

Innovative methods of wastewater treatment

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Abstract. The experience of usage of sewage treatment plants has shown that if we desist from the usage of primary settlements of domestic wastewater, we solve a problem with thickening, processing, transportation and placement of raw sludge. Of course, the grates for screening the waste and sand traps for removal of mineral pollutions from wastewater is still very important part of the treatment facilities. If we desist from the usage of primary settlements, we should pay great attention to the modernization and intensification of the work of sand traps and grates. Unlike with a raw sludge, waste from grates and sand mixture from sand traps can be easily recovered in an ordinary urban landfill with a solid household waste. The most part of Western countries stop to use primary sedimentation of municipal wastewater; the Russian Federation still employ this method. At the same time, the residual floc can be completely mineralized by active sludge.

1. Introduction

The vital activity of activated sludge is accompanied by its continuous growth. The resulting excess sludge condensed in the sludge thickener, the pulp is fermented in digesters, dewatered in sludge ponds, dried in the heat treatment furnaces. However in practice, there are treatment facilities in which the active sludge does not grow in certain periods of time. Currently, sewage treatment plants are designed without the growth of activated sludge. It is now in the theory of wastewater treatment that the time has come when "old" treatment technologies can not offer solutions to problems such as swelling, surfacing and foaming of activated sludge. [1]

2. Intensification of the process of biological purification with the use of alternative cleaning methods

It is known that, applying the classical technological scheme of household wastewater treatment, the following provisions must be observed:

- excess activated sludge must be continuously removed from treatment facilities;
- the load on the activated sludge is calculated according to the biological oxygen demand;
- in the aeration tank, only aerobic processes take place, and separate devices are needed to activate denitrification;
- for biological removal of phosphorus from water, a toxic reagent (ferric chloride) is added);
- the smaller the age of the sludge, the better it is for the cleaning process;



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- intensive aeration leads to the decay of "chemically organized floccules".

Developed by biologists of the Moscow state University named after M. V. Lomonosov, the technology is waste-free biological treatment of wastewater puts these provisions into question, and some of them are incorrect.

The study of the structure and ultrastructure of floccular activated sludge showed that in the Mature floccular layerwise differentiation. On the surface are located aerobes (about 15% of the total biomass), in the center - anaerobes (also about 15%), and between the surface and the center are located microaerophils-about 70%.

In accordance with the traditional concept, only aerobes, that is, 15% of the active sludge community, are technically provided with life support; the remaining 85% of "workers" are not provided with life support, since, according to the old paradigm, they do not exist. The load on activated sludge is traditionally expressed in grams of biological oxygen demand per 1 g of ashless substance of activated sludge per unit time. Thus, the need for oxygen is identified in General with the need for active sludge, for which the excretion of the numerous gaseous metabolites formed is much more relevant than the supply of oxygen. Insufficient provision of mass transfer of bacteria located inside the floccules leads to the fact that the released gases accumulate inside. When the partial pressure in them reaches a critical value, there is a disintegration of the floccules into non-settling fragments (defloculation). [2]

The preservation of integrity of floccules is the key to successful processing of all types of pollution, including those that are not subject to oxidation and are destroyed only in anaerobic centers. This is a fairly extensive class of substances, such as aqueous humus, some minerals, etc. often anaerobes, microaerophils and aerobes form a food chain, passing on the products of their metabolism as a source of food for the next link. In addition, preserved integrity of the floccules most fully and tightly settle to the bottom secondary settling tanks, causing a small volume with a large mass and providing high quality purified water.

In order to ensure the safety of floccules, much more intensive mixing is used than is provided by traditional regulations. The amount of air supplied is regulated not by dissolved oxygen, but by bio-stimulation indications - a new hydrobiological control method developed to control the wastewater treatment process. Aerators are arranged in such a way as to exclude stagnant zones, common in traditional aeration tanks.

Typically, the biological treatment load is calculated based on the biological oxygen demand. But the main amount of organic pollution of wastewater is not subjected to final oxidation. It is difficult to say how much of the pollution reflects the biological need for oxygen, we can assume that very small. The mass of the most active sludge at the stage of its full maturity can serve as an indicator of the load. Sometimes this stage is not quite correctly called the stage of self-oxidation. The recommended concentration of active sludge should be 2-3 g/dm³ at the age of sludge 1-5 days. The concentration of activated sludge and its age should be significantly higher according to the proposed unconventional technology of domestic wastewater treatment [3].

