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New Progress in Dairy Wastewater Treatment Technology

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Abstract: Due to the development of modern life, people's demand for dairy products continues to increase. With the continuous increase of dairy production, dairy wastewater is also increasing. Therefore, the treatment of dairy wastewater is an important part of wastewater treatment. The commonly used processes of dairy wastewater mainly include physicochemical and biochemical methods, as well as the combination of physicochemical and biochemical methods. Membrane technology and coagulation sedimentation hydrolytic acidification CASS process are two relatively new processes, which have many advantages, so they are widely used.

1. Introduction

According to the characteristics of dairy wastewater, the industry has invented many dairy wastewater treatment processes. There are two main types of commonly used processes. First, materialization. The wastewater is treated by filtration, sedimentation, air flotation and other methods, especially the use of enhanced physicochemical treatment technology with flocculant and coagulant aid. Its advantages are: less investment, small floor area, simple operation, not affected by climate change, etc; The disadvantages are: high operating costs, unable to stably meet the emission standards. The second is biochemical method. Hydrolysis acidification aerobic biochemistry or anaerobic aerobic biochemistry combined process is a relatively mature method and technology at present. It uses different microbial population metabolism to degrade cod, BOD and other organic substances in wastewater, so as to achieve the purpose of purifying wastewater. Biochemical treatment technology has the advantages of good treatment effect, stable effluent and less sludge. However, due to the high content of biochemical treatment technology, strict operation requirements, and the great impact of climate change, the operation effect of some biochemical treatment facilities is not satisfactory [1]. This paper mainly analyzes the new progress of dairy wastewater treatment technology.

2. Water quality and quantity characteristics of dairy wastewater

Dairy waste water refers to the production waste water generated from the processing and production of dairy products with milk as raw material, the domestic waste water in the factory and the drainage of milk contact equipment cleaning [2]. Dairy wastewater is milky white, belonging to medium and high concentration wastewater, which mainly contains a large number of soluble

organic substances, including sugars, starch, protein and fatty acids. Dairy wastewater has good biodegradability, and does not contain toxic and harmful substances, nor large particle suspended substances.

There are two sources of dairy wastewater. The first aspect is the waste water discharged from the equipment in dairy production, which mainly comes from the cleaning water of containers and equipment, and its main components contain dairy raw materials [3]. The second aspect is the wastewater produced in the process of dairy production and processing. However, there are other sources, such as dumped milk and expired dairy products, which are generally not treated separately because of their small base, but are treated uniformly through the wastewater treatment plant.

As the main source of dairy wastewater, washing wastewater is high concentration organic wastewater, and its main substances are milk, acidic or alkaline detergent [4]. In factories, washing wastewater is generally not discharged throughout the day, but once or twice a day at a relatively fixed time. Statistics show that in the processing and production of dairy products, the loss of fresh milk is usually 1% to 3%, which is one of the main milk sources causing dairy wastewater.

Dairy wastewater is generally high concentration organic wastewater. Due to the high content of organic matter in its wastewater, it contains more organic pollutants, mainly casein, lactose and milk fat. However, these pollutants have good biodegradability, that is, the organic matter in dairy wastewater is easy to be decomposed by microorganisms, so dairy wastewater belongs to wastewater with high biodegradability.

At first, dairy wastewater is milky yellow alkaline wastewater. After storage for a period of time, due to fermentation, its wastewater will be acidic and produce a large number of milky white scum. Dairy wastewater is particularly easy to ferment. Once directly discharged, it will make the water body receiving drainage eutrophic. One of the major problems of eutrophication is that it will cause a large number of algae to multiply, cause a large consumption of dissolved oxygen in the water, make it difficult for aquatic organisms to survive, and cause the deterioration of water quality. Therefore, dairy wastewater must be treated before discharge.

Generally, the water volume of dairy wastewater changes greatly. The reason is that the amount of dairy products lost in the production of dairy factories every day is constantly fluctuating, resulting in the continuous fluctuation of its water volume, in which the indicators of various organic pollutants are constantly changing.

3. Basis and principle of dairy wastewater treatment

Dairy wastewater treatment is mainly based on the current national design specifications and standards. Specifically, they are: class I discharge standard of the integrated wastewater discharge standard (GB8978-96), code for design of building water supply and drainage (GBJ15-88), code for design of outdoor drainage (gb50014-2006), code for structural design of water supply and drainage engineering (GB50069-2002), code for design of building foundation (GB50007-2002), hygienic standard for design of industrial enterprises (GBZ1-2002) Design standard for auxiliary buildings and auxiliary equipment of urban sewage treatment plant (cjj31-89), emission standard of odor pollutants (gb1455-1993), code for design of pumping stations (gb/t50265-97), code for construction and acceptance of water supply and drainage pipeline engineering (gb50268-97), technical code for waterproofing of underground works (gbj140-79), as well as current national (including local) environmental protection laws and regulations, State Planning Commission The Ministry of construction jointly issued the regulations on the administration of engineering survey and design fees, the charging standards for engineering survey and engineering design fees, etc.

