MATEC Web of Conferences 67, 07036 (2016) DOI: 10.1051/matecconf/20166707036
SMAE 2016

Treatment of Preserved Wastewater with UASB

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Abstract. The preserved wastewater was treated by the upflow anaerobic sludge blanket (UASB) reactor, the effects of the anaerobic time on COD, turbidity, pH, conductivity, SS, absorbance, and decolorization rate of the preserved wastewater were investigated. The results showed that with the increase of the anaerobic time, the treatment effect of the UASB reactor on the preserved wastewater was improved. Under the optimum anaerobic time condition, the COD removal rate, turbidity removal rate, pH, conductivity, SS removal rate, absorbance, and decoloration rate of the wastewater were 49.6%, 38.5%, 5.68, 0.518×10^4, 24%, 0.598, and 32.4%, respectively. Therefore, the UASB reactor can be used as a pretreatment for the preserved wastewater, in order to reduce the difficulty of subsequent aerobic treatment.

1. Introduction

Preserved fruits are the famous leisure food in China with a long history [1]. Using fruit billet, vegetable and white sugar as the main raw materials, the preserved fruits were processed and produced by the impregnation of sugar (honey) or saline, which contain some substances beneficial to human health [2]. However, the wastewater with high concentration resulted from production processed of persevered fruits cannot be ignored.

There are abundant treatment methods for wastewater, such as coagulation sedimentation method [3], reverse osmosis method [4], and adsorption method [5]. And UASB reactor has the advantages of simple structure, no mechanical stirring device, stable operation, convenient management, good treatment effect, low investment, and large-scale application [6]. In recent years, UASB reactor has been attracted an increasing attention from people in the field of treatment of organic wastewater with high or medium concentration [7]. The host of the reactor was empty container without packing, containing a plenty of anaerobic sludge. Due to the stirring effect which resulted from the sewage flows from bottom to top at a certain velocity and a large number of miasmal produced in anaerobic process, the sewage and sludge were fully mixed, and the organic matters were absorbed and disintegrated. Using UASB reactor to dispose wastewater separately, although the treatment effect is good, it is still difficult for the effluent to reach the standard. However, when using the UASB reactor as pretreatment technology, it can not only remove some organic matters and recycle biomass

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sources such as methane, but also reduce the difficulty of subsequent aerobic treatment [8]. Since there are no carriers filled in UASB, thus it is no need to backflushing, avoiding the clogging problem caused by packing. It also can form granular sludge with good settleability, and allows higher speed and larger volume load [9], which is suitable for the pretreatment of preserved wastewater with high concentration.

The preserved wastewater was treated by UASB reactor, the change regulation of COD, turbidity, pH, conductivity, SS, absorbance, and decolorization rate of the preserved wastewater under different anaerobic time conditions were investigated.

2. Materials and Methods

2.1Experimental Materials

The wastewater used in the experiment was collected from a preserved fruit processing factory in Chaozhou, while the digested sludge (concentrated without dehydration) used in the experiment was collected from the dehydration workshop pipeline of the first sewage treatment plant in Chaozhou. The wastewater quality parameters were: COD of 3081.4 mg/L, Turbidity of 110.8 NTU, pH of 3.52, Conductivity of 0.740×10^4 us/cm, SS of 800 mg/L, Absorbance of 0.835, Chroma of 500 times.

2.2Experimental

The digested sludge of 2L was packed into an anaerobic digester, obturating the digestion reaction system, and placed for one day so that the facultative bacteria would consume the oxygen in the UASB reactor. Subsequently, the preserved wastewater of 28L was added in the UASB reactor, stirring the sludge and wastewater evenly with the blender, regulating the pH to 6.5, and the nutrient solutions (sodium glutamate as well as potassium dihydrogen phosphate) were added, which were prepared according to the ratio of COD:N:P=200:5:1. The water quality indexes such as COD, turbidity, and pH were respectively determined in different anaerobic time.

2.3Analysis Methods

The analysis methods of the water samples were shown in Table 1.

TABLE 1 ANALYSIS METHOD

COD (mg/L)	Turbidity (NTU)	Conductivity (us/cm)	pH	SS (mg/L)	Absorbance	Chroma (times)
Potassium dichromate method	Turbidimeter	Conductivity meter	Glass electrod e method	Weight method	Gravimetric method	Dilution multiple method

3. Results and Discussion

3.1Effects of Anaerobic Time on COD and COD Removal Rate of Wastewater

The effects of anaerobic time on the COD and COD removal rate of the preserved wastewater were shown in Fig.1. After treated by the UASB reactor, the COD change of wastewater was large, and the treatment effect of the COD was obvious in the early stage of the anaerobic reaction, while the downward trend became moderation in later period. The COD and COD removal rate of the preserved wastewater were 1600.8 mg/L and 49.6%, respectively after the anaerobic treatment for 60h.

