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USE OF HIGHER CONCENTRATION OF ACTIVE SLUDGE ORGANISMS FOR INTENSIFYING DAIRIES' WASTEWATER TREATMENT PROCESS

O. Semenova, N. Bublienko, J. Smirnova, T. Tkachenko
National University for Food Technologies
L. Reshetnyak
National Aviation University

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Corresponding author:

E-mail:
npnuht@ukr.net

ABSTRACT

The ecological state of food industry enterprises, namely the dairy plants, has been analyzed. The concentrated wastewater is proved to carry substantial risk for water bodies. The effectiveness of the integrated anaerobic-aerobic technology to treat wastewater of this category has been confirmed, which includes the process of methane fermentation at the first stage followed by further aerobic treatment in aeration tanks to indicators of sewage pollution upto acceptable values to be discharged into a centralized sewer system of settlements and natural water objects. A method of intensification stage of aerobic fermentation by applying higher concentration of active sludge organisms has been suggested. Separation of sludge-water mixture is carried out by using a separator followed by further separation of active sludge from treated water in the secondary clarifier. The introduction of the studied ways of aerobic fermentation intensification allows substantially accelerating the treatment process, and reducing the working sizes of the aeration tank.

ВИКОРИСТАННЯ ПІДВИЩЕНОЇ КОНЦЕНТРАЦІЇ ОРГАНІЗМІВ АКТИВНОГО МУЛУ З МЕТОЮ ІНТЕНСИФІКАЦІЇ ПРОЦЕСУ ОЧИЩЕННЯ СТІЧНИХ ВОД МОЛОКОЗАВОДІВ

О.І. Семенова, Н.А. Бублієнко, Є.С. Смірнова, Т.Л. Ткаченко
Національний університет харчових технологій
Л.Р. Решетняк
Національний авіаційний університет

Проаналізовано екологічний стан підприємств харчової промисловості, зокрема, молокопереробної галузі. Встановлено, що концентровані стічні води чинять значну небезпеку на водні об'єкти. Підтверджено ефективність застосування комплексної анаеробно-аеробної технології для очищення стічних вод даної категорії. Запропоновано спосіб інтенсифікації стадії аеробної ферментації шляхом застосування підвищеної концентрації організмів активного мулу. Розділення муловодяної суміші здійснюється за допомогою сепаратора з подальшим відокремленням активного мулу від очищеної води у

вторинному відстійнику. Впровадження дослідженого способу інтенсифікації аеробної ферментації дозволяє значно прискорити процес очищення та зменшує робочі розміри аеротенку.

***Ключові слова**: концентровані стічні води, аеробна ферментація, хімічне споживання кисню, культуральна рідина, сепаратор.*

Food production technology suggests at each enterprise the formation of some wastes that differ in quantity, indicators of pollution, the state of aggregation, etc.

Wastewater of some food industries due to pollution is related to concentrate. It contains substantial amounts of organic matter that get into them during processing of raw materials.

The most contaminated wastewater is of alcohol, meat, dairy and sugar industry. Since these companies are mainly in urban areas, wastewater of some of them is discharged into a centralized sewer. However, the analysis of ecological situation of settlements shows that municipal treatment plants are not working effectively. In addition, wastewater of most of food companies does not meet the requirements of their discharge into the sewer by contaminants concentration. So, the discharge of wastewater into sewers is substantial violation of rules and regulations.

The problem of wastewater sewage has not been solved yet at any field of food industry.

For many years food industry has tried to solve the problem of wastewater treatment. Meanwhile, the construction of wastewater treatment facilities took place on the basis of conventional biological treatment technology used for the disposal of sewage. However, this technology is not suitable for concentrated polluted wastewater purification.

To solve the problem of concentrated wastewater treatment the anaerobic-aerobic treatment technology was proposed [1 – 2].

The main point of it is that the concentration of contaminants initially is sharply reduced by methane fermentation, followed by the purification method of aerobic fermentation in the aeration tanks.

Implementation of methane fermentation affected the search of new, alternative energy sources. Methane fermentation is of great importance for biogas, which is a cheap and promising energy source.

Liquid and solid wastes of almost of all food enterprises can be converted into biogas [3].

Assortment list of dairy industry companies can be safely regarded as one of the most diverse. Up-to-date powerful, competitative dairy has 60-80 items of finished products — from traditional milk and yogurt to curd desserts and butter. Dairy plants, such as, for example, Ltd. «Lubensky dairy plant», produce more than 200 kinds of products, including Rennet, solid, sausage and melted cheeses, as well as ice cream. Therefore it is quite clear that the range of dairy products and technologies of its production involves the formation some waste at each plant which differs in terms of pollution indicators: chemical oxygen demand (COD) — 1000 ÷ ÷ 5000 mg O_2/dm^3; biochemical oxygen demand (BOD) — 700 ÷ 3700 mg O_2/dm^3; total nitrogen content — 20 ÷ 170 mg/dm^3; pH — 4.5 ... 10.4.

Aerobic stage of wastewater treatment at dairies is an integral technology component to neutralize contaminants.

One of the ways to intensify the process of aerobic fermentation is the use of higher concentration of active sludge organisms.

Studies were conducted on the wastewater, the concentration of pollutants for which the COD was 900 mg O_2/dm^3, was achieved after methane fermentation. And it also may be typical for those dairy enterprises that specialize in producing only drinking kinds of milk.

Two series of experiments — using conventional active sludge concentration — 10.0 g/dm^3 and higher concentration of silt — 30.0 g/dm^3 — were conducted simultaneously. This in terms of dry weight constituted 5.0 and 15.0 g/dm^3 correspondently.

In both series of experiments aeration of various duration took place: 4, 8, 12, 16, 20 and 24 hours. After each period of aeration the value of COD was determined. The experimental results are shown in Fig. 1.

