Research on the Method of Treating Petroleum Industry Wastewater through Biological Means in the New Era

Jianzhao Tian
School of Arts and Communication of Yangtze University, Wuhan 430000, China.

Abstract: With the rapid development of social economy and the gradual deepening of cooperation in the world industrial system, the industrial level of a large number of developing countries, especially China, has been significantly improved. Behind the significant rise of the industrial system, energy, as the pillar of industry, plays an irreplaceable role. As the "black gold" in the industrial system, petroleum has a wide range of applications in industries such as smelting, refining, transportation, national defense, and textiles. With the significant increase in demand for petroleum in China, the treatment of wastewater from the petroleum industry has become an unavoidable issue for researchers. At present, the water content of most oil development in China has reached over 90%. How to make inefficient wells "turn waste into treasure"? As a relevant researcher, the author has conducted a unique analysis of the methods for treating oil industry wastewater through a combination of extensive literature research and practical work, hoping to bring more help to future research work.

Keywords: Biological Means; Biochemistry; Oilfield Wastewater; Pollutant

1. Composition of pollutants in petroleum industry wastewater

In the production process of the petroleum industry, many toxic and harmful pollution elements are generated. If these toxic and harmful substances are distinguished, they can be classified into organic pollutants and inorganic pollutants through chemical methods; If these pollutants are carefully distinguished based on their physical properties, they can be divided into suspended solids with particle sizes ranging from 0.1 to 0.45 microns, colloidal substances with particle sizes ranging from 0.001 to 0.1 microns, and soluble substances[1]-[3].

2. Process methods for treating petroleum industry wastewater through biological means

The treatment of the petroleum industry through biological means mainly involves the transformation of toxic and harmful substances in petroleum industry wastewater into non-toxic and harmless directions through natural biological and microbial metabolism. In the process of biological treatment, it is mainly sorted out through methods such as microorganisms and bacteria. Due to the relatively simple acquisition of bacteria and microorganisms, as well as their large number, microorganisms and bacteria that match the real environment can be found in different environments for wastewater treatment. Due to the different growth environments of different microorganisms and bacteria, some microorganisms and bacteria grow in the environment mentioned in the text, while some nitrifying bacteria live in high-temperature environments. Therefore, during the cultivation process, it is necessary to have a targeted approach, treat the microorganisms and their characteristics through appropriate and reasonable biological cultivation processes, and achieve the goal of transforming pollutants. At present, there is a consensus in the industry on the composition of oilfield wastewater. The vast majority of oilfield industrial wastewater is composed of hydrocarbons. After the compounds are transformed and absorbed by microorganisms and bacteria, the pollutants in the wastewater become the main energy source for microbial growth, which is

then consumed by microorganisms. Some of the pollutants become the skeleton of microorganisms and will be directly utilized. In the process of using biological processes to treat oilfield wastewater, the efficiency of pollutant degradation is relatively fast. However, it is necessary to reasonably select the types of microorganisms to ensure that the treatment effect of oilfield wastewater meets relevant standards. Taking paraffin based petroleum wastewater as an example, its petroleum wastewater contains a high content of solid paraffin, volatile phenols, and some polycyclic aromatic hydrocarbons. However, in this wastewater, it is extremely difficult to degrade polycyclic aromatic hydrocarbons and volatile phenols. It is necessary to start with the characteristics of these two substances, analyze their properties reasonably, and introduce suitable strains for microbial treatment[4]-[7].

Based on the above biological methods for treating petroleum industry wastewater, the author has summarized them, and will briefly elaborate on these methods below.

Tab. 1 Methods for treating petroleum industry wastewater using biological methods

Biological treatment methods for petroleum industry wastewater	Microalgae treatment method	Low cost and no secondary pollution	Toxic substances in wastewater can affect the activity of microalgae
	Aerobic biological method	Low operating cost, good treatment effect, and stable effluent quality	High equipment investment and maintenance costs, high sludge production
	Anaerobic biological method	Low sludge production, low cost, and easy operation	Long wastewater treatment cycle and unstable treatment effect

3. Process methods for treating petroleum industry wastewater through biological means

3.1 Microalgae treatment method

As the most common method of using biological means for oil industry wastewater treatment, microalgae treatment has been highly recognized by researchers for its ability to absorb a variety of pollutants, excellent carbon sequestration effect, and high oxygen release. Current research has confirmed that microalgae can effectively absorb elements such as nitrogen and phosphorus in petroleum industry wastewater, and heavy metals such as copper, cobalt, and lead in petroleum industry wastewater have a certain removal effect. This method is low-cost, effective, and does not generate secondary pollution, and has been applied in the vast majority of petroleum enterprises. However, due to the harsh growth environment of microalgae, suitable light, temperature, and nutrient elements are required. Therefore, if this method can improve the survival characteristics of microalgae itself, it will be more widely used[8].

3.2 Aerobic Biological Method

The aerobic biological method is also one of the commonly used methods for the treatment of petroleum industry wastewater. Activated sludge method and biofilm method are both of these methods, which have low costs and good application effects. However, the treatment effect is not very stable, and researchers need to continue experimental research.

3.3 Anaerobic Biological Method

The method of using anaerobic bacteria and microorganisms to convert organic pollutants in petroleum industry wastewater into carbon dioxide and methane under anaerobic conditions is commonly referred to as anaerobic biological method by researchers. Due to the poor biodegradability and high COD concentration of petroleum industry wastewater, the use of anaerobic biological method can effectively improve the biodegradability of wastewater, thereby improving the

treatment effect of subsequent aerobic biological treatment on wastewater.

