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PURIFICATION DEGREES OF WASTE WATER UNDER DIFFERENT IRRIGATION REGIMES

Abstract. In the process of irrigation wastewater treatment is as its movement in the horizontal direction, and when leaking from top to bottom on the soil profile.In order to identify the degree of soil purification of wastewater, a complex of lysimetric studies was carried out in the territory of Almaty, Zhambyl and South Kazakhstan regions in various varieties of loamy soils.

Key words: lysimeters, aeration, biological uptake, wastewater, ingredients.

Introduction. Metal lysimeters had a height of 35, 65, 95, 155, 205 cm, and soil monoliths 30, 60, 90, 150, 200 cm. Lysimeters of small height (up to 1.5 m) were filled with monoliths of undisturbed structure, and more than 1.5 m - with soil of natural genetic structure with compaction close to natural.The inner surface of the lysimeters was covered with bitumen in 2 layers, filtered water through the pipe was sent to special containers. The lysimeters were planted with the same crops as for wastewater treatment and the irrigation regime was identical.

Comparison of the data of the chemical composition of the source water and filtration makes it possible to judge the degree of its purification.

The general quantitative and qualitative expression of the processes of absorption and migration of ingredients in waste water introduced into the soil with irrigation water had their regularities [1, 3].

Wastewater treatment occurred mainly in the zone of aeration, where he is actively in the process of nitrification, oxidation of proteins, cation exchange, biological uptake, etc. (table 1).

Sixty centimeter layer of soil, depending on the value of irrigation norms holds up to 100% of suspended solids, from 80 to 91% of nitrogen and from 90 to 99% of phosphorus.

Reducing the degree of purification soil of various ingredients can be found in the weakening at the end of the vegetation consumption of their higher vegetation, reducing the end of the vegetation consumption of their higher vegetation, reducing the microbiological activity of serozems, the relative "saturation" of the filter layer by the substances, changing the cationic composition of the arable horizon as a result of irrigation, meteorological conditions and other factors individually or in combination causing changes in the sorption properties of the soil.

Similar phenomena were observed in the crops of maize for silage in South Kazakhstan region (table 2).

From mineral elements absorption of phosphorus was greater than the absorption of nitrogen.As irrigation rates increase, losses of nitrogen and phosphorus increase (table 3).

The absorption of the upper soil horizons decreases from irrigation to irrigation depending on the frequency of irrigation and water supply rate. Naturally, the greater the rate of water supply, the greater the flow of various organomineral substances. In this regard, the soil is oversaturated in a short period of inter-irrigation period does not have time to be completely exposed to various soil processes.

V.T.Dodolina noted that during the inter-irrigation period, part of the absorbed substances will be used by agricultural crops, and part under the influence of various processes is decomposed into simple compounds.

Table 1 – The degree of absorption of waste water ingredients by different soil layers, % (average loam) (on sugar beet crops)

# irrigation	Irrigation norm, m^3/ha	Layer, cm	Suspended matter	HCO_3	Cl	SO_4	Ca	Mq	Na+K	N	P_2O_5
Option II (irrigation at 60% of the water pressure)											
1	700	0-30	50	40	50	40	40	40	42	60	50
		30-60	50	41	31	32,9	37	55	20	40	30
	Total	0-60	100	81	81	72,9	77	95	62	100	80
4	1100	0-30	50	39	40	50	39	40	45	50	45
		30-60	50	44	18	18	28	40	24	29	25
		60-90	–	7	22	22	19	20	15	1,0	6
	Total	0-90	100	90	80	90	86	100	84	80	76
Option III (irrigation at 70% of the water pressure)											
1	500	0-30	60	51	52	44	31	50	50	58	51
		30-60	40	45	30	45	69	36	38	34	28
	Total	0-60	100	96	82	89	100	86	88	92	79
7	800	0-30	60	40	10	30	24	44	40	49	46
		30-60	40	18	10	30	12	16	10	30	19
		60-90	–	28	50	21	17	36	36	17	25
	Total	0-90	100	86	70	81	53	96	86	96	90
Option IV (irrigation at 80% of the water pressure)											
1	400	0-30	55	49	68	40	27	60	55	63	58
		30-60	45	43	20	51	68	28	39	35	33
	Total	0-60	100	92	88	91	95	88	94	98	91
10	650	0-30	40	30	10	25	10	30	41	40	46
		30-60	50	16	18	14	22	10	6	29	15
		60-90	10	43	55	39	34	60	41	31	31
	Total	0-90	100	89	83	78	66	100	88	100	92