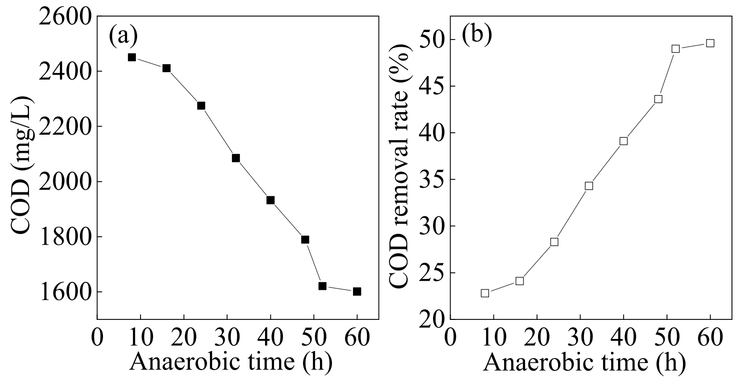

Fig.1 Effect of anaerobic time on COD and COD removal rate of wastewater

3.2Effects of Anaerobic Time on Turbidity and Turbidity Removal Rate of Wastewater

The effects of anaerobic time on the turbidity and turbidity removal rate of the preserved wastewater were shown in Fig.2. The wastewater and sludge were stirred together in the process of anaerobic treatment, and the samples were taken out from the bottom of the UASB reactor, so that the wastewater was mixed with the sludge, leading to turbidity in wastewater. After treated by the UASB reactor, the change of turbidity removal rate was high. The turbidity and turbidity removal rate of the preserved wastewater were 69.3 and 38.5%, respectively after the anaerobic treatment for 60 h.

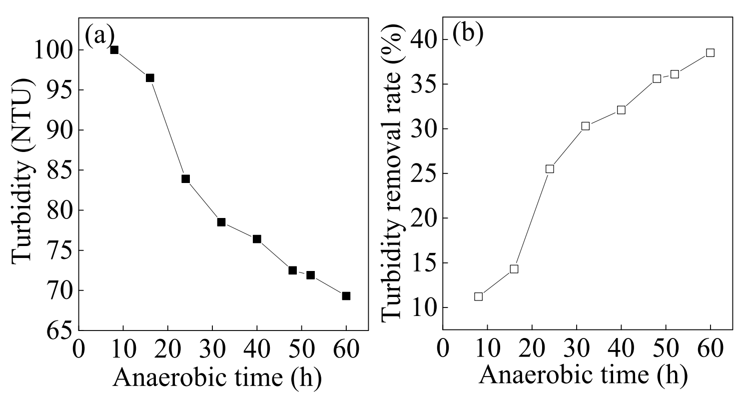

Fig. 2 Effect of anaerobic time on turbidity and turbidity removal rate of wastewater

3.3Effects of Anaerobic Time on pH and Conductivity of Wastewater

The effects of anaerobic time on the pH and conductivity of the preserved wastewater were shown in Fig.3. From Fig.3, the pH decreased with the anaerobic time increased, because it was required to keep pH of the preserved wastewater in the range of 6.5~7.2 in the anaerobic process, so it was needed to regulate the pH constantly in anaerobic process, and the pH reached 5.68 after anaerobic treatment for 60 h. The conductivity was constantly decreased with the increase of the anaerobic time. The change of the conductivity was large before 24 h, while after 24 h, the change of the conductivity was small, showing a ladder type down. The conductivity of of the preserved wastewater was 0.518x10^4 after anaerobic treatment for 60 h.

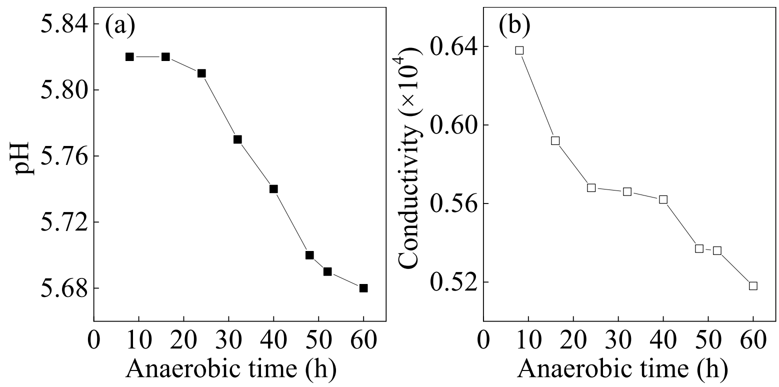

Fig. 3 Effect of anaerobic time on pH and conductivity of wastewater

3.4Effects of Anaerobic Time on SS and SS Removal Rate of Wastewater

The effects of anaerobic time on the SS and SS removal rate of the preserved wastewater were shown in Fig.4. The SS concentration decreased gradually with the increase of aeration time, while the SS removal rate increased gradually. The rangeabilities of the SS and SS removal rate were the largest when the anarobic time was 32~52h. The lowest concentration of SS was 608 mg/L, while the largest removal rate of SS was 24%.

