclamation work, the state of Kachanove village soil can be described as degraded and organically depleted, but suitable for agricultural use.
2. In the soil of an "ecologically clean" zone, significant losses of mass at insignificant content of organic substances were detected during calcination. This may indicate the probable presence of contaminations with organic substances of technogenic origin (oil, condensate spills, etc.), which requires additional research on the presence of these substances in the soil.
3. Soils of both studied areas require a significant amount of organic fertilizers.
4. Drinking water of the decentralized water supply in the Kachanove village does not meet the quality standards for the content of hydrocarbonate ions, and this indicator will not be brought to the proper value even after boiling due to low stiffness.
5. Since the water hardness is carbonate, according to this indicator water corresponds to the norm after boiling, but does not correspond to the physiological need of the person.
6. Exceeding the content of aluminum ions is dangerous for the human body and requires the involvement of appropriate water treatment activities.
7. The content of water-soluble salts corresponds to the norms for the water of mine wells, but is 1.5 times greater than that of centralized water supply.
8. Drinking water from an "ecologically clean area" is unsuitable for consumption because of the level of nitrate ions and total iron. The fact of drinking water by children is unacceptable, since it is a place of rest for the population and children's camps.
9. There are man-caused or anthropogenic sources of these ions, which entering aquifers. This is a particularly dangerous fact, since this territory is considered an ecologically clean area for children's recreation.

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ANALYSIS OF TECHNOGENIC IMPACT (GAS-INDUSTRIAL COMPLEX) ON THE STATE OF SOIL AND GROUNDWATER

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The results of experimental studies of soil properties in area that was contaminated following the disaster at drilling of the gas-bearing-well at oil and gas production facility are represented. The local population uses this soil for agricultural purposes. Conclusions on the impact of emergency on the state of soil, natural and drinking water of decentralized water supply to nearby settlements are made.
Keywords: *soil, decentralized water supply, gas-bearing-well, macrocomponent composition*

The Kharkiv region, like Poltava region, is one of the leading oil and gas producing regions of Ukraine. The Kharkiv region annually produces up to 8-10 billion cubic meters of natural gas. This represents over 41% of total production in the country [1]. Oil and gas complex is one of the main sources of anthropogenic pollutants which are toxic to the environment. Emergency situations, which are accompanied by significant emissions of pollutants, are the most dangerous. After an elimination of obvious factors of accidental releases a significant amount of impurities are remains in the soil, groundwater and water bodies. They change the basic physical and chemical properties of the soil. Pollutions fall through a water-soluble component into aquifers and negatively affect a human body through drinking water and agricultural products. The majority of Ukrainian rural settlements use the water of first aquifers [2], which in most cases does not comply with norms due to soil contamination [3].

In 1963 during the drilling of wells nearby v. Antonivka of Kegichevska district accident situation has occurred. The depth of the well had to be 3000 m. Gas discharge has occurred during the passage of salt crusts. A formation pressure had the value 300 atmospheres. Attempts to extinguish the flow of gas did not succeed. 20-meter torch was burning for almost a year. The information was classified. The method of liquidation of the disaster remained unknown. We have received the information from eyewitnesses and former employees. Therefore, there is assumption about the using of an underground nuclear explosion. At the site of the accident the crater with in diameter about 60 m was formed. It was filled with formation water. Drilling rig and the tractor disappeared under the ground. The water of technogenic lake has not been investigated, and the local population uses it for cultural purposes.

We carried out the qualitative and quantitative analysis of the technogenic and natural lakes water samples and drinking water of v. Antonivka and v. Chapaeve of Kegichivka district of Kharkiv region. The basic physical and chemical properties of water samples from lakes and v. Chapaeve were investigated. The results of our experimental studies are presented in [4].

At the same time, the problem of soil and water pollution (especially near populated areas) has remained unknown to the local population, which uses it for agricultural purposes.

Therefore, the aim of our work was to experimentally investigate the main physical and chemical properties of soil samples in the vicinity of the technogenic lake and natural lake, as well as the soil samples of lands v. Antonivka and v. Chapaeve of Kegichivka district of Kharkiv region; to perform the correlative analysis of the macrocomponent composition of the water extracts of the soil with the macrocomponent composition of the water samples representated in [4] and draw conclusions about the state of the soil, and natural water and drinking water of decentralized water supply to nearby settlements.

5 samples of soil in the vicinity of the technogenic lake were selected and experimentally investigated by us. Also 5 samples of soil in the vicinity of the natural lake were selected and experimentally investigated by us. Natural lake is located about 1.5 km from the technogenic lake. We also selected 5 samples of homestead plots and 5 samples of the water of decentralized drinking water