Monitoring of Performance of the Municipal Wastewater Treatment Facilities

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Abstract – The paper has engaged monitoring of performance of the municipal wastewater treatment facilities of Lviv by analyzing the average monthly data of their operation, obtained in a chemico-bacteriological laboratory of the Lviv City Utility Enterprise "Lvivvodokanal". Also, performance of aerotanks of the same facilities has been studied by carrying out check measurements of the concentration of dissolved oxygen and ammonium in them.

Key words – monitoring, wastewater treatment facilities, dissolved oxygen, aerotanks, active sludge.

I. Introduction

According to specialists, today quarter of the wastewater treatment facilities and sewerage networks in Ukraine in monetary terms is out of their depreciation life [1].

Most of the operating treatment facilities have a range of deficiencies in common. In particular, majority of the plants is characterized by low energy efficiency, poor wastewater purification and unsolved sludge disposal issues [2].

II. Page Setup

Today, the determinant method is a method of biological wastewater treatment. The most popular objects, where this process is carried out, are aerotanks, which operation is based on the utilization of active sludge. Aerotanks have unquestionably positive features, which are especially useful in treatment of domestic wastewater. Among others, these are structural simplicity, operational reliability (i.e. treatment of stable, nontoxic and moderately concentrated in terms of contamination wastewater), relatively low cost of water processing and ability to treat wastewater of the different content [3].

Aerotanks are widely used in combination with secondary settling tanks for wastewater treatment. A role of the secondary settling tanks in a biological wastewater treatment complex is to retain sludge microorganisms coming to the sludge mix from the aerotanks.

Efficiency of the treatment process in aerotanks and a state and oxidizing capacity of the sludge are determined by a range of conditions, among which are: wastewater content and properties, hydrodynamic mixing conditions, the relation between the amount of delivered impurities and viable sludge, oxygen regimen in the facility, temperature and active reaction of the environment, availability of nutrients, presence of process activators or inhibitors [4]. We studied performance of the wastewater treatment facilities in Lviv.

III. Page Setup

The wastewater treatment facilities of Lviv consist of two parts (Facility 1 and Facility 2) (Tab. 1).

TABLE 1

LVIV TREATMENT FACILITIES

Lviv treatment facilities	Hydraulic capacity (ths.m^3/24 h)	Actual wastewater amount (ths.m^3/24 h)
Facility 1	140	100
Facility 2	350	300
Treatment facilities in total	490	Around 400

Domestic, industrial and runoff wastewater flows to the wastewater treatment facilities by a closed sewer (the Poltva River). The total design capacity of the Lviv wastewater treatment facilities, as shown in the Table 1, is 490 ths.m.^{3}/24 h. The average daily wastewater treatment rate is 440 ths.m^3/24 h)

By content, wastewater flowing to the Facility 1 is industrial and domestic, and to the Facility 2 is mostly domestic.

Performance of the aerotanks is assessed based on the average monthly data on operation of the Facility 2, provided by the chemico-bacteriological laboratory of the Lviv City Utility Enterprise "Lvivvodokanal". After comparing the received output concentrations of contaminants from the Facility 2 with the relative TLV values, we cannot state that the wastewater is entirely treated at the treatment facilities and that the treated water is suitable for domestic or fishery utilization, since the required level of purification by a range of indicators (ammonium nitrogen, nitrites and iron) is not reached, according to the TLV for fishery utilization of treated wastewater.

In the aerotanks at the Facility 2 we measured the concentrations of dissolved oxygen and ammonium nitrogen. The obtained results are provided in the Table 2, where, besides the readings of a sensor of the treatment facilities and potentiometeric measurements, measurement results received in the chemico-bacteriological laboratory of the Facility 2 are given.

The Table 2 shows that the readings of the dissolved-oxygen meter and the instrument of the treatment facilities are somewhat different, and in some cases vary greatly. However, there is a certain correlation in the relation between the dissolved oxygen measured by the sensor of the treatment facilities and by us under the laboratory conditions. Better conformity in the measurement results can be observed in the potentiometric measurements and the results of the chemico-bacteriological laboratory.

The results also show that the highest DO values are recorded in the 2nd aerotank. Therefore, we have decided to study the DO concentration profile more precisely within the 2nd aerotank. The measured values are shown on the diagrams below (fig. 1 and 2).

