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# WAYS OF IMPROVING EFFICIENCY OF WASTEWATER TREATMENT FOR AGRICULTURE

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## SPOSOBY USPRAWNIENIA WYDAJNOŚCI OCZYSZCZANIA ŚCIEKÓW W ROLNICTWIE

STRESZCZENIE: Obrotowe i zamknięte obiegi wodne to najbardziej obiecujące sposoby na ograniczenie zużycia słodkiej wody. Prawdopodobnie w przyszłości oczyszczone ścieki staną się głównym źródłem wody w rolnictwie. Słodka woda będzie dostępna dla zapotrzebowania domowego.

SŁOWA KLUCZOWE: obrotowe i zamknięte obiegi wodne, wydajność oczyszczalni ścieków, woda w rolnictwie

Modern human civilization is characterized by one of the actual problem, the protection of natural environment from pollution and depletion of water resources. The Republic of Kazakhstan pays special attention to the problems of natural environment, the law „On the protection of the environment in the Republic of Kazakhstan" and other developments in the water balance of the system and the use of waste water. In our republic, wastewater irrigation has intensified since 1966, when research on this problem started. Already in 1968, the area of irrigated wastewater to Almaty was 1916 hectares, and in 1985 in Kazakhstan, the area irrigated by sewage was 2296 hectares.

In Kazakhstan tense environmental conditions associated with the inefficient operation of the treatment plants remains. Currently, it is especially important, because the negative impact on the environment reaches catastrophic proportions. Prolonged operation without reconstruction of treatment facilities often do not have a full range of facilities for the type of structures to exacerbate environmental protection from pollution, have not undergone adequate wastewater treatment. Many wastewater treatment plants are obsolete, in need of major repairs and upgrades, others processes are often overloaded, wastewater treatment does not correspond to the design data.

Kazakhstan belongs to the category of countries with high water stress. Currently intensively polluted water bodies in mining, metallurgical and chemical industries, utilities and cities represent a real environmental threat. The imbalance between the anthropogenic impact on water bodies and their capacity to recover has meant that ecological trouble was characterized by almost all major river basins, and the lack of financing needs of water resources has caused extremely poor (sometimes accidental) of the technical status of water bodies.

In general, there is a need to address the issue of the construction of new wastewater treatment plants, as well as major repairs are required. Activities to be undertaken rehabilitation and construction of new treatment plants and reservoirs remain unimplemented due to lack of funding. A complex of measures to improve the sewage ponds.

The main direction of the discharge of waste water and contamination of water bodies is to create a closed water systems. Under the closed system of water supply for industrial enterprises defined as a system in which water is used in the production of many times without cleaning or after appropriate treatment, prevents the formation of any waste and sewage into the pond.

The main objectives of environmental production development of Kazakhstan in the near future are:

- the main comprehensive study of the effect of composition and volume of waste water ecosystems to environmental safety at the present level, for reliable forecasts and recommendations for the effective use of treatment facilities;
- development, implementation of a system of measures and activities to ensure environmental security situation in the areas of formation, lead, waste

water disposal, by optimizing the use of water, improvement of economic and legal planning, development and implementation of modern low-and non--waste technology, high-performance methods of cleaning, disinfection, sewage disposal, regional regulations and methods of regulation and control measures for the protection of the environment.

The existing requirements for the use of wastewater for irrigation and fertilization. According to them, for this purpose can be used in household, industrial and mixed sewage of cities, towns, farms, processing of agricultural products. Quality of waste water and sludge used for irrigation is regulated by chemical, bacteriological and parasitological parameters. Wastewater containing trace elements, including heavy metals in amounts not exceeding the maximum permissible concentration for drinking water, can be used for irrigation without restrictions.

In Kazakhstan in regions with large reserves of land and water scarcity strategic direction wastewater is the use of treated wastewater for irrigation of agricultural and industrial crops.

At the present stage in our country for the disposal of the increasing volume of waste water are more often use the natural method of cleaning them in the fields of irrigation, which are used as nutrients contained in wastewater to produce high crop receiving of food crops. In this case, the irrigated fields can be seen as a final link to their natural purification and disinfection, which is socio--economic, economic, environmental and technological aspects.

Proceedings of the 30-year research scientists of the Republic of Kazakhstan, indicates that one of the main waste water disposal is the use of treated wastewater for irrigation of fields with the cultivation of crops and trees and bushes planted.

After many years of broadly defined research and manufacturing experience, field irrigation established as sewage treatment plants and was recognized as their agricultural efficiency.

Stroganov S.N. in 1939, wrote: „The refusal of the ways to clean by washing is a direct assault on the purity of water, soil, air, on public property, it is not valid under the socialist system."