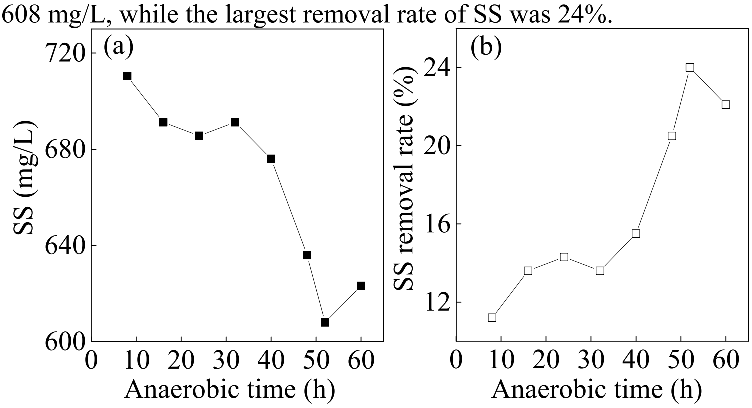

Fig. 4. Effect of anaerobic time on SS and SS removal rate of wastewater

3.5Effects of Anaerobic Time on Absorbance and Decolorization Rate of Wastewater

The effects of anaerobic time on the absorbance and decolorization rate of the preserved wastewater were shown in Fig.4. The absorbance decreased gradually with the increase of aeration time, while the decolorization rate increased gradually. The rangeabilities of the absorbance and decolorization rate were not obvious when the anarobic time was 24~40h. After anaerobic treatment for 40h, the changes of the absorbance and decolorization rate were large. The absorbance and decolorization rate were 0.598 and 32.4%, respectively after anaerobic treatment for 60 h.

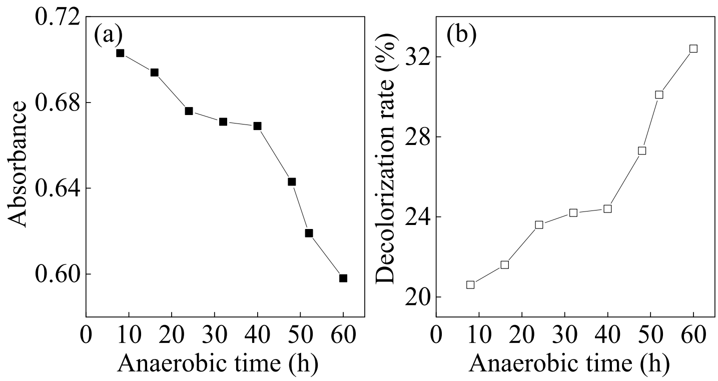

Fig. 5 Effect of anaerobic time on absorbance and turbidity removal rate of wastewater

3.6Effects of Anaerobic Time for Wastewater Treatment

The wastewater quality indicators after UASB treatment were shown in Table 2.

TABLE 2 WATER QUALITY INDICATORS AFTER UASB TREATMENT

Anaerobic time (h)	Absorbance	Decolorization rate (%)	Turbidity (NTU)	Turbi-dity removal rate (%)	COD (mg/L)	COD removal rate (%)	SS (mg/L)	SS removal rate (%)	Chroma (times)	Conductivity ($*10^4$)	pH
8	0.703	20.6	100	11.2	2450.6	22.8	710.4	11.2	400	0.638	5.82
16	0.694	21.6	96.5	14.3	2411.1	24.1	691.2	13.6	400	0.592	5.83
24	0.676	23.6	83.9	25.5	2275.1	28.3	685.6	14.3	200	0.568	5.81
32	0.671	24.2	78.5	30.3	2085.1	34.3	691.2	13.6	200	0.566	5.82
40	0.669	24.4	76.4	32.1	1932.5	39.1	676	15.5	200	0.562	5.74
48	0.643	27.3	72.5	35.6	1789.3	43.6	636	20.5	100	0.537	5.70
52	0.619	30.1	71.9	36.1	1620.6	49.0	608	24.0	100	0.536	5.69
60	0.598	32.4	69.3	38.5	1600.8	49.6	623.2	22.1	80	0.518	5.68

With the extension of the anaerobic reaction time, the preserved wastewater gradually became clear, as the result of which, the UASB reactor can be used as a pretreatment for the persevered wastewater, in order to reduce difficulty of the subsequent aerobic treatment. In the UASB reactor, with the combined effects of methane bacteria and non-methane bacteria, macromolecular organic matters were eventually converted to methane, carbon dioxide, water, hydrogen sulfide, ammonia, and other substances through three stages (hydrolysis and fermentation stage, hydrogen production and acetate production stage, methane production stage).

4. Conclusions

(1) With the increase of anaerobic time, the treatment effect of the UASB reactor on wastewater was improved.

(2) Under the optimum anaerobic time condition, the COD removal rate, turbidity removal rate, pH, conductivity, SS removal rate, absorbance, and decoloration rate of the preserved wastewater were 49.6%, 38.5%, 5.68, 0.518×10^4, 24%, 0.598, and 32.4%, respectively.

(3) The UASB reactor can be used as a pretreatment for the preserved wastewater, in order to reduce the difficulty of subsequent aerobic treatment.

5. Acknowledgments

This work was supported by the 2015 Guangdong science and technology project (2015A020208019).

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