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# Circular Nitrogen Removal, Recovery and Reuse Technologies

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**Abstract :** The excessive discharge of nitrogen in sewage greatly intensifies the eutrophication of water bodies and threatens water quality. Nitrogen pollution control has become a global concern. The concentration of nitrogen in water is reduced by converting ammonia nitrogen, nitrate nitrogen and nitrite nitrogen into nitrogen-containing gas through biological treatment, physicochemical treatment and oxidation technology. However, some wastewater containing high ammonia nitrogen including landfill leachate, is difficult to be treated by traditional nitrification and denitrification because of its high COD content. The core process of denitrification is that denitrifying bacteria convert nitrous acid produced by nitrification into nitrite under anaerobic conditions. Still, its low-carbon nitrogen does not meet the conditions for denitrification. Many studies have shown that the natural autotrophic anammox bacteria can combine nitrous and ammonia nitrogen without a carbon source through functional genes to achieve total nitrogen removal, which is very suitable for removing nitrogen from leachate. In addition, the process also saves a lot of aeration energy consumption than the traditional nitrogen removal process. Therefore, anammox plays an important role in nitrogen conversion and energy saving. The short-range nitrification and denitrification coupled with anaerobic ammoX ensures total nitrogen removal. It improves the removal efficiency, meeting the needs of society for an ecologically friendly and cost-effective nutrient removal treatment technology. In recent years, research has found that the symbiotic system has more water treatment advantages because this process not only helps to improve the efficiency of wastewater treatment but also allows carbon dioxide reduction and resource recovery. Microalgae use carbon dioxide dissolved in water or released through bacterial respiration to produce oxygen for bacteria through photosynthesis under light, and bacteria, in turn, provide metabolites and inorganic carbon sources for the growth of microalgae, which may lead the algal bacteria symbiotic system save most or all of the aeration energy consumption. It has become a trend to make microalgae and light-avoiding anammox bacteria play synergistic roles by adjusting the light-to-dark ratio. Microalgae in the outer layer of light particles block most of the light and provide cofactors and amino acids to promote nitrogen removal. In particular, myxoccota MYX1 can degrade extracellular proteins produced by microalgae, providing amino acids for the entire bacterial community, which helps anammox bacteria save metabolic energy and adapt to light. As a result, initiating and maintaining the process of combining dominant algae and anaerobic denitrifying bacterial communities has great potential in treating landfill leachate. Chlorella has a brilliant removal effect and can withstand extreme environments in terms of high ammonia nitrogen, high salt and low temperature. It is urgent to study whether the algal mud mixture rich in denitrifying bacteria and chlorella can greatly improve the efficiency of landfill leachate treatment under an anaerobic environment where photosynthesis is stopped. The optimal dilution concentration of simulated landfill leachate can be found by determining the treatment effect of the same batch of bacteria and algae mixtures under different initial ammonia nitrogen concentrations and making a comparison. High-throughput sequencing technology was used to analyze the changes in microbial diversity, related functional genera and functional genes under optimal conditions, providing a theoretical and practical basis for the engineering application of novel bacteria-algae symbiosis system in biogas slurry treatment and resource utilization.

**Keywords :** nutrient removal and recovery, leachate, anammox, Partial nitrification, Algae-bacteria interaction
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