Treatment of canned fish factory wastewater by upflow anaerobic sludge blanket (uasb) reactors

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Abstract

Application of UASB method for wastewater treatment of canned fish factory reduces the costs of pre-treatments processes such as neutralization, and also reduced the costs of final aeration process. In this study, an UASB reactor which was equipped with a 3-phase separator system has been used. At first, a complex of anaerobic digester sludge and return sludge of activated sludge was added to reactor with ratio of 25 to 15. Then, the wastewater of factory entered into the reactor with inlet Organic Loading Rate (OLR) of 0.5 kg/m³.day which was increased gradually up to 4 kg/m³.day. Then, sampling was done for various tests during 75 days. The results of this study showed that UASB method neutralized and reduced the pH of the inlet wastewater from 10.5 to 7.3; and also reduced the SS of the inlet wastewater from 43 gr/l to 8 gr/l. the COD removal rate of this method was around 87%.

Keywords: canned fish wastewater, anaerobic treatment, UASB, COD, OLR.

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1. Introduction

In under developing societies, around 75 to 80 % of water consumption will become wastewater, which must be rejected from societies. If these wastes are the result of industrial activities, we call it "industrial wastewater". In addition, there are other kinds of wastewater such as urban and agricultural wastewater that threaten human life. The physical and chemical and biological methods which are divided into two categories of aerobic and anaerobic are among the wastewater treatment methods. Because of ability for treatment of highly contaminated wastewater (such as industrial wastewater) and lower costs, the anaerobic methods are widely applicable for treatment of industrial wastewater. UASB anaerobic systems have a special place among the anaerobic treatment methods.

UASB reactor is a kind of anaerobic biological treatment method that has been invented for the first time by Lettinga in the Netherlands in 1979 and after that, it was widely used for the treatment of different kinds of wastewater, especially industrial one (such as food and paper industries) (Forster, 1999; Patil, Kulkarni & Kore, 2012). The especial design of UASB reactor allowing the separation of three phase of solid, liquid and gas, inside of a reactor, which will increase the capabilities of the system (Gahngrekar, Aslekar & Josh, 2006; Aina, Kpondjo & Adounkpe, 2012).

By considering the mentioned characteristics of the UASB systems, we defined a project to apply this method in a laboratory research for treatment of canned fish factory wastewater. In this study, we investigated the ability of UASB reactor for primary treatment and removal of organic compounds from canned fish factory wastewater.

2. Material and methods

The UASB reactor used in this study was designed and created in accordance to previous studies and integrating of the available information in this field. Total volume of the reactor is about 117 L and it was equipped with a 3-phase (solid-liquid-gas) separator system. The cylindrical reactor was made of P.V.C material and placed on a steel base. The height of the reactor from entrance point to the highest point was equals to 254cm and internal diameter was equals to 24cm. sampling valves placed in 5 proper points on the body of the reactor for monitoring and quality control of sludge inside of the reactor. Also for sampling from inlet wastewater into reactor and outlet swage, some proper places installed on inlet and outlet path toward the reactor. This study was performed on mesophilic conditions (mean temperature between 30-35°C) in order to reach better performance and achieving higher efficiency. The Coarse particles settling on the upper part of the entrance, but remaining suspended because of upward flow of fluid inside of the reactor. On the upper part of this zone, which is under the 3-phase separation zone, settling will occur as a result of collision and sticking of sludge particles together and forming of heavier flocks. Low height of this zone (lower than 1m) cause to the washing of sludge and smaller granules, which itself leads to adverse operation and performance of the system. on the other side, too much height of settlement zone, will cause additional costs of construction and operation (Vierra & Garcia, 2002; Muthusamy, Murugan & Manothi, 2012) so, in this study, the height of this part of the reactor selected around 170 cm. for monitoring of concentration variations and particles size, 5 sampling valves with same distance equals to 50 cm installed in this zone.

The fluid inside of the reactor after passing through a spillway was discharged from reactor. Inside of the reactor, there was a specific part that designed for collecting of bulbs generated inside of the reactor.

