Assessment of the effectiveness of biological treatment wastewater at “Binokor” aeration station located at Urta Chirchik district of Tashkent region

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Assessment of the effectiveness of biological treatment wastewater at "Binokor" aeration station located at Urta Chirchik district of Tashkent region

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Abstract. The article summarizes the results of research on improved sewage treatment technology at the "Binokor" Aeration Station, the biological treatment technology of pistia and eichhornia aquatic plants; studies have shown that the physical and chemical composition of wastewater improved after 7 days of planting aquatic plants, that is, the smell of the water has disappeared, the color has become clearer, the pH of the water has been neutral, the nutrients were absorbed by plants from 50% to 70% of, and the demand for oxygen was satisfied to 95%. It should be noted that the pistia plant has a more active absorption of substances in the domestic wastewater than the eichhornia species.

1. Introduction

It is known that the world consumes 3,300 - 3,500 km^3 of water annually, and the demand for water is increasing year by year. The problem of water supply is aggravated by urban expansion, the rapid development of industry and agriculture, expansion of irrigated land, population growth and improved living conditions, and other factors. As a result, at present, more than one-fourth of the world's population lives in countries that lack water. Such a situation is quite acute in some African countries, in the Middle East, and even in developed European countries [1, 2, 3]. The aforementioned disadvantages have not been avoided by the Republic of Uzbekistan, and this problem is becoming more acute every year. One of the factors for its prevention and eradication is the rational use of water resources, improvement of the use of water, and protection of water resources [4,5,6].

It is well-known that one of the main objectives of the rational use and protection of water resources is the different use of wastewater from industrial enterprises, agricultural production, and domestic utilities, especially the biological treatment of urban wastewater [7, 8, 9, 10].

The most important sources of water pollution are sewage from industrial and domestic utilities. [11, 12, 13] These wastewaters contain various substances that are potentially harmful to the living organism, which combines with wastewater into lakes and reservoirs to pollute them [14, 15, 16].

At present, some of the used water is being treated and the remaining (50%) is discharged into ponds without any treatment [17, 18]. One of the main ways of preventing these negative consequences, that is, maintaining the hygienic status of water bodies, is to build various wastewater treatment plants, apply modern methods, and develop a scientific basis for the reuse of wastewater. [19, 20].

The above-mentioned data shows that the biological treatment of domestic wastewater is poorly studied, and no research has been carried out to reduce the treatment time and increase the purity by using the aquatic plants. With this in mind, we planned to research to improve the technology of biological treatment of domestic wastewater formed at the "Binokor" Aeration Station in Urta Chirchik district of Tashkent Region.

The purpose of the research.

The purpose is to save water resources by improving the technology of domestic wastewater with aquatic plants: pistia an eichhornia; improving the technology of wastewater treatment.

The tasks of the research.

The main objectives of the study are:

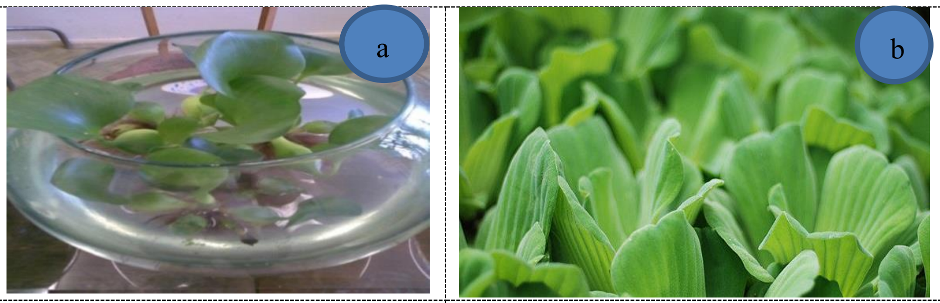
1. Determine the regularities of changes in the volume and physical and chemical characteristics of sewage at the "Binokor" Aeration Station in Urta Chirchik district of Tashkent Region, depending on the season.
2. Investigation of the efficiency of sewage treatment technology in the conditions of treatment facilities of the "Binokor" Aeration Station in Urta Chirchik district of Tashkent Region.