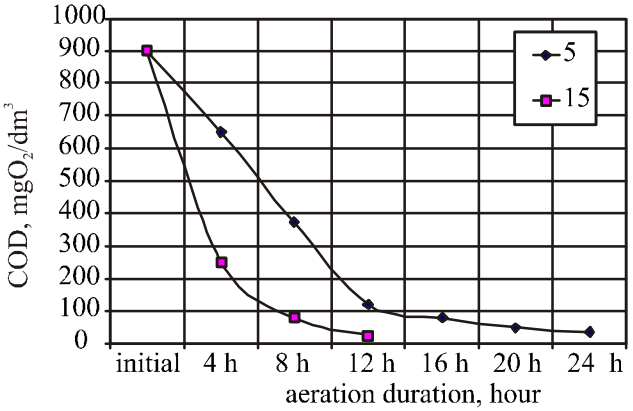

Fig. 1. Effect of active sludge concentration to replace COD during aerobic wastewater treatment

Under the higher concentration of active sludge (15.0 g/dm^3) in production conditions, in our opinion, the 8-hour aeration would be sufficient for the complete pollution elimination at their such relatively low (900 mg O_2/dm^3) original content.

In laboratory conditions, they had to need 12 hours, during which the concentration of contaminants for COD decreased upto 25 mg O_2/dm^3 that corresponds to BOD within 12 – 13 mg O_2/dm^3 i.e. purification of wastewater by standards is achieved that allows to discharge wastewater into natural water bodies. In addition it should be noted that if a food industry plant (dairy) is situated within a settlement, equipped with its own set of facilities for sewage treatment, primarily household, the duration of aeration can be reduced upto 4 hours, because according to the «Rules of discharging of enterprises wastewater into communal and departmental sanitations of towns and villages of Ukraine» wastewater with pollution index for COD at 300 mg O_2/dm^3, can be routed to centralized sewage treatment plants [4].

Practical implementation of higher concentration of active sludge is problematic because it can lead to disruption of the secondary clarifier.

Theoretically, there are two ways to solve this problem:

1) separation of active sludge from treated water through a separator and rotating it into the aeration tanks. In this case, the need to use the secondary clarifier disappears at all;

2) partial separation from active sludge-water mixture through a separator, followed by further separation of culture fluid in traditional secondary clarifiers using gravitational forces within a standard two-hour period.

It's determined empirically: the separation of sludge-water mixture to the content of suspended solids (sludge) upto 15 – 20 mg/dm^3, i.e., the necessary standards one requires the separator with the number of revolutions over 3000 per minute, with duration of separation — 15 minutes.

Experimental verification showed that raising in the concentration of suspended solids (sludge) leads to increase of separation duration. First the precipitate of large flakes of silt occurs followed by fine particles that deposit hard under the influence of centrifugal force.

Using higher sludge concentration in the aeration tanks (15 g/dm^3) for separation of silt mixture the separator with a frequency of 600 rev per min^{-1}, should be used which will run 4.6 minutes. During this operation incomplete separation of culture fluid will occur and detained suspended matter will come back into the aeration tanks to maintain constant sludge concentration, which should ensure a smooth process of wastewater treatment.

Sludge remaining in the culture fluid after separation (its concentration is up to 5 g/dm^3) will precipitate naturally for two hours in the clarifier, some excess sludge is removed from the system and after partial dehydration can be used as a fertilizer or feed supplement for cattle .

Conclusions

The proposed intensified technology of wastewater treatment in this category (COD contamination index is about 900 mg O_2/dm^3) by aerobic fermentation method allows to accelerate the oxidation process of wastewater pollutants from 24 to 12 hours. Separating of culture fluid is used by a separator with the frequency of revolutions 600 min^{-1}, the period of work is 4 – 6 minutes. During this time, such an active sludge concentration in sludge-water mixture will be received that can be separated from the treated water by a process of mechanical precipitate of silt particles in the secondary clarifying tank. The introduction of the studied method of aerobic fermentation intensification can substantially reduce the working sizes of aeration tanks.

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ИСПОЛЬЗОВАНИЕ ПОВЫШЕННОЙ КОНЦЕНТРАЦИИ ОРГАНИЗМОВ АКТИВНОГО ИЛА С ЦЕЛЬЮ ИНТЕНСИФИКАЦИИ ПРОЦЕССА ОЧИСТКИ СТОЧНЫХ ВОД МОЛОКОЗАВОДОВ

Е.И. Семенова, Н.А. Бублиенко, Е.С. Смирнова, Т.Л. Ткаченко
Национальный университет пищевых технологий
Л.Р. Решетняк
Национальный авиационный университет

Проанализировано экологическое состояние предприятий пищевой промышленности, в частности, молокоперерабатывающей отрасли. Установлено, что концентрированные сточные воды несут значительную опасность для водных объектов. Подтверждена эффективность применения комплексной анаэробно-аэробной технологии для очистки сточных вод данной категории, которая включает в себя процесс метанового брожения на первой стадии и дальнейшую аэробную доочистку в аэротенках до показателей загрязненности сточных вод до значений допустимых для скидывания в централизованные канализационные системы населенных пунктов и природные водные объекты. Предложен способ интенсификации стадии аэробной ферментации путем применения повышенной концентрации организмов активного ила. Разделение иловодяной смеси осуществляется с помощью сепаратора с последующим отделением активного ила от очищенной воды во вторичном отстойнике. Внедрение исследованного способа интенсификации аэробной ферментации позволяет значительно ускорить процесс очистки и уменьшить рабочие размеры аэротенка.

***Ключевые слова**: концентрированные сточные воды, аэробная ферментация, химическое потребление кислорода, культуральная жидкость, сепаратор.*