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MODERN BIOLOGICAL WATER TREATMENT PROCESSES

The volume of water on our planet (sea and ocean, surface and underground plus ice and glaciers) is a constancy. Water may be in different states of aggregation, but the total amount of water cannot decrease or increase. Pure drinking water reserves, on the other hand, are variable and are currently valued at only 3%, or even slightly less, of total water reserves. And human activity is the reason why the planet's supply of clean drinking water is rapidly disappearing.

It is only logical that today the problem of wastewater treatment is particularly acute.

Wastewater treatment was first introduced in England in 1889. At first, waste water was used to irrigate fields or filtered through a layer of soil. In 1914 in England, the first aerotank was built - a biological treatment device in which pollution is decomposed by bacteria and microorganisms [1]. Such aeration tanks, albeit greatly improved, are still the main stage of municipal wastewater treatment everywhere. Before entering the aeration basin, the wastewater goes through several mechanical treatment stages.

The size of today's spillways is astonishing: the length of a single Mosvodokanal sewer network is more than 7000 km and in St. Petersburg it is 6,160 km, including 190 km of tunnel collectors. Wastewater carries a lot of rubbish. To get rid of it, grates are placed at the inlet [2].

The first grid, similar to that of a medieval castle, screens out the largest debris and protects the next, more "delicate" grids from damage. From there, the water is divided into several narrow channels and passes through 5mm mesh screens in each.

The next stage is the sand trap, an oblong concrete tank in which the flow of water slows down and all heavy particles precipitate out.

The primary sedimentation tanks, where the water enters in the next stage, are designed to settle suspended organic matter. The basins are reinforced concrete "pools" 5m in depth and 40m and 54m in diameter.

Their centres are fed with effluent from below, the sediment is collected in a central pit by scrapers running along the entire plane of the bottom and a special float on top pushes all the lighter-than-water contaminants into a hopper. The water then flows through a sluice into the aeration basin, the biological wastewater treatment unit, the main and most complex stage. Modern aeration tanks are huge concrete basins, 300 m long, divided into tracks that form a 'serpentine' shape. The paths are made to increase the water run and to separate special zones, in each of which there is a different cleaning stage [3, 4].

The active sludge is responsible for it - flakes, which are an accumulation of various micro-organisms that decompose and oxidise dissolved impurities. Its composition is very diverse: mainly bacteria, but also protozoa, rotifers, worms, water fungi and yeasts.

In those areas of the aeration basin that require oxygen for the purification process, air pipes are installed at the bottom. The division into stages is caused by different types of impurities [5].

In addition to dissolved and suspended organic matter, nutrients must be removed from waste water. These include phosphates and nitrogen compounds: nitrites, nitrates, ammonia nitrogen.

Once in the water, they act as fertiliser. Their accumulation leads to excessive blooming of water bodies and subsequently to fish freezing.

Today Southwest Wastewater Treatment Plant in St. Petersburg has the most advanced technology of biological treatment in our country. Here, the technology of the biological treatment unit is based on the Cape Town University scheme. Purification is carried out in six aeration tanks. Modified technological process provides removal of phosphorus, nitrogen and organic pollutants [6, 7].

Aerotanks are successively divided into aerobic, anoxic, transitional anoxic-aerobic and again aerobic zones. At a design wastewater flow rate of 163 thousand m3 /h the duration of their stay in the aeration basin is 6.8 hours.

After the aeration tanks, the water flows to the secondary sedimentation tanks. Before this, the excess sludge is removed in one of the distribution chambers and from there sent to the sludge thickener. The resulting mixture is then dewatered.

The clarified water from the secondary clarifiers is collected in a total chamber, which is used to distribute the water to the three ultraviolet disinfection units. It is only after this last treatment stage that the water flows back into the river system.

Water treatment with UV radiation is one of the reagent-free physical treatment methods. A distinction is made between two methods of UV irradiation - pulsed irradiation with a wide wave spectrum and constant irradiation in a selected wave range.

The disinfecting (bactericidal) effect only corresponds to the part of the UV spectrum in the wavelength range of 205-315 nm.

wavelength range of 205-315 nm, with maximum effectiveness in the region of 260±10 nm. Disinfecting effect of UV radiation is primarily due to photochemical reactions occurring under its influence in the structure of DNA and RNA molecules, leading to their irreversible damage. In addition, UV radiation causes disruptions in the structure of membranes and cell walls of microorganisms. All this eventually leads to their death [8].

As practice has shown, purifying water is only one of the problems. The second, no less important, is what to do with the resulting dehydrated mixture? Tens of millions of tonnes of it are produced in Russia each year. Until 1990 the sludge was widely used as fertiliser. However, in 1990, there were several newspaper reports about the heavy metal content of sludge and its use in agriculture was banned without major investigation. (It must be noted, however, that the occurrence of heavy metals in sewage sludge was known before and special regulations existed to regulate the application rate of sewage sludge per hectare depending on its contamination). [9].

So where should the by-product of water treatment be disposed of? In Moscow, this sludge is used to backfill mined out pits and reclaim disturbed land, e.g. after sand or peat mining. Most of the sludge is disposed to landfills - sludge is poured as a many-metre layer, and trees are planted on top and the land is transferred to the Forest Fund.

Sludge incineration is currently the most advanced method of disposal. The resulting ash can be used in the production of construction materials: foam or aerated concrete, road paving, etc. [10].

It is obvious that the incineration of sewage sludge is indeed the most advanced technological technique, which allows a significant reduction of sludge volume. And the ash, which is safe for sanitary purposes, can be used in a variety of areas of the economy.

In addition, the large amount of surplus heat produced is used both for heat supply and for the generation of additional electricity.

Referenses:

1. Голицин А.Н. Основы промышленной экологии: Учебник для нач. проф. образования. - 2-е изд., стер. - М.: Академия, 2004. - 240 с.
2. Зайцев В. А. Промышленная экология. — М.: Бином. Лаборатория знаний, 2012. — С. 512. — ISBN 978-5-9963-0812-5.
3. Ксенофонтов, Б.С. Промышленная экология: Учебное пособие / Б.С. Ксенофонтов, Г.П. Павлихин, Е.Н. Симакова. - М.: ИД Форум, НИЦ Инфра-М, 2013. - 208 с
4. Медведев, В.Т. Охрана труда и промышленная экология: Учебник / В.Т. Медведев. - М.: Academia, 2019. - 464 с.

5. Семенова, И.В. Промышленная экология / И.В. Семенова. - М.: Academia, 2017. - 190 с.

6. Экология для технических вузов В.М.Гарин, И.А.Клёнова

7. Очков В. Ф., Чудова Ю. В. Анализ качества питьевой воды и корректировка производительности для обратноосмотических и нанофильтрационных установок // Водоочистка. Водоподготовка. Водоснабжение. 2010. № 2. С. 44−48.

8. Первов А. Г., Андрианов А. П., Юрчевский Е. Б. Совершенствование систем очистки поверхностной воды // Аква-Терм. 2008. № 4. С. 3–7.

9. Черкасов С. Электроионизация воды: теория и практика применения // Энергослужба предприятия. 2005. № 4. С. 21−26.

10. Baudin I. Advanced Training in Drinking Water. Treatment Processes. EuroAquae Course. 2009. January 19th. URL: http//:portail.unice (дата обращения: 11.09.2015).

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