The load problem is usually associated with the problem of "excess" active sludge, for the removal of which special silt compactors and other devices are built. "Excess" active silt, as well as sediment, requires significant funds for its processing, transportation, placement, payment of fines for erosion of stored sludge by rain and meltwater [4]. There is also a forced removal of part of the activated sludge due to incorrect technology or poor performance of mechanical wastewater treatment, when the sludge was heavily contaminated with garbage, sand, etc. In our practice, there was a case when the sewage treatment plants, which received the effluents of the malt factory, about 90% of the concentration of active sludge were scales and pruning roots of malting barley seedlings.

3. Results and Discussion

We believe that the concept of "excess" activated sludge is outdated. The mass of activated sludge increases only if there are still nutrients in the treated water that have not been processed during the aeration period; when they are exhausted, the mass of sludge stabilizes. This phenomenon has often

been observed by us at existing sewage treatment plants. The concentration of Mature activated sludge can fluctuate around a certain maximum value, then slightly increasing, then decreasing following the changing unknown concentration of water pollution, according to the feedback principle. This maximum, relatively constant mass of activated sludge becomes an indirect measure of the unknown load. It is impossible to calculate in advance the maximum mass index of activated sludge; at each aeration station it is installed during its operation. This is due to the fact that the true load on the activated sludge can not currently be determined (by the biochemical oxygen demand, and even by the chemical oxygen demand, only part of it is determined). We worked with a concentration of active sludge 16-32 g / dm³ at the age of sludge 30-50 days. In figure 1, a solid line indicates a graph of increasing the concentration of activated sludge during intensive aeration and the maximum possible preservation of sludge in the system, and a dashed line-a graph of reducing the sludge index as the concentration of activated sludge increases [5]. The graph shows that the initial value of the sludge index, equal to 281 cm³/g, for the month was reduced to 18 cm³/g, the Experiment was carried out in one of the settlements of the Republic of Bashkortostan at the existing sewage treatment plants, such as KU-600. On these facilities, in addition to the usual village drains, periodically brought and drained the contents of the cesspools by sewage disposal machines, so the active silt was extremely overloaded. At the very beginning, the concentration of activated sludge remained within 2 g / dm³, despite the fact that its "withdrawal" staff stopped (according to the regulations it should be about 6 g/dm³). The entire increase in activated sludge went overboard in the form of suspended solids, as the existing system of recycling of activated sludge was designed for a much lower load and did not provide in the current conditions its full return to the aeration zone. It took a number of measures to strengthen the recycling and preservation of sludge removal. As seen in Fig. 1, when the concentration of activated sludge reached 18 g / dm³, and this was on the 9th day from the beginning of the experiment, a rapid decrease in the sludge index began. On the 15th day we found it possible to return to the normal operation of the KU-600, disabling additional temporary devices that we had to mount to enhance the recycling of activated sludge. After that, the sludge index decreased to the normal value of 60 cm³/g for these treatment facilities. Since that time, the decrease in the sludge index became less noticeable, but continued until the end of the experiment. The maximum concentration of activated sludge reached 32 g / dm³, after which it was established at a relatively constant value, with a tendency to a slight decrease (table. 1).

It is important to note that when the maximum mass of the active sludge acquires additional properties:

- the lack of biomass growth;
- maintenance of the minimum value of the sludge index;
- immunity to many components of industrial wastewater;
- resistance to shock loads;
- absence of pathogenic agents.

It is now in the theory of wastewater treatment, the time has come when the old technology can not offer solutions to problems such as swelling, surfacing, foaming of activated sludge, the formation of a silt floating layer. The unconventional concept of wastewater treatment proposed by us will lead to the creation of a new type of treatment facilities – reliable and economical. High and stable water quality at the outlet of treatment facilities is achieved through the use of successive stages of bio-treatment with separate recirculation of activated sludge [6].

In nature, the community of microorganisms that purify water is a qualitatively and quantitatively self-regulating system. Since biological purification is a repeatedly accelerated self-purification, all the properties inherent in both individual microorganisms and the entire natural community are inherent in biotechnical systems. We must take them into account and provide adequate technical means of life support of microorganisms-reducing agents, extremely intensively "working" in aeration tanks.

