RESEARCHING ON TREATING WASTEWATER FROM PRODUCTION OF CANNA VERMICELLI BY ACTIVATED SLUDGE TECHNOLOGY

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ABSTRACT

Canna wastewater has high contents of pollutants; BOD5 from 209 to 325mg/L; COD 460.8-891.0 mg/L; SS 625-766 mg/L and pH 2.48-3.0. This study was conducted to determine the optimum parameters for the design of a biological treatment system for Canna wastewater. The results show that with a PAC concentration of 200 mg/L. The SS treatment efficiency is 95-97% SS; Biomass content of 3000mg/L; The retention time of 6 hours, the treatment efficiency ranges from 84.0 to 89.3%. The effluent reaches the industrial waste water standards; The rate of biomass growth increased from 19.72-21.98%; The range for optimal SVI can be between 105 and 127ml/g.

Keywords: *Aeroten; wastewater; wastewater treatment; activated sludge; Canna vermicelli*

INTRODUCTION

Nowadays, activated sludge is a secondary biological method that is commonly used to remove nutritional ingredients in wastewater. This process is no longer unfamiliar to the treatment facilities, but it is necessary to optimize the activated sludge process for each type of wastewater in order to reduce the cost of treatment [1]. Moreover, no model can accurately predict the complex biological phenomena that occurs in biological processes [2]. The use of parameters in the activated sludge process of this wastewater does not seem to be optimal for others. Therefore, determining the optimal parameters in the pilot model is not only to ensure efficient process but also to save energy [1].

The effectiveness of the aerobic treatment for urban wastewater reaches 88-91% with retention time of 7 hours, biomass of 3500 mg/L [4]. For waste water of potato produce, it is 82% with a retention time of 7.5 hours, biomass of 3000 mg/L [5]. One of the important factors is that pH of urban wastewater and potato wastewater range from 6 to 7.5 that is suitable for biological treatment. The aerobic treatment has the advantage of handling high organic compounds ($BOD_5 \leq 1500$ mg/l) for short periods of time. On the other hand, this process consumes high energy and costs energy (40-60%) [8,10]. This is a suitable solution in Vietnam because the cost of building the system is not high. So, to reduce the costs for this method, determining the dynamic parameters of this process that can reach optimum value is necessary. This improvements can raise the efficiency of the wastewater treatment system.

Wastewater mainly consists of starch and lignin. Size of starch are so large that they can easly settle, similar to those found in other starches 1.4 Glucose, 1.6 Glucose [9]. Most of the starch used in vermicelli is wet starch with the moisture content of 30-40% [10]. pH of waste water is about 2-4 because in the transported time, the organic acids are created by the transitional metabolism that microorganisms such as mold, yeast, bacteria especially the anaerobic fermentation takes part in this process [10]. In addition, starch has a small content of cellulose and lignin (0.3-0.8%). Before being put into the vermicelli production, starch is washed with water, so it should settle quickly because of high density. The other products are washed away following effluent.

Waste water consists of the washing starch 180 (m^3/day), the flour-making process 320 (m^3/day), washing of machines 15 (m^3/day). These parameters: COD; BOD_5, TSS, TN, TP are high but, especially, pH is very low

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causing the serious environmental pollution in this craft village. The purpose of this research is to provide an effective treatment solution in the waste water treatment of Viet Cuong craft village, in particular and vermicelli production villages, in general.

METHODS

Object of study

Wastewater from production and processing of canna vermicelli in Nguyen Thanh Kien's household in Viet Cuong Craft Villages. Hoa Thuong commune, Dong Hy district, Thai Nguyen.

Research contents

- Characteristics of this wastewater.
- Study of coagulation - flocculation treatment.
- Research on aerobic biological treatment.

Methods

Sampling and analysis methods

Samples were taken after settling tank one times per hour and ware determined the parameters. The sampling methods were TCVN 5999: 1995.

Analytical methods:

Characteristics	Standard	Characteristics	Standard
Suspended solids (SS)	TCVN 4560: 1988	BOD_5	TCVN 6001-1: 2008
COD	TCVN 4565: 1988	Total nitrogen	TCVN 6638: 2000
Phosphate by Ascorbic acid method	TCVN 6202: 1996	Total phosphorus	TCVN 6202: 2008
Ammonia	TCVN 4563: 1988	$SVI = \frac{settled\ sludge\ volume(ml/l)x\ 1000}{suspended\ solids\ (mg/l)}\ (\frac{ml}{g})$	

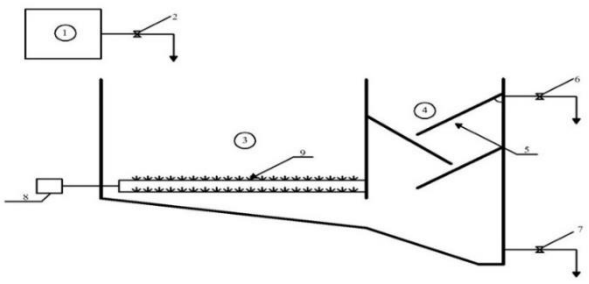
Equipment and chemical research

Research equipment

- Equipment for analyzing COD is DRB200, HACH - USA
- Identified NH_4^+; PO_4^{3-} by UV-5200 color comparator, China.
- Analyzed Coliform by Memmer warmer - Germany.
- JARTEST JJ-4A – China, with 6 stirrer speeds of 10-300 rpm and stirrer of 0-1100 rpm.