4. Experimental Study on the Treatment of Petroleum Industry Wastewater by Anaerobic Biological Method

After anaerobic treatment of anaerobic granular sludge in the wastewater of petroleum enterprises in Area A, the removal effect of COD from coagulation effluent was observed. Through experiments, the following conclusions were obtained: (1) Three coagulants, polysilicate iron aluminum, polyaluminum chloride, and ferric chloride, were used to treat oilfield wastewater. By comparing the removal rates of turbidity and COD in oilfield wastewater with the three coagulants, it can be concluded that polysilicate iron aluminum has the best treatment effect on oily wastewater among the three coagulants. (2) The experiment shows that the appropriate dosage of polysilicate iron aluminum is around 40mg/L, and the turbidity removal rate can reach over 97.3%. The COD removal rate can reach over 80%; Under the same dosage conditions, its turbidity removal rate is about 5% higher than that of the sewage treated with polyaluminum chloride, COD removal rate is about 15% higher, and turbidity removal rate is about 3% higher than that of the sewage treated with iron chloride. COD removal rate is about 15% higher, indicating a good treatment effect on oily wastewater.

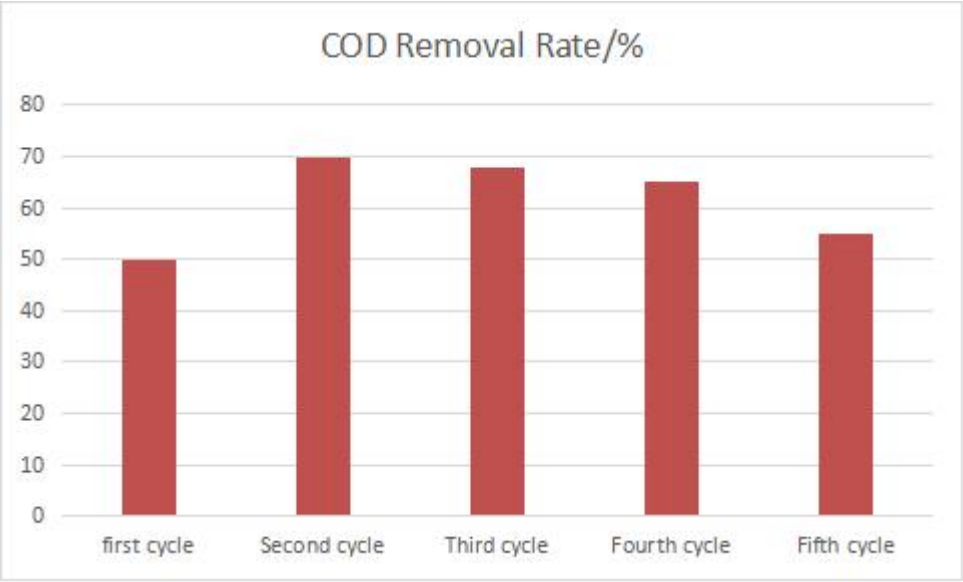

Fig. 1 COD removal rate of petroleum industry wastewater after coagulation and anaerobic treatment

5. Conclusion

Through a large collection of viewpoints and the organization of arguments, the author believes that with the continuous progress of technology and the continuous emphasis on science and technology at the national level, biological treatment technology will be more and better implemented in oilfield wastewater. The treatment of petroleum industry wastewater through biological means will be more effective in protecting the environment and reducing pollutant emissions, These technological advancements will also help other industries continue to develop and help oil companies achieve sustainable development.

References

[1] Leech CA, Radhakrishnan S, Hillyer MJ. Perfomarlce Evaluation of Induced Gas F10tation(IGF) Machine Thmugh Math ModeIing. Journal of Petroleum Technology, 1980, 32(1): 48-58.

[2] Tellez, Gilbert & Khandan, Nirmal & Gardea-Torresdey, Jorge. (2002). Performance Evaluation of an Activated Sludge System for Removing Petroleum Hydrocarbons from Oilfield Produced Water. Advances in Environmental Research. 6. 455-470.

[3] Campos JC, Borges RM, Oliveira Filho A, Nobrega R, Sant'Anna GL Jr. Oilfield wastewater treatment by combined microfiltration and biological processes. Water Res. 2002 Jan;36(1):95-104.

[4] Nancharaiah YV, Kiran Kumar Reddy G. Aerobic granular sludge technology: Mechanisms of granulation and biotechnological applications. Bioresour Technol. 2018 Jan;247:1128-1143.

[5] Du, K., He, M., Lian, M. et al. Catalytic Wet Air Oxidation Treatment of Oily Wastewaters. Chem Technol Fuels Oils 52, 85–89 (2016).

[6] Lutzu GA & Ciurli Adriana, & Chiellini C, & Di Caprio, Fabrizio & Concas, Alessandro & Dunford, Nurhan. (2021). Latest developments in wastewater treatment and biopolymer production by microalgae. Journal of Environmental Chemical Engineering. 9. 104926.

[7] Fu K, Leng J. Research Progress on Artificial Wetland Wastewater Treatment Technology [J]. Urban Water Supply, 2022 (1): 75-80.

[29] Zhao TL, Qin FL. Research on the treatment of high salinity oil recovery wastewater using activated sludge method [J]. Journal of Xi'an Petroleum University (Natural Science Edition), 2008 (2): 63-66.

[8] Ju CF, Qin Y, Dai XM, et al. The effect of anaerobic sludge microbial action on the surface properties of microplastics [J]. Journal of Donghua University (Natural Science Edition), 2023,49 (3): 81-88.