For primary inoculation of reactor, 60 L digester sludge of municipal wastewater treatment and 15 kg cow dung and also 20 L sludge of industrial wastewater treatment were mixed together. For adaptation of bacteria with wastewater and fresh food, diluted wastewater discontinuously added into the reactor during a month, in order to reach to the complete mixing, and with it some Nitrate

and phosphate fertilizer were added into the reactor to supply nitrogen and phosphorous requirements of bacteria. The specifications of the used sludge are presented in Table 1.

Table!1. Specifications of sludge which were used for inoculation of the reactor.

parameter	values
TSS	9800 mg/L
VSS	6200 mg/L
	34

Fig 1. Reduction of SS in the outlet flow of the system

When the growth rate of micro-organism was entered into the new stage and parallel to increase of OLR about 25 days after inoculation! of the reactor, the sludge cloud was largely formed and this issue was continued till the complete filling of the reactor by

very active microorganism in the structures of the granules and increasing of its efficiency. It was observed that 70% of the system efficiency occurs at lower one third of the height of the reactor. So it can be claimed that decrease of COD concentration related directly on the size of the granules.

Fig 3. VSS concentration in the height of the reactor

According to COD removal rate measurement at various heights of the reactor, this result is achieved that there is limitations in increase of reactor height and excess increase is not effective on performance. According to conducted sampling, first granules were observed as small round particles with diameter of about 1 mm at 70-75 days. At the end of this period, larger granules with diameter of about 2-3 mm formed and COD removal rate reached to about 86% which is an acceptable value. Fig (4) and (5) shows the variations of inlet and outlet COD and removal rate of COD during the experiments.

Fig 4. comparison of inlet and outlet COD

Fig 5. COD removal rate during the experiments

4. Conclusion

Duo to the variety of compounds and high load of certain pollutants, the treatment of canned fish factories wastewater must be all-examined and according to the characteristics of different sections of treatment process, the desirable option is selected and used. It means that for an appropriate treatment in accordance with wastewater treatment regulations, a wastewater treatment plant consist of different sections and various contaminants removal efficiencies is required. Application of UASB process in treatment of food industry wastewater reduced the costs of pre-treatment stages such as neutralization and also, reduced the costs of final aeration process. The organic load resistance

of UASB reactors is different for wastewater of various industries. In this study, application of 4.5 kgCOD/m³.day organic load from food industries wastewater had acceptable performance. In this study, COD removal efficiency from food industries wastewater by UASB process was about 86 %. For treatment of cannery industries wastewater, in order to provide sufficient retention time and right upward velocity, at least 2.5 m height must be considered for the reactor. On start up of the process with wastewater as a matter of food, two kinds of granules with relatively different characteristics were observed in the reactor. First group were dull reddish granules with a very pungent odor and low pH which were more at the lower parts of the reactor. The second group was black granules with fewer odors than previous groups of the granules. Environmental pH of this group of bacteria was higher and about 6-7.5. The first groups were acidic granules and second group were methanol bacteria.

Due to the sensitivity of the microbial mass of UASB anaerobic system, and severe reduction of removal efficiency during the fall of temperature, application of mesophilic system for treatment of industrial wastewater at temperate and cold regions is not recommended, because a lot of costs will be needed to heat the system which doesn't justify the application of it. So, in regions with warm climates and mean temperature of at least 25 °C, the system performance will be useful and acceptable. By regarding the same operation conditions, partial destruction of weaker granules during adjustment and feeding by wastewater can be attributed to the presence of complex and hard-degradable and even toxic compounds in the wastewater which affect on the microbial tissue of the system. As compounds of the feed becoming more complex and hard-degradable, formation and durability of the granules in the UASB system will be slower and finally, smaller granules will be formed, in comparison to the system consist of wastewater with easy-degradable compounds. This topic is related to the mass transfer equations. In the case of granules with large diameter, the penetration of complex organic compounds into it will be impaired which finally will lead to the death of bacteria in core of granule and happening of scattering of granules phenomena and significant increase in the outlet and drop of removal efficiency of the system.

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