The chemicals used in the study are pure German and British chemicals.

Research models



(1) water tower;
(2) (6) flow valve;
(3) Aeroten tank;
(4) sedimentation chamber;
(5) sedimentation plate;
(7) sludge circulation valve;
(8) air pumps;
(9) air distribution system.

Figure 1. *Aeroten Experimental Mapping System*

Research on aerobic biological treatment combining sedimentation at Thai Nguyen University of Technology. The model is composed of organic glass with two parts: Aeroten 130 liters; sedimentation chamber being 20 liters (Figure 1). Activated sludge in the tank is a broth media composed of the following groups: Aerobic respiration bacteria: *Pseudomonas putida. Pseudomonas stuzeri, Aerobacter aerogenes. Bacillus subtilis, Nitrosomonas;* Facultative anaerobic respiration*: Rhodopseudomonas, Cellulomonas bizotera, Nitrobacter Microthrix and Thiothrix. These bacteria are isolated and cultured in the laboratory.*

RESULTS AND DISCUSSION

Characteristics of wastewater of Viet Cuong Craft Villages

Table 1. *Survey of wastewater quality in Viet Cuong Craft Villages*

No	Parameters	Unit	Results	Standard QCVN 40:2011/ BTNMT (B)
1	pH	-	2.48 – 3.0	5.5-9
2	BOD_5	mg/l	209-325	50
3	COD	mg/l	460.8-891	150
4	TSS	mg/l	625-766	100
5	Total N	mg/l	10.1-14.6	40
6	NH_4^+	mg/l	0.98-2.32	-
7	Total P	mg/l	1.73-2.05	6
8	PO_4^{3-}	mg/l	0.23-0.81	-
9	Colour	Pt-Co	<5	150
10	Coliform	MNP/100ml	<3	<5

Note: Samples are taken from March 25. 2012 to May 20. 2017 at Nguyen Thanh Kien's house

The result shows that the waste water has high pollutant contents. mainly organic matter and suspended matter. Most of the parameters exceed the emission standards of Vietnam: low pH values. BOD_5, COD, TSS exceed 6.48, 5.94, 7.59 times as many as those of values in QCVN 40: 2011/BTNMT (Column B) and especially. The high SS value can make sludge flocs break down and reduce the efficiency of biological treatment.

With the characteristics of wastewater, if it is not treated, it can directly discharge into the environment causing serious pollution as well as affecting to the human and ecology.

SS removal efficiency by coagulation- flocculation with PAC (Poly Aluminum Chloride)

Wastewater taken in Kien's house is adjusted to pH 7.0 and then mixed 500 ml waste water with 200 mg/L PAC into the beakers then, that were charged to a Jatest agitator at 250 rpm for 30 seconds, after that, reduced to 40 rpm for 5 min and finally, settled for 30 minutes before analyzing.

Table 2. *Wastewater from the Viet Cuong vermicelli village before and after the agglutination by PAC*

No	Parameters	Unit	Before coagulation-flocculation	After coagulation-flocculation	Standard QCVN40:2011 BTNMT (B)
1	pH	-	2.48-3.0	7.0-7.3	5.5-9
2	COD	mg/l	267.1 ±5	197.2 ±5	50
3	BOD5	mg/l	677.1 ±3	540.7 ±4	150
4	SS	mg/l	695.9 ±5	26.6 ±5	100

The results show that BOD_5 removal efficiency is 25-27%; COD is 20-26%; SS reaches 95-97%. As can be seen, by using PAC, the efficiency of SS treatment is very high, and increasing pH can improve the efficiency of biological treatment.

Research biological treatment

Research on the effect of biomass contents

The study was conducted with wastewater with the following characteristics: pH = 7.0-7.3; BOD_5 = 184.7±3mg/L; COD = 430.3 ±5 mg/L; SS = 29.4 ± 5 mg/L. Biomass is put into the reactor with the following different concentrations: 2000 mg/L, 2500 mg/L, 3000mg/L, 3500 mg/L to provide the most suitable biomass for wastewater treatment and biosolid treatment.

