Starch wastewater treatment technology

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Abstract: Several methods of starch wastewater treatment in recent years, including physical method, physical-chemical process, biological method and combined process method, were reviewed. The advantages and disadvantages of these methods are analyzed, and the development and research direction of these methods are prospected.

1. Introduction

Starch is an important industrial raw material, widely used in food, chemical, textile, medicine and other industries. In the process of starch production, waste water discharge is very large, each production of 1t of starch will produce 10~20 m³ wastewater. COD concentration is between 5000 and 50000 mg/L, BOD concentration is between 3000 and 30000 mg/L, and SS concentration is between 1000 and 5000 mg/L. These wastewater mainly contains dissolved starch, a small amount of protein, organic acid, dust, minerals and a small amount of oil and fat, easy to corrupt fermentation, make the water black and smelly, discharge into rivers will consume dissolved oxygen in the water, promote algae and aquatic plant reproduction. When the amount of waste water is large, the river will suffer from serious hypoxia, anaerobic corruption and odorous smell, and aquatic animals may suffocate and die, thus posing a threat to human living environment. [1]

2. Physical processing technique

2.1. Adsorption method

Due to micro starch wastewater containing cellulose and starch granules, and cellulose is composed of many linear fiber molecules, there are so many hydroxyl groups, the hydroxyl groups can form many hydrogen bonds, the cellulose molecules depend on the hydrogen bond between each other cementation of bundles, micellar directional arrangement again into a mesh structure, easy to be adsorption material.[2] Chen Xia etc.[3] Activated carbon adsorption method was used to treat potato starch wastewater with low concentration. When the particle size of activated carbon was 40 mesh, the
dosage was 5g, the adsorption time was 1h, and the wastewater temperature was 27℃. When pH was 5, the adsorption efficiency of activated carbon on potato starch wastewater was up to 48%.

2.2. Air flotation separation
The air flotation method USES the water dissolved in a large number of gases (dissolved air water) as the working liquid under high pressure to release numerous tiny bubbles after sudden decompression. The floculants in the wastewater adhere to it, making the apparent specific gravity of floculants much smaller than the actual specific gravity. With the rise of bubbles, the floculants float to the liquid surface to achieve the goal of liquid-solid separation. Air flotation treatment of wastewater has the advantages of short separation time, simple device, large treatment capacity, high enrichment ratio, easy to realize continuous and automatic.[1,2,4]Animal husbandry JianBo etc.[5]The wastewater from a starch factory in hubei province was studied by using an integrated air flotation device. Through experiments, the effects of floculant, air flotation agent and various operating parameters on the treatment effect were analyzed, and the optimal operating conditions were obtained when the feeding position was 70cm, the air intake was 120L/h, the feeding volume was 100mL/min, and the liquid level was 127cm.

3. Physical and chemical processing technology

3.1. Inorganic flocculation and precipitation treatment
Inorganic polymer floculants are mainly polyaluminum and polyiron. Polyaluminum has the advantages of low dosage, fast sedimentation rate, particle compactness and good effect in addition to turbidity, while polyiron has the advantages mentioned above, but also has the characteristics of low price and wide range of application of pH.[6]Tongyong Deng[7]The flocculation property of polyferric zinc silicate was studied. The potato starch wastewater with high COD was treated by polyferric zinc silicate. The results showed that COD in the starch wastewater decreased from 5642 mg/L to 733 mg/L, with the removal rate reaching 87%, and SS decreased from 1270 mg/L to 76 mg/L, with the removal rate reaching 94%, greatly reducing the pollution of potato starch wastewater to the surface water around the garden. The precipitation generated can be used as fertilizer.