2. Methods

The object of study was the "Binokor" Aeration Station, this is due to 3 out of 4 existing stations in the city that have been carried out scientific work on sewage treatment; the sewage of this Aeration Station has not surveyed at all. The "Binokor" Aeration Station was established in 1981 with a total area of 16.4 hectares with a design capacity of 12,000 m^3. Wastewater from the southeast of Bektemir district of Tashkent City is supplied to the treatment plant via collector drainage. However, the cleanup facility, which has been operating continuously for 37 years, does not currently have any technology in the facility due to the lack of capital repairs, the sewage from the urban area is not being treated and is being transported to the collector in the areas that collect intra-district sewage. In Bektemir district, wastewater is discharged to the treatment plant through central pipes of 78 km, with central sewage receiving public utilities. The city is a flat relief that prevents sewage from moving through its stream, so the pressure-based sewage scheme currently provides sewage treatment facilities with a sewage system and a pumping station. The main collector was used to move its flow of 300 mm in diameter.

In the apartment buildings as well as in public office buildings, 1-A pump stations with in-house sewerage networks were built. The wastewater from pumping stations 1 and 2 were first supplied with pressure pipes to the treatment plant built in 1981.

Pistia and Eichhornia plant species were selected as biological treatment facilities, (The plant species are from the collection of the Botanical Institute of the Academy of Sciences of Uzbekistan) Figure 1 [21, 22]



a) *b)*

Figure 1. General view of a) eichhornia and b) pistia grown under laboratory conditions

Different locations were identified from the biological pools for wastewater sampling, and one observation point was established at the wastewater disposal sites. By Yu.Yu.Lurye and Strogonova

N.S. methods, changes in the physical and chemical composition of sewage, ie before and after planting high aquatic plants have been identified [23, 24].

3. Results and discussions

Studies have shown that all sewage formed at the “Binokor” Aeration Station comes out of the apartment buildings in Bektemir district and through the central pipelines is discharged to the “Binokor” Aeration Station. The Aeration Station treatment facility consists mainly of aero-tank and secondary dilators, where the wastewater is partially mineralized by the active “sludge” effect of the wastewater. The efficiency of wastewater treatment that goes through this process is on average 55 to 60%. Such treated wastewater is treated with chlorine in pipes with a diameter of 2,500 mm and discharged into the Akhangaran canal. “Bektemir” Aeration Station generates about 1,200 m3 / day and an average of 438,000 m3 / year of sewage. The amount of sewage, depending on the season, is as follows: summer - 157680 m3 (36%), fall - 91980 m3 (21%), winter - 78840 m3 (18%), spring - 109500 m3 (25%). Increasing the volume of wastewater in the summer months is because of the increase in the amount of water used for domestic purposes, which will lead to an increase in the amount of wastewater.

The work done at the “Suvsoz” Unitary Enterprise Laboratory for Quality Analysis of Wastewater at the “Binokor” aeration station for 2017-2018 is shown in table 1.

Table 1. Physical and chemical indicators of sewage discharged to the “Binokor” aeration station by seasons of the year

No.	Indicators	Spring	Summer	Fall	Winter
1	Smell	4	5	4	4
2	Color	4	4	4	4
3	pH	8.4	8.7	8.2	8.2
4	Dissolved Oxygen, mg O_2/l	6.3	6	6.1	6.2
5	SBS_5, mg O_2/l (BOC_5)	60.7	62.5	61.4	65
6	Phosphates, mg/l	2.58	2.98	2.74	3.0
7	Copper, mg/l	3.31	3.45	3.40	3.5
8	Ammonia, mg/l	3.60	3.80	3.20	3.30
9	Ferrum, mg/l	4.10	4.70	4.30	4.0
10	Chlorides, mg/l	429	435	433	440
11	Chromium, mg/l	0.49	0.58	0.51	0.55
12	Sulfates, mg/l	165.8	167.2	163.7	165.0
13	Nitrates, mg/l	60.4	67	64.7	66.0
14	Nitrites, mg/l	4.2	4.6	3.8	4.8