Soil treatment method, as we have in this country and abroad, to pay great attention.

The soil is a medium of very simple alien bacteria and viruses, parasitic in humans. These soil properties were observed in ancient times man has become widely used for the decontamination of soil impurities. Research V.R. Vilyamsa, S.N. Stroganova and other scientists had shown that of all existing methods of biological treatment, soil methods are the most effective and easiest to use.

Table 1 shows the effectiveness of different methods of waste treatment. As can be seen from table 1 Soil methods designed by nature for waste water treatment, as in the evolution of the soil microbial biocenosis developed, providing the destruction of organic matter in soil. Since soil biocenosis shows biological activity, therefore, it is always ready to take and destroy organic matter, which will come into it with sewage.

Table 1
Various methods of sewage treatment

| № p / p | Methods for cleaning up | Reduction [%] | | |
|---|---|---|---|---|
| | | $BOD_5$ | Suspended solids | Bacterial count |
| 1. | Manual | 30-35 | 50-60 | 40-50 |
| 2. | Biological:<br>-on biofilters | 70-80 | 70-80 | 85-90 |
| 3. | -on plants with activated sludge | 75-85 | 85-90 | 90-95 |
| 4. | Crop irrigation | 90-95 | 90-95 | 90-95 |

Source: author's elaboration.

Despite such a high degree of development, and the scientific validity of the soil wastewater, agricultural use of their remains low. This situation is due to the lack of economic incentives for enterprise and municipal services in complex problem solving treatment and use of sewage.

Soil method of sewage treatment ponds and thus facilitate resolution of the problem of sanitary protection of water bodies, reduce intake of pure natural water for irrigation of agricultural land, to continuously improve soil fertility, that is become noticeable reserve in getting high and sustainable crop, forage and improve the nutritional value of farmed products through additional unproductive agricultural use and not suitable without fertilizing irrigation land.

Currently in Kazakhstan wastewater irrigated 49.7 hectares, including 39.5 hectares of urban wastewater. So on the basis of the city's sewage Almaty 16.5 hectares of land is irrigated.

In the future, Kazakhstan through wastewater irrigation can provide 0.8-1.0 million hectares of land, the total amount of municipal wastewater republic with biological treatment will be 1720 million m3 per year, whereby you can irrigate 250-300 thousand ha.

Crops are grown in the fields of irrigation in terms other than the usual crop irrigation. They should provide maximum reception and distribution of projected amount of wastewater in the year to encourage and enhance the biochemical processes in the soil, receiving at the same time necessary for the growth and development of elements of food and water.

Correctly selected types of crops and crop rotation consisting allow year-round distribution of waste water and produce high crop receiving.

Increasing volumes of wastewater are of serious environmental concern. Not timely resolution of issues of recycling and use of waste water in a scientific manner could lead to another environmental disaster, as happened in 1987 with a reservoir capacity of Jaman Kum in Almaty region. Only in the drive to Almaty Sorbulak accumulated over – 890 million m3 of biologically treated wastewater. With the increasing population of the city of Almaty to 1.5 million, the amount of waste water will increase by 2 times. Before serving domestic wastewater

Table 2
The chemical composition of waste water storage Sorbulak [mg]

| № | Showing | Diverting channel | Drive Sorbulak | |
|---|---|---|---|---|
| | | | Small Bowl | Large Bowl |
| 1 | PH | 7,9 | 7,0 | 8,5 |
| 2 | Suspended solids | 51,8 | 40,0 | 32,4 |
| 3 | $CO_3$-soda | - | 30,0 | 41,0 |
| 4 | $BOD_5$, mg/$O_2$ | doesn't support frames | doesn't support frames | doesn't support frames |
| 5 | Hydrocarbons | 256,0 | 188,0 | 200,0 |
| 6 | Chlorides | 58,0 | 206,0 | 277,0 |
| 7 | Sulphates | 64,3 | 226,0 | 355,0 |
| 8 | Calcium | 50,0 | 60,0 | 67,6 |
| 9 | Magnesium | 8,0 | 30,0 | 28,0 |
| 10 | Na+K | 75,4 | 198,0 | 315,0 |
| 11 | total phosphorus | 6,11 | 6,8 | 7,0 |
| 12 | total nitrogen | 29,2 | 26,8 | 27,2 |
| 13 | ammonia nitrogen | 11,0 | doesn't support frames | doesn't support frames |
| 14 | Nitrates | 0,6 | doesn't support frames | doesn't support frames |
| 15 | Nitrites | 2,4 | doesn't support frames | doesn't support frames |
| 16 | Potassium | 12,06 | 13,4 | 13,0 |
| 17 | Total mineralization | 512,0 | 938,0 | 1283,6 |

Source: author's elaboration.

for irrigation is necessary to clean it. Typically, wastewater is preconditioned on structures and mechanical biological treatment followed by further purification in biological ponds or sand filters. Municipal wastewater after mechanical and biological treatment have a favorable chemical composition (table 2).

