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Bioflocculation technology Feasibility study of nitrogen removal in Marine circulating aquaculture

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Abstract: This paper is the Harbin Institute of Technology (Weihai) innovation research course "autumn Marine treasures" course paper, mainly discusses the circulating mariculture has great environmental value, but nitrogen pollution problem, briefly gives the physical chemical methods and traditional biochemical method and defects, then discusses the principle of the technology and application value, thus discusses the feasibility of biological flocculation technology in circulating mariculture, for related research and innovative research papers and design reference.

Key words: biological flocculant technology; circulating aquaculture; nitrogen removal technology

1. Brief description of nitrogen pollution in Marine aquaculture

The data of the literature show that Marine fish can only use about 20% of the protein in the bait. and residual bait nitrogen and nitrogen produced by metabolism exist in the form of ammonia nitrogen and other excrement, residual bait and feces[1]. The rapid development of the aquaculture industry leads to the excessive inorganic nitrogen content in the aquaculture tail water, which not only affects the growth of the aquaculture hosts, but also affects the increasingly serious water environment pollution problem caused by its discharge into the natural water bodies.This treatment method is to change the water, which will consume a lot of water resources and cannot solve the problem of polluting natural water bodies.The discussion is based on a second method, namely circulating aquaculture (Recirculating Aquaculture System, RAS).This method refers to the treatment and reuse of aquaculture water, and is considered as an environmentally friendly aquaculture model.This paper mainly discusses the feasible or already applied nitrogen removal technology in this model, and uses biological flocculation technologyNitrogen scheme[2]。

2. Classification of nitrogen removal techniques in aquaculture

At present, the known nitrogen removal technology can be divided into physical and chemical nitrogen removal technology and biochemical nitrogen removal technology according to its main principles and technical means.Physical and chemical nitrogen removal technology mainly includes folding point chlorination, chemical precipitation, ion exchange and adsorption, oxidation, blowing and steam, electrodialysis; biochemical methods mainly include traditional biological nitrification and denitrification, aeration, and the biological flocculation method discussed in this paper[3]。

3. Physical and chemical nitrogen removal technology and its defects in aquaculture

3.1 Fot chlorination

Broken point chlorination is the redox method of nitrogen salts to N using an effective chlorine preparation as an oxidant2A method of nitrogen pollution.This method has a great effect on removing reducing inorganic nitrogen such as ammonia nitrogen and nitrite. It is worth mentioning that this method also has a certain killing effect on microorganisms in water, and can improve water quality in two aspects.However, this method has obvious defects: chlorine oxidant has many chemical side reactions to aquatic products in aquaculture pool, which causes many other pollution and damage to water environment. Since the application of the method is the cost and reaction, it may limit the promotion of the method in aquaculture wastewater treatment, especially in circulating aquaculture[4-5]。

3.2 Chemical precipitation method

Chemical precipitation method is a certain amount of coagulation reagent and coagulant directed to water to

remove inorganic nitrogen by precipitation or co-precipitation

method.Considering the cost, not only the cost of coagulation reagents and coagulants mentioned above, but also the investment problem of solid-liquid separation and dosing device. The chemical precipitation method is similar to the chemical oxidation method represented by discount point chlorination method and related chemical drugs, so there is the problem of the cost of agents, so it is difficult to achieve low cost[5]。

3.3 Ion exchange and adsorption method

Ion exchange method and adsorption method are similar, respectively, using ion exchange resin and various adsorption materials to remove inorganic nitrogen such as ammonia nitrogen.Such methods basically meet the industry requirements in terms of processing capacity and processing effect.Among them, the physical adsorption of activated carbon and the ion exchange of natural zeolite have been verified and explored in many experiments and small applications, the two raw materials costs are also low, is considered to have great application value, especially in the treatment of active zeolite.The advantages of this method are: convenient operation, less investment, simple process, convenient to realize the combination of related operation of breeding plant and water quality reuse, and facilitate the formation of industrial chain.However, the regeneration of adsorption material, how to select local material and application is difficult to popularize this method.In particular, the cost of this approach may dramatically dramatically in mariculture with high salinity, large ion exchange capacity[5，7]。

3.4 Electrolytic oxidation method

The mechanism of electrolytic oxidation is the same as that of chemical oxidation, which is based on electron transfer to form a certain redox capacity, so as to achieve the oxidation and removal of ammonia nitrogen. The difference lies in the related mechanism of using electrolysis.Relatively speaking, the selection agent in chemical oxidation method, the water quality requirements in electrolytic oxidation method, are not widely adaptable.Although electrolytic oxidation method has advantages in operation, stability and processing capacity, it also needs to solve from the construction of finished equipment to solve high energy consumption, corrosion and electrode materialsquestion[6]。