3.2. Organic flocculation and sedimentation
Organic floculants can be generally divided into synthetic organic polymer floculants and natural polymer floculants. This kind of floculant is mainly used to form large and dense floc by adsorption bridging, with good settlement performance and short treatment time. It has been widely used in starch wastewater treatment in recent years.[8]Chaoqing Cen[9]The flocculation of cassava starch wastewater was studied by experiments. First, neutralize with lime milk, and then use imported polymer floculant n-op, 650BC, AN floculation, CODCr. The removal rate was 60% ~ 99.3%, the total solid removal rate was 45% ~ 66.8%. The optimal floculation pH value is 7.0 ~ 8.5, the amount of quicklime is 0.25 ~ 0.5 kg/t(waste water), and the total pharmaceutical cost is less than 0.3 yuan /t(waste water), the content of floculation subsidence is about 92%, easy to dehydrate and separate, can be used for cassava starch wastewater pretreatment.

3.3. Microbial flocculant treatment
Microbial floculant does not exist secondary pollution, harmless to human and livestock, has good floculation effect, sediment can also be used as protein feed, etc.[10, 11]Hui Liu etc.[12], the use of microbial floculant (MB7F) on starch wastewater has a good turbidity removal effect, and has the characteristics of safe and non-toxic, no secondary pollution, good floculation effect, and MB7F has a good thermal stability, little influence by temperature. The optimal technological parameter of MBF7 floculation reaction was: add CaCl with a mass fraction of 5mL to 1L wastewater of 10%, 20mL MBF7, pH is 9, and 600, 400, 140, 70 and 30 r/min stirring 20s, 20s, 20s, 2 min and 3min respectively, the turbidity removal rate is stable above 90%.
4. Biological processing technology

4.1. Anaerobic biological treatment
Anaerobic biological treatment method refers to the decomposition of various complex organic matters in starch wastewater into CH through the action of anaerobic microorganisms under the condition of no molecular oxygen and CO2 and so on the material process, simultaneously synthesizes the partial organic matter the bacterial cell body, through the gas, the liquid, the solid separation, causes the sewage to get the purification. Because the anaerobic treatment process has low energy consumption and low sludge yield, it can recover energy while degrading pollutants, so it has become one of the widely used technologies in starch wastewater treatment. Tianhua Xu et al. [13] The starch wastewater was treated by UASB anaerobic reactor. Treatment of high concentration p (COD) wastewater with value of 6000mg/L ~ 6800 mg/L can make its treatment efficiency reach more than 85% under the condition of 33 ~ 37℃. UASB anaerobic reactor treatment does not require human oxygen supply, with low investment, low energy consumption and power consumption, and low operating costs. In addition, the methane generated by anaerobic treatment can be recycled, energy saving and environmental protection.

4.2. Aerobic biological treatment
Compared with anaerobic biological method, aerobic biological treatment method has the advantages of strong treatment capacity, good effluent quality and less land use, so it is widely used in various countries. Xin-kai liao et al. [14], SBR was used to treat simulated starch wastewater. For the wastewater with starch concentration < 1.0g/L and COD < 1115mg/L, a good removal effect can be obtained by using the complete aeration SBR method alone. When the starch concentration increases, the hypoxia stage needs to be set to promote the hydrolysis and acidification of the starch into small molecular organic compounds, so as to reduce the inhibition effect of the excessive starch concentration on microorganisms, but on CODcr. The removal effect is not obvious, the aeration reaction to CODcr Removal plays a leading role.

