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Analysis of Automatic Control System of Oxygen Delivery in Aerotanks in Wastewater Treatment Facilities Belonging to "BUKHORA Water Supply" LLC

Son of Timirov Husen Nusratillo, Bukhara Institute of Engineering and Technology, PhD student of the Department of Energoaudit

ABSTRACT: This article presents the methodology for improving the energy efficiency of wastewater treatment plants, the main characteristics and appearance of aeration units. A review of existing automatic control systems for aeration units has been carried out.

I. INTRODUCTION

In recent years, as a result of the population growth in Uzbekistan, the demand for electricity is also increasing, in particular, the tariffs for providing services to the population are also increasing. For example, in the field of water supply, the operation of aeration systems, which require a lot of electricity, leads to the failure of the existing water supply system or the increase in the price of its services for the population. Therefore, solving these problems is one of the urgent tasks today.

The research object is the compressor station of Bukhara wastewater treatment facilities. Bukhara city wastewater treatment facilities are a large complex, and their automation has now become an urgent issue for the utility company "Bukhara Water Supply".

Aerotanks have a high energy consumption during the biological water treatment stage, where water treatment is carried out using microorganisms and air oxygen supplied by high-power compressors [1].

II. METHODOLOGIY

Oxygen concentration in aerotanks must be maintained at a constant 2-3 mg/l, and this depends on many factors. Periodically, with the help of laboratory tests, the concentration of oxygen in the air tank is determined, and measures are taken to increase or decrease the volume of air delivery from the compressor station. In treatment facilities, this principle has a number of disadvantages. Due to the manual labor of workers and the significant distance between the aeration units and the laboratory building, significant time is required to determine the oxygen concentration. In addition, there are reasons that cause changes in the amount of compressed air consumed, and there is no way to solve these problems in time, which leads to excessive energy consumption.

The compressor control method is not fully available, so the compressors are working with full load for air transfer. In such cases, the use of compressors leads to economic losses and excessive waste of electricity.

Waste water enters the wastewater treatment facilities through pressure pipes from the main sewage pumping station. Mechanical cleaning facilities: mechanical cleaning, sand traps (heavy sediments), preaerator, primary radial clarifiers, waste water is cleaned of mineral suspensions and some colloidal substances.

In aerotanks, waste liquid is supplied with air for a long time along with active sludge, which, due to its vital activity, biologically oxidizes colloidal and dissolved organic substances and cleans water. The treated wastewater from the secondary clarifiers is discharged to the outlet channel and then enters the reservoir for disinfection with chlorine.

A certain amount of constant dissolved oxygen is necessary for the normal existence of an active cloud. Critical concentration is 0.2 mg/dm3, very satisfactory for microaerophiles - 0.3 mg/dm3 dissolved oxygen. Therefore, the established standards for the amount of dissolved oxygen (at least 2.0-3.0 mg / dm3 at any point of the aeration tank) require intensive mixing of the sludge to eliminate sediments. When the concentration of dissolved oxygen exceeds the maximum required, critical value, microorganisms become saturated with oxygen and rise to the surface of the water like bubbles, and the purity of the water is not at the required level. Therefore, each treatment plant has its own "critical concentration" of oxygen, and its absorption rate is mainly determined by the nature and concentration of pollutants.

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Air supply provides several processes that occur with activated sludge: respiration of organisms, mixing of the sludge mixture, removal of metabolites, chemical oxidation of pollutants.

Causes of oxygen desaturation for the worker in aeration conditions: reduced air supply, destruction and clogging of air filter elements (filter plates, perforated pipes, thin bubble dispersants, etc.) [2,3].

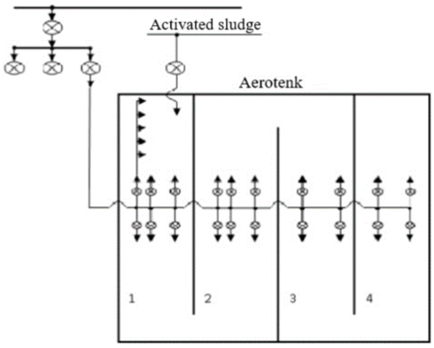

Figure 1. Scheme of oxygen transfer in an aerotank.

Improving aeration conditions can be achieved by increasing the percentage of oxygen used by the activated sludge. With large bubble aeration, when the size of the air bubble is 5-6 mm, the oxygen absorption of activated sludge is 6-7%, which does not create an ideal mass transfer of dissolved oxygen from the liquid to the cell, and the water purity indicator decreases.

Air volume: 200 dm3	Air volume: 200 dm3
Bubble diameter: 5.563 mm	Bubble diameter: 2.561 mm
Number of bubbles: 100,000	Number of bubbles: 800,000
Total gas exchange:0.7677m2	Total gas exchange:3.7677 m2

Figure 2. View of the volume of oxygen bubbles.