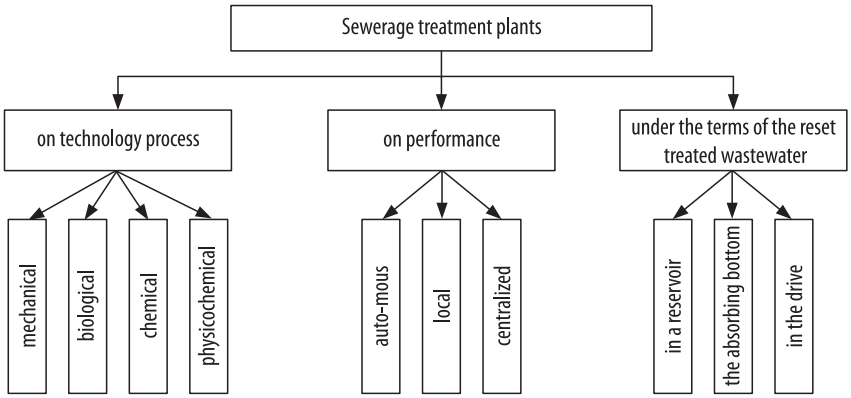
Thus, in a preliminary assessment of the possibility of wastewater improves productivity of agricultural land, is the means of agricultural intensification.

Below there is the classification of treatment plants sewage systems. Sewerage treatment facilities are divided: by the processes – mechanical, biological, chemical and physical; by performance – independent, local, centralized; by discharge of waste water – reservoirs, absorbing ground in the drive.

If we compare the quality of waste water just after biological treatment and diversion canals mentioned, the reduction of easy and hard oxidizing agents, pH varies from 7.0 to 8.5, BOD5, when nitrate is not defined.

The Small Sorbulak mineralization 0.938 g/dm3 with sulfate-chloride water was 0.198% sodium, pH above 7.0, 30-ekv/dm3 CO2. In Greater Sorbulak salt concentration from 1,000 to 1,300 g/dm3 in the chemistry of the chloride-sulfate, sodium 0.315%, pH 8, 5, which has a beneficial effect on the fertility of gray

Figure 1
Classification of sewerage treatment plants




Source: author's elaboration.

soils. The chemical composition of waste water also varies during the day, which indicates the presence of discharges of industrial wastewater.

Water quality Sorbulak drive meets all the requirements of maximum permissible concentration (MPC) for the irrigation of food and industrial crops. In 1990. the array was introduced Sorbulak 10.5 thousand hectares of irrigated land, planned for 2000 bring to 22.8 hectares But to date, the use of wastewater storage Sorbulak not received serious development, so in 2000 Sorbulak array irrigated areas have less than 3.0 ha.

Through waste water rich in nutrients and microorganisms, in the fields of irrigation conditions improve plant nutrition. And at the same time because of the continuous flow of effluent from wastewater treatment plants in these fields supported by high soil moisture.

In assessing the irrigation water on the basis of quantitative and qualitative composition of soluble salts draws attention, first of all the possibility of soil salinity and alkalinity.

The material shows that over the last 15-17 years, significant changes in the composition of waste water in the storage Sorbulak happened. In the waste water may contain many trace elements. For example, in wastewater Almaty, where 40% of the production, the content of individual trace elements exceeds the MCL for irrigation water (table 3).

The sanitary rules permit to cultivate economic, technical, grain, forage crops, trees and bushes. Cropping is not allowed adding into human food raw vegetables, berries, melons and potatoes.

Ways to solve the water problem are outlined as follows:

- reduced wastewater and expanding recycling Water plants in the closed cycle;
- improved methods of purification of waste water;
- the use of waste water from its respective treatment for irrigation;

Table 3
Concentration of trace elements in sewage Almaty [mg/l]

| Data [dm$^3$] | In diverting channel | To accumulate. Sorbulak | MPC for irrigation water | Data [dm$^3$] | In diverting channel | To accumulate. Sorbulak | MPC for irrigation water |
|---|---|---|---|---|---|---|---|
| Zinc (Zn) | 0,026 | 0,0129 | 2,0 | Mercury (Hg) | 0,001 | 0,0007 | 0,005 |
| Cuprum (Cu) | 0,005 | 0,0135 | 0,20 | Arsenic (As) | - | 0,0019 | 0,10 |
| Cobalt (Co) | - | 0,0031 | 0,05 | Chrome (Cr) | 0,01 | 0,0034 | 0,10 |
| Manganese (Mn) | - | 0,0363 | 00,02 | Plumbum (Pb) | 0,05 | 0,0467 | 0,20 |
| Molybdenum (Mo) | - | 0,0025 | 0,01 | Nickel (Ni) | 0,05 | 0,0118<br>0,0021 | 0,20 |
| Gland (Fe) | - | 0,844 | 1,0 | Cadmium (Cd) | 0,005 | | 0,03 |

Source: author's elaboration.