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TABLE 2

CONCENTRATION OF DISSOLVED OXYGEN IN AEROTANKS OF THE FACILITY 2

AEROTANK / C(DO), MG/L		№1		№2		№3		№4		№5		№6	
		Corridor II	Output	Corridor II	Output	Corridor II	Output	Corridor II	Output	Corridor II	Output	Corridor II	Output
Jul. 17, 2013	1	0,18	0,25	9,9	6,04	5,69	0,24	8,55	4,01	6,3	0,29	0,32	0,19
	2	0,44	0,41	3,67	2,33	3,4	0,54	2,69	1,73	3,15	2,6	0,11	0,37
	3	-	0,96	-	3,12	-	2,24	-	1,68	-	2,56	-	0,37
Oct. 02, 2014	1	0,32	0,26	0,35	3,64	0,36	4,82	0,99	6,16	0,28	1,69	0,82	0,80
	2	0,46	0,35	0,89	2,16	3,64	2,12	0,61	2,21	0,12	1,23	0,42	0,39

1 – readings of the sensor of the treatment facilities, 2 – readings of the dissolved-oxygen meter **sens*ion* *6***, 3 – data measured in the lab

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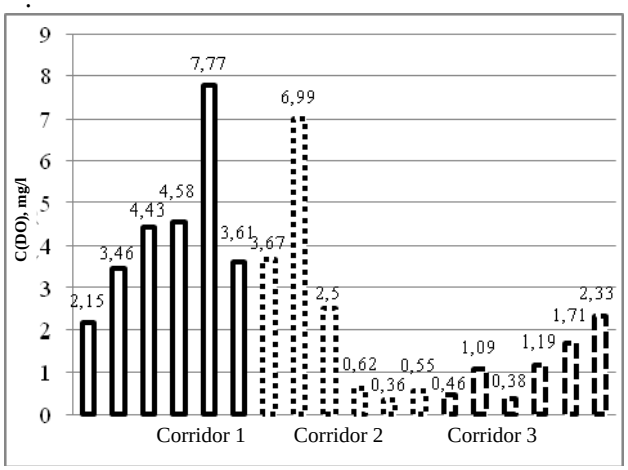

Fig. 1. DO concentration profile in aerotank No. 2 (July 17, 2013)

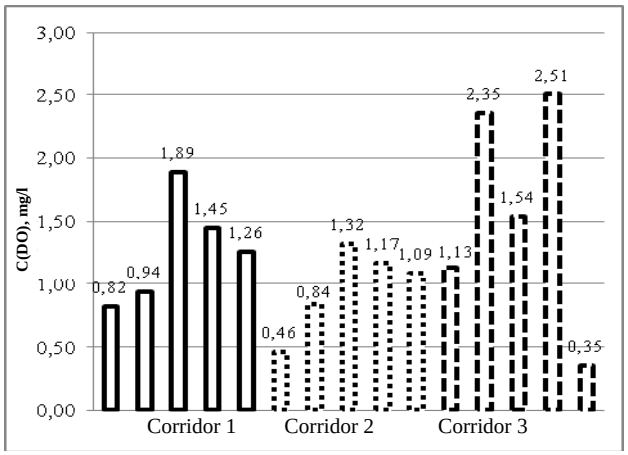

Fig. 2. DO concentration profile in aerotank No. 2 (October 02, 2014)

The obtained results allow us to make a conclusion that the DO concentration is not always within the values, which ensure the required purification level. At some points it is too high (9.9 mg/l), and at the others it is too low (0.18 mg/l), when normal aeration requires the DO concentration to be within 2.0 mg/l. The present aeration level does not provide necessary purification of wastewater and results in higher power consumption.

An analysis of the monitoring data shows that there is no consistency in the organization of the process of wastewater treatment from ammonium ions. First of all, the data shown in the Figures does not give a reason to say that automatic regulation of a constant dissolved-oxygen concentration value by the aerotank's profile is efficient. The data in the Fig. 1 and 2 demonstrates that the concentration of dissolved oxygen by the aerotank's profile is more of a random nature. This may be explained either by faulty operation of the sensors, imperfect automatic regulation or improper installation of the air supply system in the aerotank, and most probably – by all of these factors together.

Conclusion

Based on the conducted measurements and the obtained results, we can make a conclusion that after final outflow the treated wastewater is of a required quality level for its further domestic utilization, but not fully meet the norms for water to be used for fishery purposes.

Performance of the aerotanks at the Facility 2 is not efficient enough and requires improvement. This improvement should involve replacement of the system of oxygen supply to the aerotank on the basis of control signals of the sensors. The control signals should be generated based on the concentrations of ammonium ions, and not the DO concentrations.

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