Application of Microbial Technology in Wastewater Treatment

Quansheng Dong, Qixing Chen, Zehui Li, Shouwei Zeng

School of Environmental Engineering, Hainan University of Science and Technology, Hainan, China

ABSTRACT

The biological treatment of sewage is the strengthening of water self-purification. After removing the pollutants in the sewage, the microorganisms must be separated from the water. This separation is mainly through the flocculation of microorganisms and the ingestion of protozoa and rotifers completed. This paper mainly introduces the application of microorganisms in sewage treatment, and several major sewage biological treatment technologies.

KEYWORDS: Microorganism; sewage treatment; activated sludge method; biofilm method

1. Introduction

With the continuous improvement of human socialization and the increasing frequency of social and economic activities, the problem of environmental pollution is becoming more and more serious, and the pollution of water body is especially prominent. Industrial wastewater and domestic sewage discharge, is the main cause of water pollution. Increasing water pollution poses a great threat to human survival and safety and becomes a major obstacle to human health, economy and sustainable development. How to use modern scientific and technological means to deal with sewage, so that people can be assured that the use of water resources, while fundamentally contain water pollution, reduce water pollution, purify our ecological environment, become a top priority.

2. Types and sources of water pollutants

Sewage because of its different sources, can be divided into domestic sewage, industrial wastewater and agricultural wastewater. Industrial wastewater biodegradability is poor, usually only by chemical method to deal with. And the living sewage can be biochemical relatively high, so the use of biochemical treatment effect is better. Most of the urban sewage treatment plant of raw water is mainly domestic sewage, which doping industrial wastewater only a small part, so the biochemical method has been the preferred process of urban sewage treatment plant.

(1) Domestic sewage is a major source of pollution. Domestic sewage contains a lot of inorganic and organic matter. Inorganic substances such as chloride, sulfate, phosphate and sodium, potassium, calcium, iron and other carbonates, organic matter with cellulose, starch, fat, protein and urea. Emissions into the environment to promote phytoplankton growth and mass reproduction, the formation of red tide and bloom.

(2) Industrial wastewater is the main source of pollution of water bodies, including iron and steel industry wastewater, food industry wastewater, chemical wastewater.

(3) Agricultural wastewater is mainly used in agriculture, chemical fertilizers, pesticides into the water caused by pollution of water, it is wide and large and easy to disperse, easy to cause water eutrophication.

3. Principle of microbial treatment of sewage

The use of microbial treatment of sewage is actually through the microbial metabolic activities, the decomposition of organic matter in the sewage, so as to achieve the purpose of purifying sewage. Microorganisms can absorb sugar, protein, fat, starch and other organic compounds from sewage as a microbial nutrient, through a series of enzymatic reactions, these organic matter in the microbial decomposition and use, some synthetic microbial structure and functional substances, while others provide the necessary energy for the microorganisms. Microbial metabolic types are both aerobic and anaerobic, so the biological treatment of sewage is divided into aerobic biological treatment and anaerobic biological treatment.
3.1. **Aerobic biological treatment**

Aerobic biological treatment is in the presence of dissolved oxygen in the water under the conditions of aerobic and facultative anaerobic microorganisms, which is mainly aerobic bacteria to carry out the role. In the process, the vast majority of organic matter can be oxidized by the corresponding microbial decomposition. Treated with aerobic method, basically no odor, the processing time is relatively short, if the conditions are appropriate, - can be removed BOD5 80 - 90% or more.

3.2. **Anaerobic biological treatment**

Anaerobic biological treatment is anaerobic digestion or anaerobic fermentation by anaerobic and facultative anaerobic microorganisms (mainly anaerobic bacteria) under anaerobic conditions to decompose organic matter in the effluent. Anaerobic biological treatment is mainly used in organic sludge and high concentration of organic sewage treatment. Because it is closed fermentation, so in the process does not affect the surrounding environment; at the same time isolated from the air and high temperature fermentation, can cruciate parasitic eggs and pathogens; and can produce bio-energy methane. Therefore, anaerobic digestion in recent years has gradually been taken seriously, but because of the long time required, strict equipment requirements, thus affecting its rapid promotion.