3.5 Blowoff method and steam formulation

Blowoff method and steam formulation are using the mechanical way of blowing gas, using solid-liquid phase mass transfer balance, so as to promote the removal of ammonia nitrogen volatilization.However, this technology has little effect on nitrate and nitrite nitrogen, and can only be carried out in combination with the biochemical

nitrogen removal described below.Blow stripping can use different technologies, generally divided into natural ventilation, mechanical ventilation and drum air ventilation.However, in terms of low ammonia nitrogen concentration pollution, only strong mechanical ventilation or high air ventilation can be used, which will lead to huge operating costs.Through direct or indirect heating or steam to remove ammonia nitrogen, there is a serious energy consumption problem.In the case of relatively low ammonia nitrogen concentration, the above shortcomings are more magnified[7-8]。

4. Traditional biochemical nitrogen removal technology and its defects in aquaculture

Traditional biological denitrification techniques generally include two processes: nitrification and denitrification,

A series of nitrifying bacteria and denitrifying bacteria were used, respectively.Biological nitrification generally refers to a series of biochemical effects of nitrification bacteria in converting ammonia nitrogen into nitrite and nitrate under aerobic conditions.Denitrification refers to the use of denitrifying bacteria to reduce nitrate and nitrite nitrogen to nitrogen without molecular oxygen, thus transferring the biochemical effect of the gas phase[9].

Traditional biological nitrogen removal processes include anaerobic-aerobic method and anaerobic-hypoxia-aerobic method.This series of traditional biological nitrogen removal processes generally have high infrastructure cost, and the operation management and maintenance are difficult for ordinary breeding personnel, which need specific technical personnel to complete.Including activated sludge and biofilm and other aspects will have the corresponding technical problems in the operation.In addition, the traditional biological nitrogen removal technology is not closely combined with the characteristics of aquaculture sewage, so it is not good to recycle the low cost water quality of Marine aquaculture plants, but on another perspective, it has a certain significance for the nitrogen sewage collected in centralized aquaculture areas[10-12].

5 Solution to nitrogen removal problem by using biological flocculation technology

5.1 Overview of biological flocculation technology and its principle

Bio-flo c Technology (BFT) is considered to be an effective solution to the problems of nitrogen pollution, environmental constraints and high cost of some aquaculture feed faced by Marine aquaculture, especially circulating aquaculture[13]. Biofloc-Aquaculture System (BAS) based on biological flocculation technology can purify the water environment of aquaculture, and also realize multiple utilization of some bait.Therefore, this model is considered as a circulating water and aquaculture model with good ecological and economic benefits, and is now being studied, practiced and gradually promoted in Israel, the United States and other countries.

This bioflocculation process was first studied as a treatment method for urban sewage.Its essence is the inorganic nitrogen assimilation process of heterotrophic microorganisms, that is, microorganisms convert inorganic nitrogen such as ammonia nitrogen into their own substances.In recent years, the biological flocculation technology has been popularized and applied to a large extent.Although there are many studies on the mechanism of biological flocculation, the empirical results of the principle of biological flocculation technology are still relatively blank, and this phenomenon also indicates the complexity of the technical mechanism.

In terms of glue system flocculant mechanism alone, the more classic flocculation mechanism includes extracellular electrical neutralization mechanism, polymer bridge mechanism, in vitro cellulose fibre mechanism, hydrophobic mechanism, capsule mechanism, etc.According to the comprehensive literature reports, the flocculation process is complex, and the configuration, molecular weight, molecular type, flocculant concentration, water pH, flocculant colloidal properties and other factors affect the process and mechanism.

At the application level, the application value of this technology is mainly to realize the effective transformation of inorganic nitrogen in water bodies.This is to say, the dissolved carbon and nitrogen ratio in the water body maintains a certain balance (for example, the carbon-nitrogen ratio is greater than or equal to 15), and the inorganic nitrogen in the water body can be converted into the biomass of heterotrophic microorganisms through absorption and utilization.A large number of studies show that the growth and metabolic rate of heterotrophic bacteria is faster than that of autotrophic bacteria, so both experimental and theoretical analysis shows that heterotrophic nitrogen conversion is faster than the autotrophic conversion achieved by nitrification and nitrification, so the biological flocculation technology optimizes the nitrogen in circulating aquaculturePollution treatment and the whole process[14-15].