- water saving separate water lines for food and industrial water;
- reduction of water cooling and the transition to the air;

Optimistic assessment of water resources can be a reality only when careful use and protection of natural waters. Thus, the greater evil, which now represent sewage, may be excluded. Their use in agriculture solves important problems in water environments, and that not only avoiding stranded costs, but taking from the measure economic benefit. This is the main way of preventing the depletion of water resources, quality, maintain a favorable condition for the people of one of the most important elements of the natural environment. But along with that is the main measure of a number of other tasks. These include, for example, include water saving. This problem is partially covered due to water consumption in the industry. The period of intensive development of the chemical industry until recently characterized by a sharp increase in water consumption per unit of production. Take just one specific example that illustrates this trend. If the 1 ton of cotton fabrics takes 10-15 m$^3$ of water, then 1 ton of synthetic-2500-4000 m$^3$.

The purpose and objective of monitoring is an assessment of the effectiveness of treatment facilities, state of the water quality and storage, reservoirs, ponds, compliance with the maximum permissible discharge (MPD) and the maximum permissible concentration (MPC), as well as the effect of complex treatment and disposal of wastewater on the environment. The degree of impact of natural and artificial factors, the environmental and hydrogeological conditions in the study area of Almaty region detected during routine observations of the level and composition of groundwater in the various control points. Analysis used as materials research in previous years, the results of the inspection of hydraulic culvert deferent canals, reservoirs, sludge beds and fields of filtration. Operation of treatment plants, which discharge canals, reservoirs, fields of filtration, sludge beds and the whole complex WWTP is in accordance with the approved „technological regulations of sewage treatment plants WWTP Almaty /1998/

„And" Operating Rules Sorbulak wastewater storage systems, storage of the Right Bank Sorbulakskogo channel (PSC) and disaster relief in the river or canal /2000/.

„Over the last few years is not established adverse effects of sewage irrigation on the quality and quantity of the crop of heavy metals in products have always been well below the permissible value. All this allows us to recommend wastewater Almaty (after cleaning) to irrigate crops without restriction. Waste water containing micro-macro elements in quantities not exceeding the limits, and in most cases they have a stimulating effect on plant growth and development, improve quality and increase productivity.

Long been developed optimal irrigation schedules of different cultures on the basis of wastewater calculated irrigation norms and their implementation are essential for stable yields.

With irrigation, sewage solve multiple problems: post-treatment soil is waste water is reduced intake of natural water for irrigation than preventing depletion and pollution, soil enriched with nutrients and naturally increase their fertility, increasing yields of irrigated crops, eco-efficiency is achieved by reducing the or termination of sewage into the river Ili.

If it was set up the corresponding area of land irrigated with wastewater, then all the water has could be used to grow food and industrial crops, vegetables, wood, etc. Would be reduced by the cost of operating and cleaning deferent canals, maintenance of facilities purification and disinfection of wastewater.From 1973 to 1995, wastewater Almaty focused mainly drive Sorbulak total capacity of 1,000 million $m^3$, under his influence, and evolved a specific hydrogeologic setting.

Then institute „Kazgiprovodkhoz" project was carried Sorbulakskogo Right Bank Canal (PSC) with a cascade of ponds drives maximum capacity of up to 62 million $m^3$, which began operations in August 1990 and was completed in 2000 after the construction of bio-ponds.

Until January 1992 went filling first pond, and then the second (in 1993), and subsequently was completed filling third pond. In 1996, completed and put into operation last section – Emergency relief channel through which waste water as needed can be discharged into the river Ili. Total length of the CPM, along with the alarm reset after bioponds is 63 kilometers.

In connection with the construction of the CPM formed a new hydrogeological conditions in the neighborhood. She caused the formation of specific hydrogeological and geotechnical conditions, the study of which, as well as the implementation of a third-party control over them, should be held in the first years of operation of the CPM and to date, not only in order to prevent the repetition of disastrous accidents, but also to improve the methods of use wastewater for irrigation at the site drainage.

