The Application of Immobilized Microorganism Technology in Wastewater Treatment

Xiaofan Zhang[1,a], Shaohong You*[1,2,b], Lili Ma[1,c],chunquan Chen[1, d], Chao Li[1,e]

[1]Guangxi Key Laboratory of Environmental Pollution Control Theory and Technology, Guilin University of Technology, Guilin 541004, China;

[2]Guangxi Collaborative Innovation Center for Water Pollution Control and Water Safety in Karst Area, Guilin University of Technology, Guilin 541004, China

[a]623192050@qq.com, [b]646761963@qq.com, [c]35688181@qq.com, [d]1206244690@qq.com, [e]lichao.315315@qq.com

*Corresponding author: Shaohong You. Email:646761963@qq.com

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Abstract. Immobilized microorganism technology is one technique of the effective biotechnology for wastewater treatment.It has the advantages of the seed culture of bacteria with high activity and stability the reaction easily controlled low amount of sludge produced and removal the organic matter and substances difficultly degraded. The application research development of immobilized microorganism technology on wastewater treatment was analyzed through the introduction of immobilized technology and the different selection of carriers. It reviews the recent application of immobilized microorganism technology in difficult degrades wastewater, toxicity heavy metals wastewater organism wastewater, N and P wastewater.

1. Introduction

Immobilized microorganism technology [1] is a new technology began to develop rapidly from the late 1960s. It is by means of chemical or physical means to limit cells or enzymes in the confined space area, keep them active and can be repeatedly used. Because of the microbial density, fast response, low sludge production, resistance to environmental impact and the advantages of easy to control reaction process, Immobilized microorganisms has been widely research and application in wastewater treatment [2].

2. Carriers

The research and development of the carrier with good performance is one of the most important issues in the application of immobilized microbial technology for wastewater treatment. Ideally, the immobilized microbial cell carrier should have the following characteristics. There is no poison affection on microbial cells. It has good mass transfer, air permeability and transmittance. It will be stable and not easy to be decomposed by microorganisms. It has high mechanical strength, long service life and low cost, etc.

At present, the commonly used carriers can be divided into three kinds: organic carrier, inorganic carrier and composite carrier. Inorganic carrier has porous glass, diatomite, activated carbon, quartz sand, etc. Organic carrier can also be divided into two categories: one is the polymer gel carrier such as agar, carrageenan and calcium alginate, etc; the other one is polymer gel carrier of organic synthesis such as polypropylene ammonium polyacrylate gel, polyvinyl alcohol gel, light hardening resin, polypropylene acid gel, etc. The composite carrier is a combination of inorganic and organic materials, so that the performance of the two types of materials are complementary, which shows the superiority of the composite materials [3].

3. Preparation methods

3.1 Adsorption method

The adsorption method is one of the earliest and the most widely used methods in the treatment of wastewater. The adsorption method includes two kinds of methods, physical adsorption and ion adsorption [4].

Physical adsorption is the use of a high adsorption capacity of silica gel, activated carbon or other adsorbents to immobilize microbial adsorption to the surface. Ion absorption is based on the microorganisms in the dissociated state. Due to the electrostatic attraction, it immobilize with different electric charges of the ion exchange agent.

3.2 Embedding method

Embedding method is that make the microbial cells intercept in insoluble polymer gel pore network space, by polymerization, or by ion network form, or by deposition, or by change the solvent, temperature or pH, to make the cell interception. The gel polymer network can prevent the leakage of the cell, and can also allow the substrate to penetrate and the production to spread out. The embedding method can be divided into the polymer synthesis embedding, the ion network embedding and the precipitation embedding. This method is simple and has little effect on the microbial activity, which can be locked in a specific polymer network. The embedding method is the most commonly used method to prepare immobilized microorganism.

At present, the adsorption method and embedding method are the most studied and widely used in all kinds of immobilized microorganism methods. There are also many other kinds of immobilized microorganism methods which need we to explore and research.

4. Application of wastewater treatment

4.1 Treatment of refractory organics wastewater

The conventional biological treatment methods have lower efficiency for treating wastewater containing refractory organic compounds (phenol, cyanide, aniline and DDT, etc.). This is because these microorganisms have a longer growth period and they are difficult to exist in the conventional biological treatment structures. The use of immobilized microbial technology can be used to select the dominant bacteria culture, and fixed it to the carrier to increase the concentration of microorganisms, then we can effectively deal with this kind of refractory organics.

Anselmo [5] was studied by agar, alginate, carrageenan and polyacrylamide as carrier of immobilized microorganism to degrade the phenol. And they made the polyurethane foam as the carrier to immobilize Fusarium sp. to degrade the phenol in an complete mixer. The results showed that the rate of phenol degradation by immobilized microorganism was much larger than that of free bacteria and had a lower biological production.