5.2 Biological flocculation process and its conditions in the aquaculture process

The removal of nitrogen compounds with an impact on water quality can be carried out mainly through the following ways during bioflocculation: (1) photosynthesis of algae and protozoan; (2) assimilation of heterotrophic microorganisms; (3) synthesis of

nitrification bacteria.Comparing these three, we can see that the growth and reproduction of heterotrophic microbial community is stable, which generally does not cause substantial changes in the physical and chemical properties of water bodies, and is not affected by light and other conditions.Thus, biological flocculation differs from other autopurification techniques by transforming the autotrophic purification of phytoplankton communities in the cultured environment into heterotrophic bacterial community purification.The conditions of biological flocculation process include but not limited to: sufficient mixing strength, aerobic environment, sufficient enough Machine carbon source and C / N, appropriate temperature, p H, total suspended solids[16]。

5.3 Advantages of bioflocculation method in aquaculture

Biological flocculation technology In circulating water, aquaculture also uses carbon sources such as residual bait and feces in water to form biological flocculates that can be fed by breeding objects.This process realizes the reuse of nitrogen contained in feed and improves the nitrogen conversion rate in feed.Simply put, the use of BFT in aquaculture system only needs to provide carbon source, which does not require high physical and chemical properties, so the difference and the above chemical method cost is low[17]. The technology can solve the problem of water quality in the process of breeding, also can reduce the cost of feed, in Israel, Canada, the United States and other countries are promoting, to achieve "for the sea, the sea" seawater strategic change, and "both green water castle peak, also to jinshan yinshan" sustainable development strategy provides a good concentrated aquaculture reference mode.

5.4 Classification of biological flocculation technology in aquaculture

The biological flocculation process in aquaculture can be divided into two kinds: one is the combination of autotrophic and heterotrophic bacteria, and the other is the biological flocculation mainly with heterotrophic microorganisms such as bacteria.algae symbiotic flocculation needs light, suitable for outdoor breeding, bacteria main biological flocculation does not need light, suitable for indoor treatment.The application of biological flocculation technology in the aquaculture system can also be classified as follows: first, it is carried out directly in the aquaculture pond, such as adding carbon source in the open-air sea shrimp aquaculture pond and aeration.The second is to pump out of the original breeding pool, in the sequential batch reactor (Sequencing batch reactors, SBR) for biological flocculation.The latter completes the biological reaction after backwater or collected catkins can be fed, can be better combined with circulating aquaculture, solveTreatment problem of nitrogen-containing wastewater in aquaculture[18-19]。

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(Ppage 38)

(3) Break the asynchronony of teaching management and teaching practice

Expand the coverage of management content and strengthen the dynamic supervision of the implementation process.The teaching system should disperse the objectives from a single form standard, content standard and implementation standard to the teaching image, teaching atmosphere, teaching materials and other aspects; analyze and practice needs, flexibly adjust the management system according to the needs, and make it feasible in each development stage of online courses.More importantly, pay attention to the quality of management and get rid of the formalization of management.College management in China regards teaching as a tool to achieve some political and economic purposes (Biedrong, 2004). When teaching management attaches formalism pressure, it not only suppresses the interest of teachers and students, wastes teaching time and energy, but also has little effect on improving teaching quality.Therefore, university management should pay full attention to the relevant opinions of students and frontline teachers; clarify the necessary and unnecessary boundaries, control the management distance, cancel the inefficient form norms; emphasize

humanized management, give teachers and students more time and space, and balance the relationship between rigid and softness, creation and stimulation, authoritative control and service benefits.

(4) The three main subjects of online courses fulfill their responsibilities and coordinate

Teaching resources are shared together to realize the warehousing of high-quality courses.Schools and colleges can provide teachers and students with the integration of various quality teaching resources, classify resources and improve the utilization of teaching resources, select authoritative quality demonstration resources, study and find gaps between universities and teachers; teachers to contact "online forum" and "cloud classroom" in fragmented time, maintain real-time information sharing, through discussion groups, data upload, information feedback and other forms.Education and cultivation is also particularly important in the interaction.Colleges and universities actively organize teachers to conduct online course training, be skilled in the online course operation process, and update the online course resources flexibly and dynamically; and guide teachers 'teaching behavior through training to improve teachers' adaptability in the online course era

Force: integrate various online course skills, innovate interactive skills, improve students' attention and teaching effect; give enough attention to teachers with advanced age, conservative style, unfamiliar operation, insufficient equipment and other special conditions and patience.

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