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Microbial degradation of wastewater

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ABSTRACT. Pollution of the pond and lakes where waste water is discharged has a negative impact on the state of its flora and fauna. The purpose of the work was to study the species composition of bacteria involved in the process of industrial wastewater treatment in the Leningrad region. Biological treatment, which is based on microbiological processes, is the most cost-effective and affordable. Amount of bacteria was from 10^{9}–10^{12} CFU / cm^3. Biological wastewater treatment is the result of the "active sludge - waste water" system. The quality of wastewater treatment is determined by the content of coliform bacteria, coliphages in treated wastewater. For wastewater treatment, it is advisable to use bacteria that participate in the anaerobic oxidation of ammonium. Bacteria performing anammox belong to the phylum Planctomycetes. During cleaning of wastewater with a high content of carbohydrates and nitrogen deficiency, there was an intensive development of heterofermentative lactic acid bacteria of the genus L*euconostoc,* which form a dextran capsule that makes it difficult to deposit silt in the secondary settling tank. With insufficient level of aeration anaerobic processes with the participation of microorganisms that perform butyric fermentation, sulfate reduction, denitrification, and the like were found. It is advisable to use nitrifying bacteria as indicators of the purification process, since their appearance in the treated water indicates the mineralization of the main part of organic substances.

Keywords: waste water, microbiocenosis, biological method, carbon-oxidizing flocculating and filamentous bacteria, nitrifiers

1. Introduction

Protecting the environment (water) from pollution generated during wastewater treatment is of great importance. To protect the pond from pollution, the conditions for the release of waste water are determined, in which the quality of water in water basins does not decrease below the established maximum permissible concentrations (Water code of the Russian Federation…; State standard of the Russian Federation 5.592-2000; Sanitary rules and regulations 2.1.5.980-00; State standard of the Russian Federation 2.1.5.2582-10).

2. Material and methods

We studied the species composition of bacteria involved in the process of industrial wastewater treatment in the Leningrad region. Water samples were taken in accordance with State standard of the Russian Federation 5.592-2000 (State standard of the Russian Federation 5.592-2000). The number of bacteria was from 10^{9}–10^{12} CFU /cm^3. Defined cultures were identified according to the description given in Bergey's "Manual of Systematic Bacteriology". The cultures were also identified using 16S rDNA analysis.

3. Results

The microbiocenosis of wastewater living in industrial wastewater is understood as a microbial community, a set of populations of different types of microorganisms. Two main groups of pollutants were observed in wastewater: conservative, practically non-biodegradable (soil particles, ore and waste rock, slag, inorganic salts of heavy metals, phenols, pesticides); non-conservative pollutants (petroleum products, organic acids, etc.) that were successfully undergone a processes of self-purification the pond (Bergey's manual…, 1974; The Prokaryotes, 1981). The biological method of wastewater treatment is based on the ability of microorganisms to use dissolved and colloidal organic pollutants as a source of nutrition and mineralize them in their life processes. Biological treatment of waste water is carried out in order to remove suspended and soluble organic and inorganic compounds from them

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to concentrations that do not exceed the pre-regulated ones. Most of the bacteria involved in cleaning are heterotrophs. They consume only organic substances. These are usually representatives of the aquatic microbiota and some inhabitants of the gastrointestinal tract of humans and animals that come with fecal waste.

4. Discussion

Under aerobic conditions in the aeration tanks with a continuous supply of air capacity of activated sludge is increased. In the conditions of an aerotank, microorganisms are selected. The most intensively developed are those bacteria that find favorable conditions for themselves, while other species are suppressed. Factors that determine the direction of selection are aeration, contamination composition, temperature, growth rate, etc. (Trotsenko et al., 2010). Aerobic wastewater treatment involves two microbiological processes: organic carbon oxidation and nitrification. The biomass of activated sludge consists of two main groups of bacteria: acid-forming and methanogenic. Up to 80% of the number of active silt bacteria were microorganisms of the genus *Pseudomonas*. All natural organic and even synthetic compounds can be decomposed by pseudomonads. Broad enzymatic capabilities allow certain types of bacteria of the genus *Pseudomonas* to decompose antiseptics, disinfectants, toluene, benzene, ethylbenzene, naphthalene, rubber, rubbers, lubricants, etc. (Zhmur, 2003; TerBeek et al., 2013).

The active sludge contains microorganisms of the following genera: *Actinomyces*, *Alcaligenes*, *Aeromonas*, *Arthrobacter*, *Bacillus*, *Brevibacterium*, *Cellulomonas*, *Cellulovibrio*, *Corynebacterium*, *Desulfotomaculum*, *Flavobacterium*, *Micrococcus*, *Mycobacterium*, *Nocardia*, *Pseudomonas*, *Sarcina* and others.

Brevibacterium bacteria oxidize various components of oil, paraffins, naphthenes, phenols, aldehydes, and fatty acids. The oxidation of aliphatic hydrocarbons occurs due to bacteria of the genus Bacillus, hydrocarbons of various groups-*Mycobacterium*, and cellulose – bacteria of the genus *Cellulomonas*. Bacteria of the genus *Zoogloea* (*Z. ramigera*) participated in flocculation. They decomposed a wide range of contaminants in wastewater. *Z. ramigera* cells were found in highly polluted reservoirs, where flakes were observed suspended in water, and mucous fouling (zooglia) on objects in the water. Carbon-oxidizing filamentous bacteria provided the formation of a “skeleton” around which floccules are formed, filamentous forms were also active oxidizers of numerous organic substances.

Bacteria of the genera *Nitrosomonas*, *Nitrosospira*, *Nitrosococcus*, and *Nitrosolobus* oxidize ammonia to nitrites. Another group of nitrifiers (*Nitrobacter*, *Nitrospina*, *Nitrococcus*) oxidize nitrites to nitrates. Most nitrifying bacteria are autotrophs, and their growth is inhibited in the presence of organic substances.

Bacteria that perform anammox are members of the genera *Kuenenia* (*K. stuttgartiensis*), *Brocadia* (*B. anammoxidans*, *B. fulgida*, *B. sinica*), *Anammoxoglobus* (*A. propionicus*), *Jettenia* (*J. asiatica*), *Scalindua* (*S. brodae, S. sorokinii, S. wagneri, S. profunda*) (The Prokaryotes, 1981). These bacteria were characterized by a low growth rate: doubling their number took several weeks. They are able to carry out the conversion of substrates anammox (ammonia and nitrite) at low concentrations. The enzymes of these bacteria, which carry out catabolic anammox reactions, give the cells a characteristic red color. The quality of wastewater treatment is determined by the content of coliform bacteria, coliphages in treated wastewater. A prerequisite is the absence of pathogenic microorganisms in the water (Sanitary rules and regulations 2.1.5.980-00; State standard of the Russian Federation 2.1.5.2582-10; Bergey’s manual…, 1974; Zhmur, 2003).

5. Conclusions

During aerobic wastewater treatment, microbial processes of organic carbon oxidation and nitrification occur. The biomass of activated sludge involved in anaerobic decomposition consists of two main groups of bacteria: acid-forming and methanogenic. The most numerous were microorganisms of the genus *Pseudomonas*. The indicators of wastewater treatment are coliform bacteria and coliphages, in the absence of pathogenic microorganisms in the water. As a result of this useful activity of bacteria, waste water is purified so that it is converted into technical clear water without smell and color.

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