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Deodorization of food wastewater by using strong oxidants

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Abstract. Wastewater from food processing enterprises is a strong organic-polluted wastewater. It contains mostly organic compounds, which fits to be treated by using biotechnology. The best technology for treatment is anaerobic. Deodorization is one of the most important points of this technology since anaerobic process generated some odor compounds. The main reason which causes bad smell in wastewater was a present of compounds which contains N and S. In this paper we report the result of deodorization by using several oxidant agents. The deodorization was taken after anaerobic process. The result shown that at pH 7-8.5, 4 gram/l of CaO or 120 milligram/l of $CaOCl_2$, 2.4 milligram/l of $KMnO_4$ or 1.6 ml/l of H_2O_2 can be useful separately. The recommendation is using of $CaOCl_2$ for the best economic choice.

Keywords: Food processing wastewater, wastewater treatment, deodorization, oxidant.

1. Introduction

Wastewater from food processing enterprises contains large amount of organic compounds. With high BOD/COD rate it is suitable for using biotechnology [1,2]. The best technology was demonstrated as anaerobic [12]. The influent was filtered by varied screens before pumping to UASB (up-flow anaerobic sludge blanket) system. The effluent was then drained off to deodorization treatment process. Most odors occurred in anaerobic process. Strongest odors of wastewater were derived from H_2S, SO_2, benzyl mercaptan (alpha-toluenthiol), dimethyl sulfur (DMS) and ammonium (NH_3)... There are some methods were studied to deodorize wastewater such as liquid absorption, solid adsorption, using microorganism and burning... [3-7] but the cost is their limitation. Oxidization of odors by using strong oxidants which contain oxygen, chlorine and Mg molecules was the best choice with high effect and low cost [8].

2. Materials and Methods

Wastewater

Wastewater was taken from wastewater treatment system in Food Industries Research Institute (FIRI) which has a capacity 25 m^3/day. The effluent was wastewater of beer processing.

Odor detection

Odor is detected by sensory method.

COD measurement

COD was measured as specification TCVN 6491-1999.

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BOD_5 measurement

BOD_5 was measured as specification TCVN 6001-1999.

SS measuarement

Suspended solid was measured as specification TCVN 6625-2000 (ISO 11923-1997)

3. Results and Discussions

Influent has COD about 1500 - 1800 mg/l was pumped to wastewater treatment system after filtered by varied screens. The properties of the out stream from anaerobic stage were as following: pH 6.5-7; COD 150-200 mg/l; SS 80-120 mg/l and quite offensive smell. After odor treatment, effluent was COD 80-100 mg/l; pH 7-8 and SS 90-100mg/l. The effect of several factors was studied to find out the optimal value. Wastewater was taken after anaerobic stage for experiments.

pH effect

Since the state of sulfur and organic compounds is depended on pH, then effects of pH to the odor of wastewater were studied. The result in Table 1 showed that pH of influent effected to sulfur removal process. The odor intensity is increased with decreasing of pH, it may due to the incompletely reduction of compounds of sulfur and nitrogen in acid state. These compounds are volatile and caused offensive smell. In pH higher than 7, Ca^{2+} precipitated with organic acid then settled in the filter, this process may reduce COD and SS. The range of pH 7-8.5 is suitable for deodorization; this also is an advantage condition since this range is common in almost wastewater [1-9].

Treatment time effect

As reported before [13], wastewater was added 0.4 g/l and 0.25 g/l of CaO and $CaOCl_2$ respectively. After certain time of treatment, effluent was taken out and removed precipitate before measuring other factors. Treatment time seems not effect to odor and color of wastewater, this may due to the immediately reaction of $CaOCl_2$ with S^{2-} and organic compounds. Results in Table 2 indicated that odor is diluted by time, but it is not significant. Then the concentration of oxidant should be increased rather than elongate the treatment time.

Effect of CaO concentration

Concentration of CaO was varied in range of 3.2 to 4.8 g/l with 0.25 g/l of $CaOCl_2$ added. The effect of concentration of CaO to the odor of wastewater was shown in Table 3. When the concentration of CaO increase, wastewater is transparence and odorless. S^{2+} is totally removed. This can be explained by precipitation of Ca^{2+} with soluble pollutants.

Effect of $CaOCl_2$ concentration

Wastewater was added with a range of 40 - 200 mg/l of $CaOCl_2$ with fixed 4.4 g/l of CaO. From Table 4 we can see that concentration of $CaOCl_2$ effected to color, odor and COD of wastewater. The higher $CaOCl_2$ concentration, the higher effect of odor treatment. With 120 mg/l of $CaOCl_2$ the factor of effluent was reached to B class of TCVN 5945-2005.

After combination of results in tables 2, 3 and 4 we demonstrate that 120 mg/l of $CaOCl_2$ and 4 g/l of CaO is the best condition for treatment of 1 litre wastewater. After treatment by oxidants, wastewater was settle and drained directly to the sewage without any treatment.

Effect of $KMnO_4$ concentration

$KMnO_4$ and H_2O_2 were added to wastewater. The results in Table 5 and Table 6.indicated that the higher concentration of $KMnO_4$, the lower COD value of effluent after treatment, this result is quite similar to previous reports [10-12]. With 4 g/l $KMnO_4$ the COD value of effluent is strange, this may be explained by the excess amount of $KMnO_4$ used which may cause error in measurement. In general, the optimal concentration is 2.4 g/l of $KMnO_4$.