According to national standards, the general requirements for water quality after treatment are shown in the table 1:

Table 1: Effluent quality

project	COD_{cr} (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	NH_3—N (mg/l)	PH
Water quality requirements after treatment	≤100	≤20	≤70	≤15	6—9

Dairy wastewater treatment should adhere to the following main principles: implement the basic national policy on environmental protection, and implement the relevant national policies, regulations, norms and standards; According to the characteristics of wastewater, select a reasonable process to achieve reliable technology, convenient operation, easy maintenance and simple process; On the premise of ensuring the treatment effect, try to reduce the floor area, reduce infrastructure investment and daily operation costs, and the main treatment facilities are built underground, which will not affect the beautification and greening of the plant; Waste water treatment equipment should be energy-saving and high-quality products with reliable performance, stable operation and high degree of automation to ensure project quality and investment benefits; In the design, the prevention and control of secondary pollution shall be fully considered, the equipment shall be corrosion-resistant, and the noise shall meet the standard, so as not to affect the surrounding environment; As an environmental protection project, the waste water treatment station is designed to minimize the negative impact of the waste water treatment station itself on the environment, such as odor, noise, solid waste, etc; he architectural style and color of relevant civil works are coordinated with the surrounding environment, and the appearance design strives to be novel and beautiful.

4. Two new processes for dairy wastewater treatment

As mentioned at the beginning of this article, the commonly used processes for dairy wastewater treatment mainly include physicochemical method and biochemical method. In view of the shortcomings of physicochemical method and biochemical method, the combination of the two methods has better treatment effect, so it has been widely used. Here are two relatively new processes.

4.1 membrane technology

Due to the development of membrane technology, there are many membrane technologies used in dairy wastewater treatment, such as reverse osmosis membrane technology, ultrafiltration, microfiltration and so on. Filtration through reverse osmosis membrane technology can effectively treat dairy wastewater, and then through other membrane technologies in the pretreatment process to achieve the effect of removing pollutants [5]. Because these membrane technologies can intercept a large amount of organic matter and target the wastewater with high organic content, membrane technology is widely used in dairy wastewater treatment.

There are mainly the following processes for the treatment of dairy wastewater by membrane technology: first, pretreatment, that is, chemical or biological flocculation, to remove the membrane pore blockage or pollutants in the visible wastewater. Second, microfiltration [6]. It is a pressure driven membrane filtration technology, which is used to remove micron sized particles in water treatment. Its role is to control molecules, usually using cell collection method, bacterial removal, etc. Third, ultrafiltration. For the purpose of separating macromolecules and small molecules, it mainly deals with lactose and soluble salts in wastewater, thereby reducing the nutrients and cobalt content in wastewater. Fourth, nanofiltration. It is a pressure driven membrane separation process

between reverse osmosis and ultrafiltration [7]. The pore size of nanofiltration membrane is about several nanometers. Nanofiltration is used to separate substances with relatively small molecular weight, such as inorganic salts or small molecular organics such as glucose and sucrose, from the solvent. By allowing some inorganic salts and some solvents to penetrate the membrane, the separation effect can be achieved.

Because dairy wastewater has good biodegradability, the organic matter in dairy products is easy to be decomposed by microorganisms; Because the biofilm process has large microbial biomass and strong adaptability to the changes of water quality and quantity, it is suitable for the characteristics of large changes in the quantity and quality of dairy wastewater, so it can be used to treat dairy wastewater. Through the treatment of biofilm, the content of organic pollutants in dairy wastewater can be greatly reduced, which can meet the requirements of dairy wastewater treatment. Moreover, denitrification treatment can be added to biofilm technology, through which nitrobacteria and nitrifying bacteria can also treat the nitrogen in dairy wastewater, preventing the problem that dairy wastewater is very easy to cause water eutrophication, and reducing its pollution damage to a very low level. At the same time, membrane technology can not only ensure purification and treatment, but also recover useful substances from wastewater [8]. It also has the advantages of high efficiency, energy saving, simple equipment, convenient operation, environmental protection and so on. Therefore, biofilm process is a more suitable process for dairy treatment.