Table 2 – Degrees of wastewater treatment by different soil layers on maize crops for silage (SKR)

Soil layer, cm	Norm of watering, m^3/ha	Ingredients, mg/l					
		HCO_3	Cl	SO_4	Ca	Mq	Na+ K
0-30	700	120,7	19,8	72,6	31,2	11,6	50,4
0-30	900	131,3	21,2	74,3	31,8	12,6	53,4
30-60	700	96,4	11,4	34,3	10,5	6,3	20,5
30-60	900	87,2	10,1	32,6	9,9	6,0	18,7
60-100	700	14,6	6,2	18,9	5,3	2,8	7,2
60-100	900	12,3	5,9	16,2	5,4	2,4	6,6
Source water		235,0	36,51	174,2	77,0	20,4	102,0

Table 3 – Absorption of N, P, K in different soil layers

Performances	In layer, cm	Norms of watering, mm						
		400	500	600	700	800	900	1000
Phosphorus	0-30	61	58	60	50	41	56	50
Nitrogen	0-30	58	51	50	50	46	48	50
Phosphorus	0-90	99	93	92	90	91	79	79
Nitrogen	0-90	91	80	88	86	80	65	70

The longer the inter-irrigation period, the higher the absorbing capacity of the soil, and hence the degree of purification.

Research materials and the above data show that on gray soils with deep groundwater, irrigation with a moisture threshold, 70% water norm provides not only high yields, but also an appropriate degree of soil post-treatment in the root layer.

In Almaty region were laid lysimeters depth of 1.5; 2, 3 meters.

Experimental data showed that at a depth of 1.5 m the filtrate was almost clean, and at a depth of 3.0 no changes in soil moisture were observed.

Therefore, while maintaining the optimal irrigation regime and its observance, wastewater does not affect the depth of more than 3 m [2, 4-7].

Methods. Under conditions of irrigation with wastewater, the following agrotechnical indicator is effective in substantiating the optimal values of irrigation rates and the dose of fertilizers on all types of soil: chemical composition (N, P, K content) of main and by-products; removal of elements of the mineral nutrition of the harvest unit; soil availability with nitrogen, phosphorus, potassium and microelements permissible for plants: use of fertilizers from the soil by field crops depending on the soil type, weather conditions and the level of specified crops; payback of 1 kg N, P, K. Therefore, the correct determination of the irrigation rates and the dose of fertilizers calculated for the programmed level of the crop is one of the most important elements of the entire ecosystem under consideration.

In order to use the technique in question, it is necessary first of all to calculate the "B" removal of the corresponding mineral nutrient elements with a programmed yield. Knowing the level of the yield programmed at this stage (where $Y_0$is the programmable yield of the main product, centners per hectare), and having the ratio of main production and secondary production (Y_n), it is easy to make the removal of nutrients using the ratio:

$$B_0 = Y_0 \cdot C_0 + Y_n \cdot C_n \,, \qquad (1)$$

where C_0 – nutrient content per unit of main product (kg/c); C_n – nutrient content per unit of by-product (kg/c); Y_n – by-products of the programmable crop, which is determined by the formula;

$$Y_n = \alpha \cdot Y_0. \qquad (2)$$

Here is α – coefficient that takes into account the ratio of the main product to the by - product (for corn – 2.8, perennial grasses – 0, barley – 1.1, winter wheat – 1.4).

The amount of expected receipt of mineral substances with waste water is determined by the formula:

$$N_m = \alpha \cdot M/100;\ P_m = \varphi \cdot M/1000;\ K_n = k \cdot M/1000, \qquad (3)$$

where N_m, P_m, K_n – the amount of expected intake of nitrogen, phosphorus and potassium, kg/ha; α, φ, k – content of nitrogen, phosphorus and potassium, mg/l.

Possible removal of the input mineral substances with waste water is determined from the following expressions:

$$N_{yn} = N_m \cdot \alpha_n; \qquad (4)$$

$$P_{yn} = P_m \cdot \alpha_\varphi; \qquad (5)$$

$$K_{yn} = K_m \cdot \alpha_k, \qquad (6)$$

where N_{yn}, P_{yn}, K_{yn} – possible removal of nitrogen, phosphorus and potassium with a yield of incoming mineral substances with waste water (kg/ha); α_n, α_φ, α_k – utilization rate of nitrogen, phosphorus and potassium from wastewater.