SBS - Sewer Biological System BOC - Biochemical Oxygen Consumption

Laboratory analysis of “Suvsoz” Unitary Enterprise shows that the chemical composition of wastewater discharged from the Aeration Station during the year varies. Laboratory results show that the amount of chemicals is much higher in the sewage flow to the “Binokor” Aeration Station in the summer, which is since domestic wastewater flows more in the summer, which means that the population consumes more water at this time and maximizes waste, as well as high performance of the manufacturing enterprises.

To grow the necessary planting material for biological treatment of the wastewater from the “Binokor” Aeration Station, we have grown aquatic plants – pistia and eichhornia in two 400 liters of duralumin containers [25, 26].

Up to 20 kg from each of the high water plants were planted in sewage systems of the Binokor aeration station, that is in two air-tank structures: in one of them pistia plant and the second one eichhornia plant (Fig.2).

Prior to experimenting in the “Binokor” Aeration Station, wastewater samples were collected from 4 points of the station to determine the chemical characteristics of wastewater. These points are from the pipeline leading to the “Binokor” Aeration Station - the first sample, the second sample before entering the air-tank facility of the station, the third sample at the exit from the air-tank facility of the station, and the last sample is the sewage from the bio-pool of the “Binokor” Aeration Station. Samples were taken at a depth of 10–15 cm from the surface of the wastewater in the air-tank. Wastewater samples were chemically analyzed twice, before and after planting high aquatic plants. (Table 2).

Figure 2. A view of pistia and eichhornia plants in the air-tank

Table 2. Physical and chemical indicators of sewage at the “Binokor” aeration station before and after the experiment

Chemical Indicators	from the sewage pipe of the “Binokor“ aeration station	Before the Experiment		After the Experiment			Norms
		Sewage at the output of the air-tank	Sewage coming out from the “Binokor” aeration Station	Wastewater at the Output of Air-Tank: Eichhornia	Wastewater at the Output of Air-Tank: Pistia	Wastewater from a biological pool at the “Binokor” aeration Station	
Smell	5	4	3	2	1	1	2
Color	4	3	2	2	1	1	2
pH	8.9	8.4	8	7.5	7.2	7.0	6-8
Dissolved Oxygen, mg O_2/l	6.58	8.5	8.9	10.2	12.8	13.7	4-6
SBS_5, mg O_2/l (BOC_5)	62.5	29.1	22.3	20.1	17.5	3.12	30
Phosphates, mg/l	2.98	2.34	2.70	1.98	1.06	0.44	2.5
Copper, mg/l	3.45	2.1	1.8	1.58	1.04	0.86	1

Ammonia, mg/l	3.8	2.87	2.42	2.1	1.92	0.76	2.5
Ferrum, mg/l	4.7	3.05	2.95	2.7	2.36	1.17	5
Chlorides, mg/l	435	393	382	256.8	189	87.8	350
Chromium, mg/l	0.58	0.38	0.29	0.25	0.12	0.10	0.10
Sulfates, mg/l	167.2	113.8	95.8	80.92	60.5	25.08	350
Nitrates, mg/l	67	46.4	43.7	33.8	28.9	7.2	45
Nitrites, mg/l	4.6	3.54	3.32	2.37	1.56	0.92	3.3