But at the same time, there are also membrane pollution and high cost. Because dairy wastewater often contains acid, alkali, oil and other substances, and the conditions are relatively poor, in order to maintain good separation performance and long service life under harsh conditions, the wastewater treatment membrane must have good material properties. From this point of view, it is of great strategic significance to develop a filter membrane with excellent antifouling performance.

4.2 CASS Process

CASS process is internationally recognized as an advanced process for domestic sewage and industrial wastewater treatment. Cass biological treatment is the abbreviation of cyclic activated sludge process, which was first produced in the United States and introduced into China in the early 1990s. The main principle of this method is: on the basis of sequencing batch activated sludge process (SBR), the reaction tank is designed into two parts along the length direction. A biological selection area (also known as pre reaction area) is set in the front, and the rear is the main reaction area. A lifting automatic skimming device is installed at the rear of the main reaction area. Aeration, sedimentation and drainage are cycled in the same tank periodically, eliminating the secondary sedimentation tank of conventional activated sludge process. COD removal rate is more than 90%, BOD removal rate is 95%, and good phosphorus and nitrogen removal effect is achieved.

Each operation cycle of CASS process consists of the following four stages: the first is the aeration stage. Oxygen is supplied to the reaction tank by the aeration system [9]. At this time, organic pollutants are oxidized and decomposed by microorganisms. At the same time, NH3-N in the wastewater is transformed into NO3-N through microbial nitrification. The second is the precipitation stage. At this time, stop aeration, and microorganisms use the remaining do in the water for oxidative decomposition. The reaction tank gradually transforms from aerobic state to anoxic state and begins denitrification reaction. The sludge gradually settles to the bottom of the tank, and the upper water becomes clear [10]. The third is the decanting stage. After sedimentation, the decanter placed at the end of the reaction tank starts to work, and the supernatant is discharged layer by layer from top to bottom. At this time, the reaction tank continues nitrification. Fourth, idle stage. That is, the decanter rises to its original position.

In order to maintain the appropriate sludge concentration, the system removes the corresponding

amount of excess sludge according to the amount of sludge generated. The discharged excess sludge is generally carried out after the end of the sedimentation stage.

Compared with traditional activated sludge process, CASS process has the following advantages:

First, the process flow is short, the floor area is small, and the construction cost is low. The primary sedimentation tank, secondary sedimentation tank and other structures are omitted. Compared with the traditional activated sludge process, the land occupation is reduced by 30% and the investment is saved by 20% - 40%.

Second, it saves operating costs. As the aeration is periodic, the concentration of dissolved oxygen in the tank also changes, and the dissolved oxygen decreases in the sedimentation stage and drainage stage. When the aeration is restarted, the concentration gradient of oxygen is large, the transmission efficiency is high, the energy-saving effect is remarkable, and the operation cost can be saved by 10-25%.

Third, the organic matter removal rate is high, and the effluent quality is good. For general biological treatment process, it is difficult to achieve such good water quality. Therefore, the investment in CASS process and secondary treatment can reach the water quality of tertiary treatment. The drainage is completed by the lifting weir decanter. With the gradual decline of the water surface, the treated clean water is discharged evenly, which minimizes the disturbance of the water flow to the bottom sediment sludge during drainage.

Fourth, it has strong impact load resistance and flexible operation. The influence of flow change has been considered in the design of CASS system, which can ensure that the wastewater stays in the system for a predetermined treatment time before being precipitated and discharged. In particular, CASS process can adapt to the change of inflow and water quality by adjusting the operation cycle. Although the traditional treatment process has been equipped with auxiliary flow balance adjustment facilities, it is also likely to cause activated sludge loss due to changes in hydraulic load, which will seriously affect the drainage quality.

Sixth, simple management and reliable operation. The type and quantity of equipment in the wastewater treatment plant are less, the control system is relatively simple, and the process itself determines that sludge bulking will not occur. Therefore, the system management is simple and reliable.

Seventh, low sludge production and stable sludge properties; It has the function of nitrogen and phosphorus removal; No odor.

5. Conclusion

At present, membrane technology and coagulation sedimentation hydrolytic acidification CASS process are two relatively new processes, which have many advantages and can basically meet the requirements of wastewater treatment. But at the same time, due to the complexity of dairy wastewater, any single technology is often not enough. In order to achieve the desired effect, we must pay attention to the integration technology of membrane technology and CASS process with other water treatment technologies, and use effective combined treatment methods. Moreover, due to the development of living standards in the future, the requirements of dairy wastewater treatment will only be high but not low. Therefore, the dairy wastewater treatment process can also be improved to minimize the treatment investment, achieve high efficiency and low energy, reduce the generation of pollution, and reduce the load of wastewater treatment plants.

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