Table 1. Effect of pH to the odor of wastewater

Factors	pH				
	5,0	*6,0*	*7,0*	*8,0*	*8,5*
COD (mg/l)	182	157	101	98	92
BOD_5 (mg/l)	112	97	65	102	57
SS (mg/l)	95	91	82	88	90
pH	5,2	6,3	7,2	8,3	8,9
Color	+	+	-	-	-
Odor	+++	++	+	+	+

Table 2. Effect of treatment time to the odor of wastewater

Factors	Time *(min)*			
	10	*60*	*120*	*300*
COD (mg/l)	98	94	94	93
BOD_5 (mg/l)	60	58	58	57
SS (mg/l)	95	91	82	72
Color	-	-	-	-
Odor	++	+	+	+

Table 3. Effect of CaO concentration to the odor of wastewater

Factor	CaO concentration (g/l)				
	3.2	*3.6*	*4*	*4.4*	*4.8*
COD (mg/l)	138	132	125	88	87
BOD_5 (mg/l)	80	75	73	54	55
SS (mg/l)	112	129	124	127	136
Color	-	-	-	-	-
Odor	++	+	+	+	+

Table 4. Effect of $CaOCl_2$ concentration to the odor of wastewater

Factors	$CaOCl_2$ concentration *(mg/l)*				
	40	*80*	*120*	*160*	*200*
COD (mg/l)	98	82	84	78	105
BOD_5 (mg/l)	60	50	51	50	64
SS (mg/l)	128	126	115	117	92
Color	++	+	-	-	-
Odor	++	++	+	+	+

Table 5. Effect of $KMnO_4$ to the odor of wastewater

Factor	$KMnO_4$ concentration *(mg/l)*					
	0	0.8	1.6	2.4	3.2	4
COD (mg/l)	138	132	125	98	87	21
BOD_5 (mg/l)	84	80	76	59	53	65
SS (mg/l)	137	132	119	117	94	126
Color	Black	Light black	Grey	Light grey	Light grey	Light violet
Odor	+++	++	+	+	+	+

Table 6. Effect of H_2O_2 to the odor of wastewater

Factor	H_2O_2 concentration (ml/l)					
	0	*0,4*	*0,8*	*1,2*	*1.6*	*2*
COD (mg/l)	150	110	85	82	79	77
BOD_5 (mg/l)	91	67	52	50	49	49
SS (mg/l)	127	112	98	95	95	94
Color	Black	Grey	-	-	-	-
Odor	+++	++	+	+	+	+

Effect of H_2O_2 concentration

In this study, the concentration of raw H_2O_2 is 30%. The amounts of H_2O_2 added to wastewater were 0.4, 0.8, 1.2, 1.6 and 2.0 ml/l. The results showed that increasing concentration of H_2O_2 caused decreasing COD of effluent after treatment. Optimal concentration was found out as 1.6 ml/l (Table 6), at this concentration of H_2O_2 the COD still high (186-119 mg/l) but it is suitable for the following aerobic process.

4. Conclusion

The optimal condition for deodorization after anaerobic stage should be pH 7-8.5. The result shown that at pH 7-8.5, 4 gram/l of CaO or 120 milligram/l of $CaOCl_2$, 2.4 milligram/l of $KMnO_4$ or 1.6 ml/l of H_2O_2 can be useful separately. After combination of the economic benefit and optimal conditions, we suggest that $CaOCl_2$ is the best choice.

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Nghiên cứu khả năng khử mùi của nước thải nhà máy chế biến thực phẩm bằng một số chất ôxy hóa mạnh

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Ô nhiễm nước thải các nhà máy chế biến thực phẩm đang là vấn đề đang được cả xã hội quan tâm. Nhiều đề tài, dự án khoa học đã và đang triển khai nhằm xử lý triệt để vấn đề này. Với đặc thù ô nhiễm chủ yếu là các hợp chất hữu cơ, công nghệ chủ đạo trong xử lý nước thải các nhà máy chế biến thực phẩm là công nghệ kị khí. Xử lý mùi sau khi xử lý kị khí là một trong những điểm mấu chốt của công nghệ này. Trong phạm vi bài báo này, chúng tôi đi sâu vào nghiên cứu khả năng khử mùi của nước thải bằng một số chất ôxy hóa mạnh. Nguyên nhân chính tạo mùi khó chịu trong nước thải là do các hợp chất có chứa sulphua và nitơ. Một số chất ôxy hóa mạnh như CaO, $CaOCl_2$, $KMnO_4$, H_2O_2 đã được nghiên cứu để bổ sung. Xử lý mùi được nghiên cứu là xử lý sau quá trình xử lý kị khí. Kết quả cho thấy, điều kiện tốt nhất là pH 7 đến 8,5, với nồng độ CaO 4 g/l hoặc 0.12 g/l $CaOCl_2$, 2.4 milligram/l $KMnO_4$ hoặc 1,6 ml/l của H_2O_2 30 % cho kết quả khử mùi tốt nhất. Tuy nhiên, để có hiệu quả kinh tế cao nhất thì sử dụng $CaOCl_2$ là tối ưu.

Từ khóa: Xử lý mùi, chất ôxy hóa mạnh, xử lý nước thải thực phẩm, UASB.