When the size of the air bubble decreases to 2-2.5 mm, the use of oxygen increases by 8-15 percent. This makes oxygen absorption of activated sludge ideal, reduces energy consumption and significantly improves water purity, increases its moisture release properties, and increases the level of metabolism. It also increases the resistance of active turbid organisms to the effects of toxic substances.

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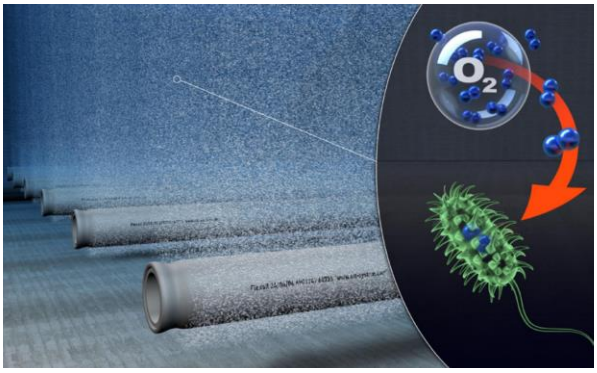

Figure 3. The uniform distribution of oxygen throughout the aerotank and the energy consumption of the membrane plate mainly depend on its operation.

The first and main expense in wastewater treatment technology is electricity consumption. Today, an effective means of reducing energy consumption in wastewater treatment facilities is the use of fans with variable frequency converters, which can be used to reduce energy consumption by adjusting the power of the blower depending on the actual load of the treatment facilities. However, using only compressors with variable frequency drives, it is not possible to reduce energy consumption without losing the quality of wastewater treatment, because the automation of air supply to the aeration process must maintain the optimal concentration of dissolved oxygen in it.

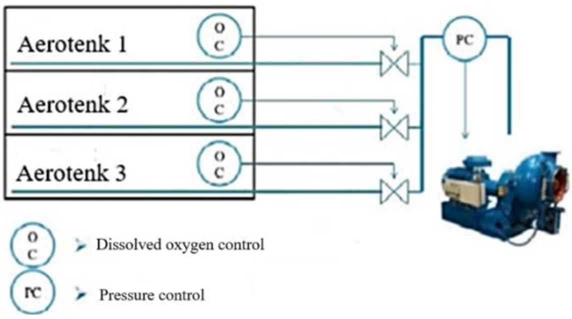

Figure 4. Automatic air transfer scheme in the aero tank.

Operational monitoring of the amount of dissolved oxygen in the aerotank by the chemical laboratory of the water supply is unfortunately impossible, because it can be done 1-2 times a day, and the oxygen concentration depends on many parameters and is not constant. Stationary "In-line" oxygen sensors should be used to control the air supply to the aerotank based on dissolved oxygen content. With the help of these sensors, it is possible not only to constantly monitor the amount of dissolved oxygen in the aerotank, but also to automate the process of regulating the ventilator with the help of controllers.

When implementing this solution, energy savings can reach 30-35%. The air supply in each aerotank is transmitted based on the readings of dissolved oxygen sensors and regulated by automatic valves in the air ducts. The operation of the blowers is controlled by changes in the pressure in the common air duct.

To solve these problems, the selection of control and measurement tools should be made taking into account the specific characteristics of the technological process of biological treatment facilities. In-line dissolved oxygen sensor, aeration tank side mounting for effluent contamination in aeration tank, for which the sensors must provide reliable measurements with minimal maintenance [4].

The most common types of dissolved oxygen sensors are amperometric and optical. Amperometric sensors are cheaper, but when used in water supply, they have a serious drawback - there is a need for regular and labor-intensive maintenance. Optical oxygen sensors are slightly more expensive, they not only improve the reliability and accuracy of measurements, but also eliminate consumables and reduce maintenance. For dissolved oxygen detection in aeration systems, Endress+Hauser offers the Oxymax COS61D optical sensor in combination with the Liquiline CM44x secondary converter. Up to eight oxygen sensors can be connected to one Liquiline CM44x transmitter simultaneously, reducing the cost of automating multiple measurement points. It is worth noting the menu of the device in Russian, as well as the ability to archive data on a flash card, and the compatibility of the system's output signal formats with all common modern automation systems.

III. CONCLUSION

As a result of the analysis, it was determined that it is necessary to regulate the oxygen regime in order to improve the quality of wastewater treatment, as well as to optimize energy consumption, and it is possible to save electricity by 30-35%. Management of the wastewater treatment process on the basis of an automated system will significantly improve the quality of water treatment, and lead to a significant reduction in maintenance work by 40-50%.

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