4.2 Treatment of wastewater containing heavy metal ions

After immobilization, the stability increased, the resistance of the damage to the outside world was improved, and the removal of heavy metal ions could be used in the treatment of organic wastewater.

Algae has a strong ability to enrich metal ions, and it can be used as biological adsorption of toxic or radioactive metal removal and rare or precious metals recycling in industrial wastewater. It is efficient, economical, simple and selective and it is an alternative or supplementary means of a highly applied value, especially suitable for low concentration. Algae is mainly go through the way of biological adsorption and recovery of metal, mainly use two kinds of enrichment systems by free living cells and immobilized cells.

Someone had done a static experimental study on the adsorption of Cu (II) in water. The results showed that the adsorption rate of Cu (II) in water by the immobilized cells was significantly higher than that not immobilized cells. And the immobilized algae cells can be used for 0.5 mol/L desorption and regeneration, the desorption rate is more than 80%. Foreign scientists [6-8] buried fungi with calcium alginate to treat wastewater containing Cu (II). The maximum adsorption

capacity was 104.8 + 2.7mg Cu(II) (live bacteria) and 123.5 + 4.3mg Cu (II). Within 0.5 hours, the cadmium adsorption reached 85%. After calcium alginate - fungus treated by 10ml HCl, the recovery rate reached 97%, and the adsorption capacity was only slightly decreased after 3 times treatments.

4.3 Treatment of high concentration organic wastewater

The treatment efficiency of immobilized microorganism technology in treating high concentration organic wastewater is relatively high. And many kinds of wastewater containing high concentration of organic matter, such as industrial and living wastewater, the treatment effect is better. Compared with the traditional biological treatment methods, it has obvious advantages.

Liu Zhipei, et al.[9] used PVA to embed the mixed bacteria to treat dyeing wastewater. The decolorization rate can be maintained at about 85%. For one month of continuous operation, the decolorization rate was between 70% and 80%.

4.4 Treatment of nitrogen and phosphorus in wastewater

It is generally considered that the microbial removal of ammonia nitrogen is required to be aerobic nitrification and anaerobic denitrification in two stages. *Cao Guomin, et al.*[10] had PVA as carrier by a new technology of single stage biological denitrification. The use of an immobilized membrane on both sides, respectively, hypoxia ethanol carbon source in contact with the aerobic ammonia wastewater, so that fixed in the film nitrifying bacteria oxidize ammonia to nitrite and nitrate nitrogen, followed by the same film in the denitrification bacteria to nitrogen.

5. Advantages and Prospect

5.1 Advantages

Compared with other environmental treatment technology, the immobilized microbial technology has the following characteristics: (1) Microbial immobilization can maintain the high concentration and activity of microorganism in the reactor, which can improve the processing load and removal efficiency of pollutants; (2) By using the technology of immobilized microorganism technology, the sludge production is lower, and the burden of subsequent sludge disposal is reduced; (3) Microbial immobilization is formed by the particle state, which is conducive to the separation of the sludge process; (4) It will have some industry wastewater which can be effectively treated by microbial immobilization; (5) Microbial immobilization have a strong ability and stability to toxic substances.

Therefore, in the environmental pollution control the immobilized microbial technology is to carry out extensive research and in-depth discussion.

5.2 Prospect

Immobilized microorganism technology in wastewater treatment and any other fields has shown a great merit. It has aroused widespread concern and conducted a wide range of research and application. At the same time, we should also see that, to achieve the industrialization of immobilized microbial technology, there are still many problems need to further study and solve：(1) The cost and service life of the fixed carrier are the key factors to determine the economic feasibility of its. Therefore, how to make the suitable development of high efficient biochemical reactor and low cost immobilized microbial carrier for immobilized microbial cells and how to improve the service life of the carrier need to be resolved; (2) Immobilized microbial cells in the process of wastewater treatment may be ineffective for some suspended substances or polymer materials, may also appear swollen up or clogging phenomenon such as bond. So we need to carry out the appropriate physical, chemical pretreatment, or with other processes, play their respective advantages to achieve the best treatment effect; (3) For many factors affecting the fixed operation, we need to select the best activity of immobilized cells to study on the optimal parameters of different immobilization methods and different carriers. It is the key to the wide application of the technology; (4) Study on the biological non destructive, high efficiency of the desorption agent.

I believe that through continuous research and improvement, immobilized microbial technology will become an effective and practical technology for wastewater treatment to obtain a wide range

of applications.

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