SBS - Sewer Biological System

BOC - Biochemical Oxygen Consumption

As can be seen from Table 2, the maximum physical and chemical indicators were observed after wastewater was formed in the Aeration Station. For example, smell, color, hydrogen ions, as well as nitrite, nitrate, phosphate, copper, and chromium are stored at levels much higher than normal. We can see the physical and chemical parameters of the wastewater have changed significantly in the process of passing through the treatment plant. It can be observed that the odor of the wastewater was reduced to 3, color to 2, pH to 8 before discharge from the air-tank (before planting water plants), copper and chromium content decreased by 50%, sulfates and ammonia - by 40%, phosphates and chlorides - by 80%, and the demand for oxygen is 60% satisfied. These indicators are due to the deposition of wastewater (iron, copper, chromium) and other substances (nitrate, nitrite, phosphate, sulphate) by microorganisms and the assimilation of aquatic plants, which is a natural self-cleaning process.

Physical and chemical composition of plants of eichhornia and pistia in laboratory conditions in a feed environment where 50% of wastewater is washed by the "Binokor" Aeration Station (in 7 days).

Tale 3. In nutrient environments with 50% wastewater

Pistia			Eichhornia		
Chemical Indicators	Before Experiment	After Experiment	Chemical Indicators	Before Experiment	After Experiment
Smell	2.50	1.13	Smell	2.50	1.41
Color	1.70	1.35	Color	1.70	1.69
pH	4.50	4.59	pH	4.50	5.74
Dissolved Oxygen, mg O_2/l	3.60	3.93	Dissolved Oxygen, mg O_2/l	3.60	4.91
SBS_5, mg O_2/l (BOC_5)	28.00	20.25	SBS_5, mg O_2/l (BOC_5)	28.00	25.31
MSS, mg O_2/l (COC)	29.40	36.68	MSS, mg O_2/l (COC)	29.40	45.84
Phosphates, mg/l	1.53	1.61	Phosphates, mg/l	1.53	2.01
Copper, mg/l	1.28	0.67	Copper, mg/l	1.28	0.83
Ammonia, mg/l	1.90	1.58	Ammonia, mg/l	1.90	1.98
Ferrum, mg/l	0.75	3.00	Ferrum, mg/l	0.75	3.75
Chlorides, mg/l	243.50	181.50	Chlorides, mg/l	243.50	226.88
Chromium, mg/l	0.40	0.03	Chromium, mg/l	0.40	0.04

Sulfates, mg/l	19.50	19.50	Sulfates, mg/l	19.50	24.38
Nitrates, mg/l	0.44	2.25	Nitrates, mg/l	0.44	2.81
Nitrites, mg/l	0.16	1.13	Nitrites, mg/l	0.16	1.41

SBS - Sewer Biological System
BOC - Biochemical Oxygen Consumption
COC - Chemical Oxygen Consumption
MSS - Municipal Sewer System

Thus, the physical and chemical characteristics of the sewage prior to experimentation at the “Binokor” Aeration Station indicate that the initial wastewater discharge to the station was 60 to 70 percent untreated. After three days of planting pistia and eichhornia into the wastewater of the air-tank, it was found that the number of substances contained in the wastewater significantly decreased. After 7 days, the physiochemical performance of the sewage discharged from the biological pool after air-tank was 90-95% purified. The demand for oxygen of the sewage (Sewage Biological System) decreased by 90-95%, phosphates by 50 - 60%, sulfates by 40 - 50%, and nitrates - nitrites - by 70%. The results of this experiment show that the sewage aided by aquatic plants at the “Binokor” Aeration Station can be increased from 60% to 90% -95% depending on the type of biological treatment used by aquatic plants.

4. Conclusions

Experiments at the “Binokor” Aeration Station indicate that the pistia plant can be used in biological treatment of wastewater formed at the Aeration Station, that is, between 90 and 95% of the effluent content is absorbed by 40 to 70% of the water in 5 to 7 days. It was found to be satisfactory and the cleaning efficiency was up to 95%. Based on these results, it was shown that the Aeration Plant’s wastewater treatment technologies could be applied to these wastewater treatment plants in various cities throughout the country.

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