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SEWAGE TREATMENT

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The basic function of the wastewater treatment plant is to speed up the natural processes by which water purifies itself. In earlier years, the natural treatment process in streams and lakes was adequate to perform basic wastewater treatment. As our population and industry grew, increased levels of treatment became necessary before discharging domestic wastewater.

Keywords: water, wastewater, treatment, sewage treatment, pretreatment, primary treatment.

One of the most important modern environmental problems is the utilization of household resources. Currently, there are many different solutions in the field of environmental protection related to mechanical, physical-chemical and biological treatment, including the use of biological technologies and flights in aeration tanks, etc. [1].

Because water is essential for life, one has to use it carefully and sustainably. In order not to disturb the natural water cycles of the environment, it is important to achieve harmony with the natural surroundings [2].

Sewage can be treated close to where the sewage is created, a decentralized system (in septic tanks, bio filters, or aerobic treatment systems), or be collected and transported by a network of pipes and pump stations to a municipal treatment plant, or a centralized system. Sewage collection and treatment are typically subject to local, state, and federal regulations and standards. Industrial sources of sewage often require specialized treatment processes [3].

Pretreatment

Pretreatment removes all materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers. Objects commonly removed during pretreatment include trash, tree limbs, leaves, branches, and other large objects.

The influent in sewage water passes through a bar screen to remove all large objects like cans, rags, sticks, plastic packets, etc. carried in the sewage stream.

This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations while in smaller or less

modern plants a manually cleaned screen may be used. The raking action of a mechanical bar screen is typically paced according to the accumulation of the bar screens and/or flow rate. The solids are collected and later disposed in a landfill, or incinerated. Bar screens or mesh screens of varying sizes may be used to optimize solids removal. If gross solids are not removed, they become entrained in pipes and moving parts of the treatment plant and can cause substantial damage and inefficiency in the process [4].

Grit removal

Grit consists of sand, gravel, cinders, and other heavy materials. It also includes organic matter such as eggshells, bone chips, seeds, and coffee grounds. Pretreatment may include a sand or grit channel or chamber, where the velocity of the incoming sewage is adjusted to allow the deposition of sand and grit. Grit removal is necessary to

1) reduce the formation of heavy deposits in aeration tanks, aerobic digesters, pipelines, channels, and conduits;

2) reduce the frequency of digester cleaning caused by excessive accumulations of grit; and

3) protect moving mechanical equipment from abrasion and accompanying abnormal wear.

The removal of grit is essential for equipment with closely machined metal surfaces such as comminutors, fine screens, centrifuges, heat exchangers, and high-pressure diaphragm pumps. Grit chambers come in 3 types: horizontal grit chambers, aerated grit chambers, and vortex grit chambers. Vortex-type grit chambers include mechanically induced vortex, hydraulically induced vortex, and multi-tray vortex separators [4].

Fat and grease removal

In some larger plants, fat and grease are removed by passing the sewage through a small tank where skimmers collect the fat floating on the surface. Air blowers in the base of the tank may also be used to help recover the fat as a froth. Many plants, however, use primary clarifiers with mechanical surface skimmers for fat and grease removal [4].

Primary treatment

In the primary sedimentation stage, sewage flows through large tanks, commonly called "pre-settling basins", "primary sedimentation tanks" or "primary clarifiers" [1] . The tanks are used to settle sludge while grease and oils rise to the surface and are skimmed off. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank where it is

pumped to sludge treatment facilities. Grease and oil from the floating material can sometimes be recovered for saponification (soap-making) [4].

Secondary treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage that are derived from human waste, food waste, soaps, and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota requires both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc [4].

Secondary clarifier at a rural treatment plant

Some secondary treatment methods include a secondary clarifier to settle out and separate biological floc or filter material grown in the secondary treatment bioreactor.

Tertiary treatment

The purpose of tertiary treatment is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, wetlands, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called as "effluent polishing".

- Filtration

Sand filtration removes much of the residual suspended matter. Filtration over activated carbon, also called carbon adsorption, removes residual toxins.

- Lagoons or ponds

Lagoons or ponds provide settlement and further biological improvement through storage in large man-made ponds or lagoons.

- Biological nutrient removal

Biological nutrient removal (BNR) is sometimes regarded as a type of secondary treatment process, and sometimes as a tertiary (or "advanced") treatment process [4].

Wastewater may contain high levels of the nutrients nitrogen and phosphorus. Excessive release to the environment can lead to a buildup of nutrients, called eutrophication, which can in turn encourage the overgrowth of weeds, algae, and cyanobacteria (blue-green algae). This may cause an algal bloom, a rapid growth in the population of algae. The algae numbers

are unsustainable and eventually most of them die. The decomposition of the algae by bacteria uses up so much of the oxygen in the water that most or all of the animals die, which creates more organic matter for the bacteria to decompose. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies. Different treatment processes are required to remove nitrogen and phosphorus [5].

- Disinfection

The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment for the later use of drinking, bathing, irrigation, etc. Common methods of disinfection include ozone, chlorine, ultraviolet light, or sodium hypochlorite [4].

References

1. Savichev O.G. Biological wastewater treatment using wetland biogeocenoses // Bulletin of the Tomsk Polytechnic University. – Vol. 312, No. 2008. – P. 69–74.
2. PSE Wassertechnik Hydraulic engineering [Electronic resource]. – URL: http://mpr.midural.ru/upload/all-files/pse_wassertechnik_russisch_230113.pdf (date of access 20.02.2020).
3. English in Engineering: Textbook for first-year bachelor students of full-time training courses (specialty 08.03.01 «Building», profiles “Water supply and sanitation”, “Heat and ventilation” / Ed. by A.A. Khafizova. – 2015. – 117 p.
4. Primer for Municipal Wastewater Treatment Systems [Electronic resource] // United States Environmental Protection Agency. Office of Water. Office of Wastewater Management Washington DC 20460. EPA 832-R-04-001. September 2004. – URL: https://www.epa.gov/sites/production/files/2015-09/documents/primer.pdf (date of access 20.02.2020).
5. Tchobanoglous G., Burton F.L., Stensel H.D. et al. Wastewater Engineering: Treatment and Reuse : 4th ed. – McGraw-Hill, 2003. – 1819 p.