The amount of nitrogen, phosphorus and potassium used from the soil is calculated by the formula:

$$N_{yp} = N_p \cdot \alpha_{np}; \qquad (7)$$

$$P_{yp} = P_p \cdot \alpha_{\varphi p}; \qquad (8)$$

$$K_{yp} = K_p \cdot \alpha_{kp}, \qquad (9)$$

where N_{yp}, P_{yp}, K_{yp} – nitrogen, phosphorus and potassium content in soil, kg/100; N_p, P_p, K_p – amount of nitrogen, phosphorus and potassium used by plants from the soil; α_{np}, $\alpha_{\varphi p}$, α_{kp} – utilization rate of nitrogen, phosphorus and potassium from soil.

At the same time, the need for mineral fertilizers should be decided in each case, based on the following definitions:

1. If the amount of nitrogen, phosphorus and potassium used from the soil and wastewater is less than the removal of these nutrients by crop products, i.e.,

$$B_N > N_{yp} + N_{yn}\ ; \tag{10}$$

$$B_p > P_{yp} + P_{yn}; \tag{11}$$

$$B_k > K_{yp} + K_{yn}. \tag{12}$$

Then mineral fertilizers are made from the calculation of compensation of the differences.

2. If the amount of nitrogen, phosphorus and potassium used from the soil and wastewater is greater than or one of them is greater than the removal of these nutrients by the crop production, i.e.,

$$B_N < N_{yp} + N_{yn}\ ; \tag{13}$$

$$B_p < P_{yp} + P_{yn}; \tag{14}$$

$$B_k < K_{yp} + K_{yn}. \tag{15}$$

Then the irrigation rate of crops is determined by the maximum value of the nutrient removal of one of the nutrients and mineral fertilizers are taken out of the calculation of compensation for the deficiency of other nutrients.

Irrigation norm of agricultural crops under irrigation by sewage is calculated by the formula:

$$M_{na} = [B(NPK)i - P(NPK)i] \cdot 100/\alpha_i\ , \tag{16}$$

where M_{na} – irrigation norm of agricultural crops taking into account the fertilizer value of waste water, m^3/ha; $B(NPK)i$ – removal of the 1st nutrient element by agricultural products; $P(NPK)i$ – use of the 2nd nutrient element from the soil; α_i – utilization rate of the 3rd nutrient element from wastewater.

If $M_{na} < M$ then, the necessity of extra amount of water, compensating the deficiency of water consumption of agricultural crops, i.e.:

$$\Delta M = M - M_{na}, \tag{17}$$

where ΔM – additional rate of supply of irrigation water to compensate the water deficit of agricultural crops.

Consequently, one of the main tasks in the use of wastewater for irrigation is to determine the share of irrigation water in the water deficit, providing optimal water-salt and food regime of the soil and high crop yields.

For the participation of irrigation water in the deficit of water consumption of agricultural crops in irrigation with waste ater is determined by the formula:

$$\alpha_c = I - \frac{B(NPK)i - P(NPK)i}{\alpha_i \cdot M} \cdot 100. \tag{18}$$

Thus, the account of nutrients content in waste water provides a normal natural regime of the soil and economical to the introduction of these elements in the form of fertilizers.

Thus, the following should be taken into account when establishing the irrigation regime for wastewater irrigation:

In some (critical) periods of vegetation, crops may be unsatisfactory inflow of wastewater. Additional irrigation from natural water bodies – rivers, reservoirs or groundwater-can be used to replenish this moisture deficit.

The amount of additional water needed to cover the water shortage is found by the formula:

$$M_a = W_w - Q_{ad} \cdot T_k, \qquad (19)$$

W_w – the need of the culture in water for the critical period, m^3/ha; Q_{ad} – average daily consumption of wastewater coming from the city, m^3/ha; T_k – the duration of the critical period in days.

In the practice of designing wastewater treatment, such periods are established by comparing the crop irrigation hydraulic module in the crop rotation (q in l/sec per 1 ha) with the wastewater supply hydraulic module determined by the formula:

$$q_1 = \frac{Q_{ad}}{86{,}4 \cdot \omega}, \frac{l}{cek}, \qquad (20)$$

where Q_{ad} – average daily waste water consumption, m^3/day; ω – area of simultaneous irrigation, ha.

When establishing irrigation and irrigation standards, it is necessary to take into account the cleaning capacity of the soil.It is known that during irrigation and subsequent movement of waste water on the surface and on the profile of the soil, their intensive purification occurs due to the mechanical, molecular sorption, ion-sorption, chemical and biological absorption capacity of the soil.The effect of soil purification decreases with increasing water supply rates.On loamy soils of the southern zone of Kazakhstan, intensive cleaning occurs at irrigation rates up to 600 mm, and at a rate of 900 mm and more, the soil will not give a cleaning effect.