To supply water for irrigation can be widely used traps and other engineering structures, provides water for irrigation without damaging the boards and levee deferent canals.

In this regard, cultivated agricultural crops must withstand higher rates of wastewater irrigation, give high yield of cheap and quality products, will pay off in the short term capital investments in construction.

Municipal sewage treatment plants – WWTP and sewage system effluent are working effectively, have a 30% reserve capacity, ensuring compliance with all environmental requirements and standards of the PDS.

Recently, there is a growth of effluent discharged from the town, with the annual increase in the concentration of pollutants. This will require in the near future to put in place additional equipment, including a number of primary and secondary clarifiers, a block of experimental deep aeration, another blowing machine. Need to accelerate the repair of the long-running facilities and related equipment.

The water balance drive Sorbulak systems, ponds Sorbulakskogo Right Bank Canal (PUK) and outlet channels for 2003-2004 and the first quarter of 2005, supported by predictive calculations, previously developed design organizations, which ensure normal safe operation of the entire system of sewage and environmental preservation areas accumulation of waste water. The actual balance sheet, the most recent ones in previous years are favorable.

In the areas of wastewater effluent Almaty established hydrogeological regime and observation network that provides safe operation. Through the network, well organized permanent control of environmental conditions.

Right Bank Canal Sorbulaksky (UCS) is a unique system that provides reliability, storage and management of (potentially) waste water Almaty. The complex consists of a number of natural components (ponds, rivers, ravine, canyon) and man-made engineering structures (canals, dams, pipelines, large-section).

Need for further research in the area adjacent to the Sorbulak and PUK are serving to enhance the study of level and hydrochemical regime of groundwater to the conduct systematic monitoring of environmental conditions. It is also excpected to identify opportunities for the use of ground water and water of filled ponds for irrigation and cultivation necessary for agricultural Almaty cultures. The development of rational design intakes, irrigation technologies is also excpected.

Special attention in the performance of research and development should be placed on the study of suffusion processes occurring during discharge of Lake Drive Zhamankum

High efficiency of wastewater irrigation of perennial grasses due to their ability to absorb good nutrients contained in wastewater, enhance the growth in high-moisture, improve soil structure and enrich it by the root remains.

The development of irrigated fields is constrained primarily poor exploration for agricultural use of sewage requires evidence-based approach to the chemical composition of the water used, technology training wastewater to irrigation, proper selection of crops, the effect on the composition and properties of the soil, the quality of products and regime groundwater principles for

complete water protection from pollution, agricultural irrigation technology in the system of crop rotation, preventing salinity and alkalinity of the soil, allowable load irrigation fields, taking into account the treatment capacity of the various layers of the soil, and finally, requires an engineering approach to the design construction and operation of irrigation fields wastewater.[1]

[1] The paper is based on: Law of the Republic of Kazakhstan „On Environmental Protection", Almaty, 1997/. Materials from the site: www.otherreferats.allbest.ru [10-02-2013]; Recommendation *Ecological bases of agricultural use of sewage*, MSKHRK, KazNIIVK, DGMSI, KIIAP. Almaty, 1994, p. 3-25; MI Ilyinsky, *Experience in the use and disposal of wastewater in agriculture hozyaystve*. Tashkent. UzNIINTI, 1984, p. 4; R.K. Kasymov, E.T. Ibrayev, *The use of treated wastewater for irrigation,* g.Tselinograda, Wastewater and their use in agriculture: N.tr.MKSi-ISV, Sb.2.-issue 2.-Almaty, 1991. p.134-135; S. Stroganov, Contamination and self-cleaning vodoemov, M, 1939; R.R. Williams Irrigation fields, Works.-M, 1941-TP, p. 452; O.Z. Zubairov, *Land improvement and water conservation on agricultural use of biologically treated sewage and livestock wastewater in irrigated areas south and south-east of Kazakhstan*, Abstract Doc. Disser.-Volgograd, 1992, p. 2-47; A.A. Shomantaev, *Hydrochemical regime and the agricultural use of return water in the lower reaches of the Syrdarya river*, Thesis. Almaty, 2002, p. 16; A.A. Korotunov, A.Zh. Yusupov, A.V. Demchenko, *Recommendations. At the WWTP (municipal sewage treatment facilities)*, by diverting channels and sewage ponds. Almaty, 2000-2010; www.pochemuha.ru [10-02-2013]; www.resursyzemli.ru [10-02-2013]; M. Myrzahmetov, E.B. Zhumartov, *Improvement and development of water and wastewater in the Kazakhstan market economy*, „Water Resources of Central Asia" Almaty 2002.