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RESEARCH PROGRESS OF HIGH SALINITY WASTEWATER TREATMENT METHODS

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The large amount of high salinity wastewater discharged has a very negative impact on the environment. This paper analyzes the current status of the physical, chemical and biological treatment methods for high salinity wastewater. Believed that the improvement of membrane treatment technology can significantly change the current status of high salinity wastewater treatment, improving the antifouling ability of membranes and new membrane materials are the main directions to improve membrane processing capabilities. Through physical modification, chemical modification and other measures to improve the membrane's flux, anti-pollution, and oxidation resistance, and actively develop new membrane materials based on graphene to improve membrane processing efficiency and reduce processing costs.

The problem of water disinfection has been and still is extremely important. Not only has scientific and technological progress reduced the urgency of this problem, it has also caused a sharp deterioration of the environmental status of the environment as a result of industrial and economic activity [1].

Wastewater with a total salt content greater than 1 % is called high salinity wastewater [2]. In addition to organic pollutants, such wastewater also contains a large amount of soluble inorganic salt ions such as calcium, magnesium, sodium, chlorine, and sulfate, and even contains radioactive substances. High salinity wastewater mainly comes from seawater, factories, municipal saline wastewater and groundwater with high salt content. The main hazards of high salinity wastewater are: (1) Discharged into water, the salinity distribution of water changes, which affects the growth and reproduction of animals and plants; (2) Wastewater may contain high concentrations of inorganic salts such as nitrogen and phosphorus, which will cause the occurrence of "red tide"; (3) Heavy metals and toxic chemicals in wastewater will enter bodies of animals and plants, destroying the physiological function and even lead to death [3, 4].

Currently, there are dozens of high salinity wastewater treatment technologies and methods, mainly divided into physical methods, chemical methods, and biochemical methods.

Physical methods for treating high salinity wastewater include natural evaporation, multi-effect evaporation, and mechanical compression evaporation [5, 6]. Natural evaporation, through the low-cost method of sun exposure, concentrating salt and other harmful substances in wastewater, thus reducing the scale of wastewater discharge. Multiple-effect evaporation mainly uses steam heating to evaporate the water in high salinity wastewater to achieve the purpose of concentrating salt and other substances [7]. Mechanical compression evaporation mainly relies on mechanical work to transfer heat from a low-temperature heat source to a high-temperature heat source, to realize the energy-saving technology of continuous circulation of latent heat which is a form of heat pump evaporation.

Chemical methods to treat high salinity wastewater mainly include incineration, deep oxidation, electrodialysis, and ion substitution. Incineration, under the condition of the high temperature of 800 - 1 000 ℃, spraying misty high salinity wastewater into high-temperature incinerator, these combustible components in high salinity wastewater undergo chemical reactions after high-temperature oxidation, generating water, carbon dioxide, harmful gases such as sulfur dioxide, nitrogen oxides, hydrogen chloride, hydrogen fluoride, soot, and some solid residues [8]. Deep oxidation is a highly oxidized process that utilizes strong oxidizing agents (ozone, hydrogen peroxide, ultraviolet ray, etc.) to completely oxidize and degrade high salinity wastewater [9, 10]. Electrodialysis converts the chloride ions in high salinity wastewater into chlorine gas at the anode, then converts them into hypochlorous acid, which as a strong oxidizer to oxidize organic matter in water, thus removing pollutants in water [11, 12]. Ion substitution is the exchange reaction between ions in high salinity wastewater and fixed anions or cations in an ion-exchange column, cations such as sodium ions are replaced by hydrogen ions, anions such as chloride ions are replaced by hydroxide ions, in the end, cations such as sodium ions and anions such as chloride ions are left in the ion exchange column to achieve the purpose of salt removal [13, 14]. At present, the membrane technology is widely used in the water treatment industry because of its extremely high treatment efficiency. As the demand for sewage treatment increases, ion exchange membranes are required to be electrochemically stable to reduce the surrounding of the cathode and the oxidation environment of the anode [15, 16].

Biological treatment process flows of high salinity wastewater are similar to the processes of other domestic wastewater and industrial wastewater biological treatment, mainly including regulating system, dosing system, aeration system, secondary sedimentation system, sludge return, dewatering system, and advanced treatment system. At present, the most promising biological treatment technology for high salinity wastewater is to isolate halotolerant bacteria and halophilic bacteria from high-salt environments in nature, or cultivate halotolerant bacteria and halophilic bacteria from the laboratory and apply them to actual processing systems, including Thiobacillus denitrificans, Nitrococcus, Zoogloea ramigera, and Vibrio anguillarum. Sometimes different bacteria species are mixed to achieve the purpose of enhancing the treatment effect [17, 18].

Conclusion

The treatment of high salinity wastewater is an important environmental protection problem in industrial development. Comprehensive utilization is an important way to solve high salinity wastewater. The application of high salinity wastewater reuse technology is an important guarantee for achieving significant economic, environmental and social benefits.

At this stage, the large-scale treatment of high salinity wastewater still has the characteristics of low treatment efficiency and high operating costs, and there are still many key technical problems that need to be breakthrough and solved. For example, when the forward osmosis method is used to treat high salinity wastewater, the core issues such as forward osmosis membranes and draw solution are still not well solved; how to increase the amount of water treated by reverse osmosis, how to extend the service life of membrane parts, and how to effectively prevent membrane pollution and other issues are still need to be resolved. In the future, the fouling of the membrane in the actual process should be considered in a systematic way. Membrane fouling directly reduces membrane flux, reduces membrane service life, and increases energy consumption and cost. In the process of anti-fouling research, compared with the traditional tribenzoyl chloride, the functional monomer of the tetrachryl chloride group reacts with m-phenylenediamine remains more acid chlorides, hydrophilic carboxyl groups will be produced after hydrolysis. Improving the membrane's anti-pollution ability needs to start from various aspects such as physical modification and chemical modification.

From the current status of high salinity wastewater treatment technology and the rapid development of high salinity wastewater treatment technology, membrane technology will continue to become the dominant direction. New membrane materials should be developed from the aspects of high-throughput, pollution resistance, oxidation resistance, and graphene 2D materials. For example, increase the research of polyelectrolyte materials, hyperbranched structural materials, porous nanomaterials, organic solvent resistant polymer materials and other high-performance membrane materials, chitosan, tannic acid and other natural polymeric materials. Developing new processes from unconventional energy sources, forward osmosis, and membrane distillation, such as increase the investment in multi-membrane process integration process, membrane and other technology coupling process, large unit membrane module combination, intelligent membrane, bionic membrane and other optimized membrane processes.

In summary, the research of high salinity wastewater treatment in the future should strengthen the analysis of salt components, develop membrane technology, improve online monitoring and regulation, and adopt different treatment technologies for different high salinity wastewater to improve efficiency, and reduce costs; it will help to fully recover and recycle water resources, reduce the salinization pollution of various high salinity wastewater to water resources and the harm caused by salinization to the soil, and achieve efficient separation of salt and water. It has important practical significance and far-reaching strategic significance for protecting the environment, saving energy and reducing emissions.

Literature

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