Results. Each soil is characterized by a certain absorption capacity. The larger it is, the higher the degree of wastewater treatment.For example, loamy soils of Zhambyl, South Kazakhstan and Almaty regions have high absorption capacity. In the meter layer of these soils, on average, 60 to 90% of the elements of mineral nutrition are retained.

As irrigation rates increase, the number of irrigations and the capacity of the soil filter layer decrease will be less pronounced.

By the end of the growing season and subsequent years of irrigation, the absorption capacity of the soil is somewhat reduced. This is due to the fact that the soil with long-term irrigation is oversaturated with substances brought with wastewater and its cleaning ability is gradually reduced.Therefore, it is very important to maintain a balance between the flow of waste water ingredients and their use by plants.

One of the reasons for the "fatigue" of the soil of irrigation fields is the overload of soil with irrigation water both during the growing season and during the non-vegetation period.As a result of the overload in the soil, the processes of transformation of substances can not proceed normally, soil fertility is ensured.

For the correct use of waste water must necessarily take into account the water-holding capacity of the soil. For wastewater treatment, the amount of runoff should be zero. Water supplied in excess of the water-holding capacity of the soil enters the groundwater.

The smaller the irrigation rate and the longer the irrigation time, the greater the difference between the inflow and outflow of wastewater.The irrigation rate should be calculated so that it does not exceed the permissible ultra-precise value of the intensity of infiltration of irrigation water and the permissible depth of the groundwater level.The value of infiltration and groundwater reaches its peak in the spring, during the snowmelt.It is, all other things being equal, on average twice as much as the growing season, when water is expended heavily on evaporation and transpiration by vegetation.Therefore, the annual irrigation rate should be sufficiently consistent with the conditions of underground outflow of groundwater, to ensure the possibility of neutralization and treatment of waste water in the infiltration process, also fully take into account the needs of plants in moisture.In order to reduce winter irrigation norms, it is necessary to organize irrigation of the entire area of irrigation fields.

The basis of the year-round irrigation cycle for wastewater treatment should be the satisfaction of the crop with moisture during the growing season and the accumulation of essential nutrients in the soil during the growing season.

The basis of the irrigation regime should be the creation of a predominant downward current, providing leaching of salts from the upper horizons of the soil.There was no danger of soil alkolining, for which the amount applied with wastewater and in the form of calcium fertilizer was greater than the amount applied with wastewater sodium. Because of this, when calculating the irrigation regime, it is necessary to observe the balance:

a) nutrients from wastewater;
b) moisture;
c) water-soluble salts.

Of the above, the most important is the provision of water to plants, which is crucial in the formation of the basis of the future harvest, especially in the southern regions of the country and the balance of water-soluble salts, which remain in large quantities after treatment facilities.

Irrigation regime of agricultural crops of wastewater treatment should consist of vegetation and non-vegetation irrigation regimes.

The basis of irrigation regime of vegetation irrigation should be based on the same principles as in conventional irrigation.

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ӘРТҮРЛІ СУҒАРУ РЕЖИМІ КЕЗІНДЕГІ ТӨГІНДІ СУЛАРДЫ ТАЗАРТУ ДӘРЕЖЕСІ

Аннотация. Суғару процесі кезінде төгінді суларды тазарту көлденең бағытта, топырақ профилі бойынша жоғарыдан төмен қарай жүреді. Алматы, Жамбыл және Оңтүстік Қазақстан облыстарының аумағында топырақты төгінді сулардан тазарту дәрежесін анықтау мақсатында саздақ топырақтардың әртүрлі сорттарында лизиметрлік зерттеу кешені жүргізілді.

Түйін сөздер: лизиметр, аэрация, биологиялық жұту, төгінді сулар, ингредиенттер.

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СТЕПЕНЬ ОЧИСТКИ СТОЧНЫХ ВОД ПРИ РАЗЛИЧНЫХ РЕЖИМАХ ОРОШЕНИЯ

Аннотация. В процессе полива очистка сточных вод происходит как при ее движении в горизонтальном направлении, так и при протекании сверху вниз по профилю почвы. С целью выявления степени очистки почвы от сточных вод на территории Алматинской, Жамбылской и Южно-Казахстанской областей в различных сортах суглинистых почв был проведен комплекс лизиметрических исследований.

Ключевые слова: лизиметры, аэрация, биологическое поглощение, сточные воды, ингредиенты.

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