5. Anaerobic - aerobic combination treatment technology

5.1. UASB anaerobic reactor + activated sludge process
Wu Miao [15] The treatment process of "UASB reactor + activated sludge aeration tank + contact oxidation tank" was adopted. The UASB reactor in the sewage treatment facility is the core of the whole treatment process, and the aerobic process is only used as the post-treatment process of the anaerobic process. The effluent of the anaerobic tank degrades more than 90% of the organic dyes, and then the aerobic process is used as the post-treatment, further degradation, and finally reaches the effluent standard. When the great. [16] The anaerobic UASB+ aerobic CASS process was added on the basis of the original treatment process in the starch factory to improve the process flow and make the effluent reach the standard. UASB process has a wide range of applications, low energy consumption, high load, and small amount of residual sludge. Anaerobic activated sludge can be stored for a long time, and can be quickly started after stopping operation for a period of time. CASS process does not need a pre-denitrification system, which can recycle nitrate nitrogen from the nitrification zone to the denitrification zone, so the internal circulation system can be eliminated. Moreover, in CASS system, there is no need to set a separate anoxic operation stage for denitrification. This process has the advantages of good water quality, small land area, low investment and good economic benefit. S. Villaverde, etc [17] UASB anaerobic reactor and SBR process were used to remove the waste water of potato starch factory. Suitable for high concentration wastewater with nitrogen content <700mg TKN/L, and organic matter <2000mgCOD/L. The total nitrogen removal rate was 79%. The hydraulic residence time (HRT), solid state residence time (SRT) and aeration rate controlling the removal of organic matter and total nitrogen were 40h, 17d and 6/12min, respectively.
5.2. EGSB anaerobic reactor + activated sludge process
Xu Fakai[18] The process of treating corn starch wastewater with expanded granular sludge bed (EGSB) and activated sludge was introduced. Expanded granular sludge bed (EGSB) has high inlet load, strong impact resistance, high removal efficiency for high concentration organic wastewater, which can be widely used in the treatment of high concentration organic wastewater. The root causes[19] High concentration wheat starch wastewater was treated by EGSB anaerobic reactor and A/O activated sludge process. In the medium temperature condition, the whole sewage treatment process to the wastewater COD, BOD5 and SS removal rate reached 98.7%, 99.2% and 94.3% respectively, and the effluent quality met local discharge requirements. Deng Yunzhi[20] The starch wastewater and COD in wastewater were treated by anaerobic expanding granular sludge bed (EGSB-CASS) Cr, BOD5 And SS removal rate reached 99.6%, 99.7% and 97.7% respectively. Intermittent pulse feeding mode was adopted during the initiation of EGSB reaction. On the one hand, the inflow mode increases the rate of rising flow in the reaction zone and improves the mass transfer efficiency. On the other hand, the uniform distribution of organic load enhances the stability of the system.

5.3. IC anaerobic reactor + activated sludge process
Yongdeng Chen [21], the original UASB reactor was replaced by an efficient anaerobic IC reactor, and the original UASB reactor was transformed into A/O reactor. Meanwhile, MBR reactor was added to meet the effluent standard after the transformation. IC and UASB reactor overflow weirs need to be cleaned regularly, but the cleaning surface of IC reactor is only 10% of that of UASB, and the inlet distributor of IC does not need special cleaning. In IC reactor, the water distribution device is in the bottom of a small area on the use of large diameter pipe special cloth, so it won't cause blockage, at the same time the IC should be allowed in the high rise velocity and solid impurity can be rushed out of the reactor and not stay inside the reactor and accumulation, so that the IC reactor long running stability is guaranteed. Li ping etc.[22], using anaerobic (IC reactor)+ aerobic combined treatment of starch production wastewater. The COD removal rate >82% in the wastewater treatment of the amylase factory and the COD comprehensive removal rate >94% in the system can meet the requirements of wastewater discharge.

6. Conclusion and prospect
Starch wastewater has the characteristics of high concentration and non-toxicity. Biochemical method and flocculation and sedimentation method are the most widely used methods for treatment of starch wastewater. The type, dosage and sedimentation time of coagulant were studied to improve the treatment effect of wastewater. We will vigorously develop clean production, resource reuse and circular economy, continue to study the recovery of useful substances in starch wastewater, and choose the combined technology of wastewater treatment and resource utilization. For example, using coagulant to recycle suspended matter in wastewater to produce protein feed. At present, most of the domestic use of "anaerobic-aerobic" biochemical method. While degrading pollutants, the anaerobic biological treatment process can also produce recycled energy methane gas. However, this process has a high investment cost, covers a large area, and is easily affected by the environment. Moreover, for amylase factories with small production scale, methane gas has no recycling value, so this process still needs to be studied and developed.

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