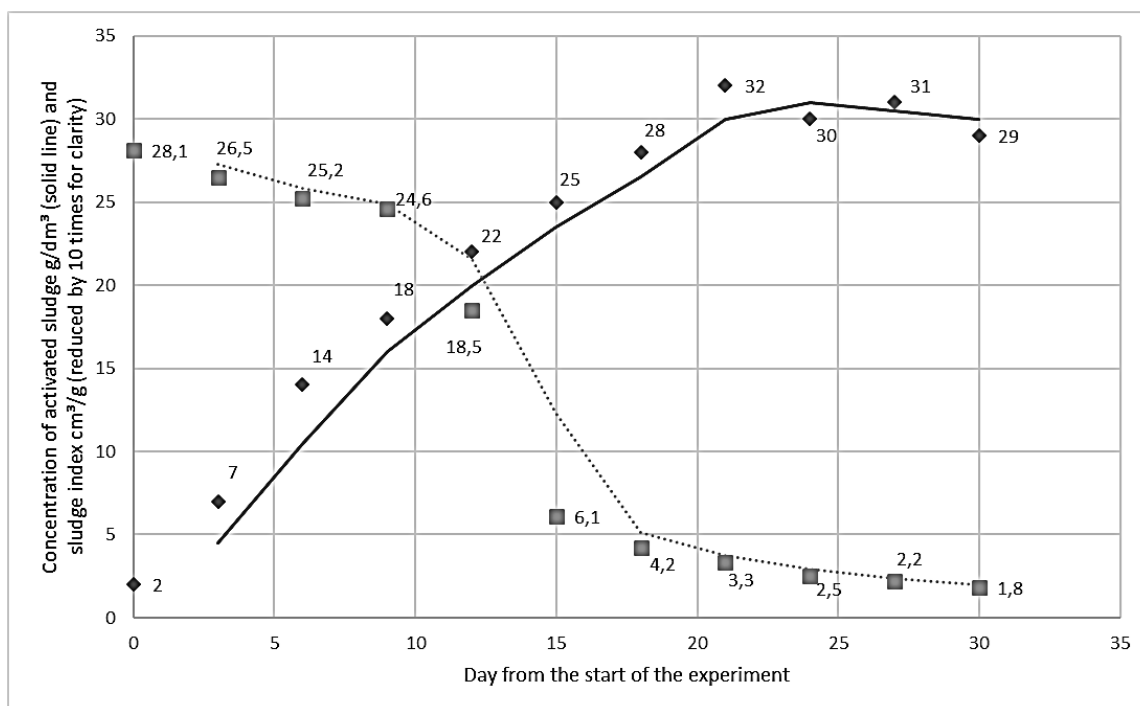


Figure 1. Graphs of changes in the concentration of activated sludge and silt index.

Table 1. Changes in the concentration of activated sludge and sludge index

Day from the beginning of the experiment	0	3	6	9	12	15	18	21	24	27	30
The concentration of the activated sludge, g/dm ³	2	7	14	18	22	25	28	32	30	31	29
Silt index, cm ³ /g	281	265	252	246	185	61	42	33	25	22	18

4. Conclusion

It is worth mentioning the ecological inexpediency of excessive requirements to the quality of treated wastewater discharged into our heavily polluted small rivers. Sanitary norms 2000 makes almost impossible requirements, which allows the Supervisory services to levy huge fines. Nowhere in the world are there such strict discharge standards. For example, 1 mg/dm³ of copper is allowed in drinking water and 0.001 mg/dm³ of copper in wastewater discharge. We will especially note inexpediency of the requirement to remove phosphorus from waste waters everywhere. First, phosphorus removal blocks the self-purification of polluted water in small rivers, as they often have a clear deficiency of phosphorus. Secondly, in rivers there is no notorious "flowering", since cyanobacteria that cause flowering are residents of low-flow and stagnant reservoirs. Thirdly, on the USC itself, cleaning is complicated due to the use of hypertoxic flocculants precipitating phosphorus on the active sludge. Fourth, phosphorus is removed only together with the active sludge, and the formation and removal from the system of a huge amount of active sludge is associated with the construction of additional facilities for its compaction, dehydration and placement.

References

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