3.3. **Biochemical oxygen demand**

In sewage treatment, the concentration of organic pollutants, such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD), is usually expressed as a comprehensive indicator of the amount of oxygen consumed by the organic matter in the oxidation process. Biodegradation refers to the amount of oxygen consumed by microorganisms in the decomposition of organic matter at specific temperatures and times (usually at 20oC, 5d), called BOD5. BOD5 accounted for about 2/3 of the total biochemical oxygen demand, so the use of BOD5 to indicate the concentration of biodegradable organic matter in sewage is more appropriate. But the organic matter in sewage is not faster degradation, in industrial waste water, can be combined with COD and other indicators that the concentration of organic pollutants.

Only BOD high wastewater is suitable for biological treatment, COD is high but BOD is not high wastewater should not be used biological treatment. For toxic waste water, as long as the toxicants can be degraded, they can be treated with biological methods, the key is to control the concentration of toxic and domesticated microorganisms.

4. **Biological treatment of sewage**

4.1. **Activated sludge method**

Activated sludge is currently the most widely used method of using water to treat water pollution. Activated sludge method refers to the use of activated sludge in the wastewater coagulation, adsorption, oxidation, decomposition and precipitation role in the removal of organic pollutants in waste water treatment methods.

Activated sludge refers to the bacteria, micro-animal-based micro-organisms and colloidal substances, suspended substances and other mixed together to form a strong adsorption and decomposition of organic matter and good settling performance of the flocculent particles. Activated sludge in the survival of a variety of micro-organisms, constitute a complex microbial community. The main microbes are bacteria (mainly aerobic heterotrophic bacteria) and protozoa, in addition to yeast, filamentous fungi, cell algae, rotifer nematodes and so on.

Microbial effects in activated sludge:

- One to improve the role of water quality
  1. Through the secretion of some protozoa, in the settlement process to promote the flocculation of free bacteria, improve the settlement efficiency of bacteria and removal rate.
  2. Protozoa predator bacteria, improve the ability of bacteria to improve the intake of soluble organic matter.
  3. Protozoa and bacteria together, common feeding pathogenic microorganisms.

- Second, the role of activated sludge in the system
  1. When the performance of activated sludge is good, the activated sludge is characterized by large flocculation, good sedimentation, microscopic observation of the occurrence of organisms are insects, insects, Streptococcus, all kinds of sucker insects, rotifers, eczema, oligosaccharides and other fixed species or creeping species.
2. When the activated sludge is deteriorated, the flocculation is small, and the creatures such as the genus Bombyx mori, Trichomonas and Trichomonas are rapid swim. When the sludge is seriously deteriorated, the micro-animal large area of death or almost did not appear, sludge settling down, poor water treatment capacity.

3. Activated sludge from the deterioration to return to normal, in this transition period of the emergence of organisms are rosewood, tube leaf insects and other slow swim or creeping creatures.

4. Activated sludge is the main creature that causes the sludge to expand when the activated sludge is expanded. As the filamentous bacteria multiply, the activated sludge is cotton-like, the particles are finely divided and the color is relatively shallow.

Advantages: BOD and SS removal rate is high, up to 90% -95%, suitable for demanding high water quality and stable wastewater.

Disadvantages: poor adaptability to changes in water quality; the actual oxygen before the big and small, so that the front oxygen less, after the oxygen; aeration tank volume load is low, covers an area of large, high infrastructure costs; produce a large number of excess sludge.

4.2. Biofilm method

The biofilm method is a method of treating sewage using a membrane-like biomass community fixed on the surface of an inert material. The function of the biofilm is the same as that of the activated sludge in the activated sludge process, and its microbial composition is similar. The main principle of purification of sewage is attached to the carrier surface of the biofilm on the adsorption of organic matter in sewage and oxidative decomposition. Biofilm method according to the media and water contact with different ways, a biological filter, biological turntable, tower biofilter and so on. Its treatment principle is basically the same, are relying on the surface of the solid medium born to the purification of organic matter, therefore, also known as biological filtration. Substance transfer in the process: Oxygen in the air → Wastewater → Biofilm, this method is less than the excess sludge produced by the activated sludge process.

Biofilm is a highly dense aerobic bacteria, anaerobic bacteria, facultative bacteria, fungi, protozoa and algae and other components of the ecosystem, the attached solid medium known as the filter or carrier. Biofilm from the filter can be divided into outside the gas layer, good gas layer, attached to the water layer, moving water layer. The principle of the biofilm method is that the biofilm is first adsorbed by the waterborne organic matter, decomposed by the aerobic gas of the aerobic layer, and then into the anaerobic layer for anaerobic decomposition. The flowing water layer flushes the aged biofilm to grow new of the biofilm, so reciprocating to achieve the purpose of purifying the sewage.

Advantages:
(1) Biofilm on water quality, water changes adaptability, good stability;
(2) No sludge expansion, easy operation and management;
(3) Biofilm rich in biological, biological population was a certain distribution;
(4) The existence of high nutritional levels of micro-organisms, more capacity, less residual sludge;
(5) Natural ventilation oxygen, energy consumption.

Disadvantages:
(1) Poor operational flexibility, difficult to man-made control;
(2) The carrier surface area is small, the equipment volume load is small, the space efficiency is low;
(3) Treatment efficiency is poor, BOD removal rate of about 80%.

4.3. Biological contact oxidation method

Biological contact oxidation method is derived from the biofilm method of a biological treatment of wastewater, that is, in the biological contact oxidation tank filled with a certain amount of filler, the use of habitat attached to the filler on the biofilm and fully supplied oxygen, through biological oxidation Role, the organic matter in the wastewater oxidation decomposition, to purify the purpose. Biological contact oxidation method is attached to the carrier (commonly known as filler) on the biofilm-based, purification of organic wastewater a highly efficient water treatment process. The biofilm method with the characteristics of activated sludge has the advantages of both activated sludge and biofilm. In the biochemical conditions, regardless of the application of industrial wastewater or aquaculture sewage, domestic sewage treatment, have achieved good economic benefits.

Advantages:
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(1) High concentration of microorganisms, high processing efficiency;
(2) The number of microbial species in the biofilm, the quantity is a stable ecosystem;
(3) High oxygen utilization (10%);
(4) Higher energy consumption than biofilm (increased artificial aeration), higher investment;

Disadvantages: cloth, cloth water is not easy, easy packing. (With vinylon soft fiber filler to avoid clogging, and cheap, durable, easy processing.)

4.4. Anaerobic biochemical method

Anaerobic treatment, is in anaerobic conditions by the facultative anaerobic bacteria and specialized anaerobic bacteria to reduce the treatment of organic pollutants. For high concentrations of organic wastewater and sludge, should not be directly used aerobic biological treatment, and pretreatment with anaerobic digestion. In the anaerobic conditions, by the facultative bacteria and anaerobic bacteria decomposition of organic matter, the product is mainly methane, can burn. By-products of hydrogen sulfide, smell large, with iron sulfide, was black. Wastewater retention time is long, equipment capacity requirements.

Anaerobic biological treatment is generally divided into four stages: hydrolysis, fermentation, acetic acid production, methane production. These inorganic substances are mainly biogas of biogas. The main components of biogas are CH4 and CO2.

Advantages:

(1) Suitable for high concentrations of wastewater and aerobic refractory organic wastewater. (Aerobic: medium and low concentration)
(2) Low energy consumption: 1/10 for the ASP.
(3) High load: aerobic 2-4KgBOD / M3d, anaerobic 2-10, up to 50.
(4) Less residual sludge: easy to concentrate, easy to dehydrate, sludge volume of ASP 5% -20%.
(5) N, P need less: aerobic BOD: N: P is 100: 5: 1, anaerobic 100: 2.5: 0.5, N, P lack of industrial waste water to be added less nutrients.
(6) Have a certain bactericidal effect (waste water, parasites in the sludge eggs, bacteria and viruses).
(7) Production flexibility, adaptability: seasonal, intermittent operation.
(8) Can produce valuable by-products: such as biogas.

Disadvantages:

(1) Anaerobic microbial growth and reproduction slow, equipment start, long processing time.
(2) Effluent water quality cannot meet the discharge standards, need further aerobic treatment.
(3) Operational control factors are more complex.

4.5. Immobilized microbiological method

Immobilized microbial technology is a modern biological engineering technique that limits or locates free microbes by chemical or physical means and within a specific spatial range, retaining its inherent catalytic activity and being able to be repeated and continuously used. The application of this technology to sewage treatment is beneficial to improve the concentration of microorganisms in the bioreactor, which is conducive to the solid-liquid separation after the reaction and shorten the processing time. Immobilized microbial methods are diverse, but are mainly immobilized by immobilization, immobilization, immobilization and immobilization, and the method of immobilization of microorganisms on the surface of the carrier.

Advantages:

(1) Immobilization of microorganisms can maintain the high concentration and high activity of microorganisms in the reactor, which can improve the treatment load and removal efficiency of pollutants.
(2) The use of immobilized microbial technology, sludge production is low, reducing the burden of subsequent sludge disposal;
(3) Microbial immobilization to form a granular state, conducive to the precipitation process of mud and water separation;
(4) Immobilization of microorganisms with the properties of degradation of certain refractory organic substances, which can effectively treat some industry wastewater;

(5) Microbial immobilization of toxic substances bear strong, good stability;

5. Sewage treatment of biological requirements for water quality

5.1. Ph

Aerobic biological treatment, the pH should be kept in the range of 6 to 9. Anaerobic biological treatment, the pH should be maintained between 6.5 to 8. In the run-time asked, the pH cannot suddenly change too much to prevent microbial growth and reproduction by inhibition or death, affecting the treatment effect.

5.2. Temperature

General aerobic biological treatment requires water temperature between 20 - 40°C. Anaerobic digestion of sludge requires high temperature microorganisms for anaerobic fermentation, the temperature should be increased to 50 - 60°C between.

5.3. Nutrition

Microbial growth and reproduction requires a variety of nutrients. City sewage can meet the nutritional requirements of activated sludge, but industrial waste water in addition to organic substances generally lack some nutrients, especially N and P, so this kind of sewage for biological treatment, the need to add domestic sewage, manure, or nitrogen , Phosphorus compounds. However, if the industrial waste water is not lack of nutrition, do not add the above substances, otherwise it will lead to anti-domestication.

5.4. Toxic substances

Industrial waste water often contains many toxic substances, such as heavy metals, H2S, cyanide, phenol and so on. Although all microbial populations (activated sludge or biofilms) that were initially inoculated into a certain waste water have undergone a natural screening process in the culture of domestication, the vast majority of the remaining bacteria are treated with the pollutants in the wastewater The main nutrient degradation bacteria, but when the toxic substances in the sewage more than a certain concentration, can still destroy the normal metabolism of microorganisms, affecting the biological effects of sewage treatment. Therefore, the biological treatment of a certain sewage must be based on specific circumstances to determine the treatment method, if necessary, to be tested to determine the allowable concentration of biological treatment of toxic substances. While at the same time strengthening microbiological acclimatization to improve the tolerance of the poison.

5.5. Dissolved Oxygen

Aerobic biological treatment to ensure the supply of adequate oxygen, otherwise it will significantly reduce the treatment effect, and even cause local anaerobic decomposition, so that aeration tank sludge floating, bio-filter or bio-turntable on a large number of biofilm off. But too much dissolved oxygen, is not conducive to biological treatment.

6. The advantages of microbial treatment of sewage

1. Save water resources, reduce energy consumption and cost;

2. The use of beneficial bacteria in the liquid than the general purification tank sewage treatment, greatly shorten the aeration time, improve work efficiency;

3. Significant pollution control effect, such as organic nitrogen, metal ions, turbidity, COD (chemical oxygen demand), BOD (the amount of oxygen required), 55 (plankton) and so fell to the national standard below the standard, and DO (dissolved oxygen) rise, water quality improved;

4. To deal with heavy metals in sewage and so on, to eliminate poison;

5. Inhibit pathogens, eliminate odor, improve air quality;

6. Can remove fecal odor, purify the ecological environment, to minimize the smell of livestock and poultry, obviously inhibit the growth of mosquitoes.
7. Conclusion

Sewage biological treatment methods compared with the traditional physical and chemical methods, the former has many irreplaceable advantages. Microorganisms are small, diverse, metabolically strong, easily variable, adaptable, almost able to use all the natural substances in nature, is the ideal tool for dealing with sewage. With the increasing emphasis on environmental issues, the development of microbial technology will be more and more attention, how to improve the existing technology to make it more in line with human needs, while developing new microbial technology to better solve the problem of sewage treatment, we are concerned about the direction.

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