Table 3. *The effection of biomass*

Time, hour	X=2000 mg/L		X=2500 mg/L		X=3000 mg/L		X=3500 mg/L	
	COD (mg/L)	**MLSS (mg/L)**	**COD (mg/ L)**	**MLSS (mg/ L)**	**COD (mg/ L)**	**MLSS (mg/ L)**	**COD (mg/ L)**	**MLSS (mg/ L)**
0	428.0	2011	433.1	2524	429.2	3027	434.7	3523
1	365.4	2184	337.4	2578	361.9	3196	380.6	3789
2	321.5	2244	289.3	2645	271.6	3257	334.3	3875
3	286.8	2303	237.4	2786	221.1	3390	296.9	3966
4	257.2	2367	203.3	2881	181.4	3450	205.3	4015
5	234.6	2410	186.0	2998	153.2	3551	156.6	4179
6	200.8	2468	151.8	3145	**111.2**	**3614**	**100.4**	**4292**
7	187.3	2511	**122.0**	**3201**	80.0	3663	71.0	4344
8	155.4	2547	105.8	3243	36.0	3707	27.0	3377
9	**134.7**	**2611**	98.7	3287	-	-	-	-
10	128.3	2671	88.3	3317	-	-	-	-
Efficiency (%)	70.0	-	79.6	-	76.62	-	76.92	-
Increasing biomass (%)	-	29.84	-	26.82	-	22.46	-	21.83
SVI (effluent)	143		127		125		115	

The microbial growth and SVI in the aerobic tank was inversely proportional to the initial biomass. and the SVI from 143 to 115 ml/g was consistent in other studies [5] and obeyed the rules of the Monod (ranging 80-150 ml/g). Biosolids that are generated from removal COD process will be treated, so, the treatment process will be more efficient when reducing biosolids. The efficiency of increasing biomass is from 20.41 to 29.84 while the appropriate biomass growth rate is ≤ 25%.

For the biomass of 2000 mg/L, the COD conversion rate is very slow; after 9 hours, when the treatment efficiency is 70%, the effluent reaches QCVN 40/2011-BTNMT (column B). Long retention time leads to large reactor volumes and costs for construction and increasing air supply in the system. When the biomass is 2500mg/L, the treatment effect after 7 hours was 79.6%, raising 9.6% compared to 2000mg/l biomass. However, biomass growth rate reached 26.82%. This value is high. which consumes dissolved oxygen and sludge treatment costs. Expanding the research with the biomass of 3000 mg/L and 3500 mg/L. The treatment efficiency was 76.62% and 76.92% mg/L after 6 hours. This result shows that the relationship of substrate to biomass is appropriate. The effluent reaches the standards B. QCVN 40/2011-BTNMT with a biomass growth rate of 22.46 and 21.83 after 6 hours, so the optimal biomass concentration is 3000mg/L.

Study the effect the effluent of COD to the process

The study was conducted with COD input ranging from 400-700 (this is characteristic of wastewater through sampling and it was treated SS by coagulation- flocculation with PAC). MLSS keeps 3000 mg/L and pH is 7.0-7.3 to determine the conversion of biomass concentration of 3000 mg/L to with vermicelli waste water. The results are shown in table 4.

With the characteristic of wastewater from 400-700 mg/L. the biomass concentration of 3000 mg/L can be effectively treated with 6 hours of retention time. The treatment efficiency ranges from 84.0 to 89.3%. the effluent rearches QCVN 40-2011-BTNMT. The sludge growth rate is 19.72-21.98%. being consistent with M. Fikar's study [4]. SVI and biomass growth rates meet the water quality standards.

Table 4. *Effect of COD to processing treatment*

Time, hour	COD = 700		COD = 600		COD = 500		COD = 400	
	COD (mg/L)	MLSS (mg/L)	COD (mg/L)	MLSS (mg/L)	COD (mg/L)	MLSS (mg/L)	COD (mg/L)	MLSS (mg/L)
0	712.8	3012	606.7	2988	466.2	3046	368.6	3017
1	576.0	3216	453.4	3244	318.6	3227	214.0	3266
2	418.4	3355	321.1	3327	235.6	3388	163.7	3383
3	341.6	3469	212.9	3456	163.2	3412	121.5	3427
4	197.6	3511	154.3	3520	114.0	3517	65.8	3507
5	133.0	3612	108.7	3571	64.0	3581	32.4	3562
6	92.0	3674	62.0	3601	38.0	3658	22.8	3612
Efficiency (%)	84.0	-	86.3	-	88.1	-	89.3	-
Increasing biomass (%)	-	21.98	-	20.52	-	20.09	-	19.72
SVI (ml/g)	118		125		127		105	

CONCLUSION

Vermicelli wastewater has high contents of pollution; BOD_5 from 209-325 mg/L; COD460.8-891.0 mg/L; SS 625-766 mg/L; Especially very low pH from 2.48 to 3.0. To improve the efficiency of biological treatment of pre-treated, SS in wastewater is treated by PAC. With PAC concentration of 200 mg/L, the treatment efficiency is up to 95-97% SS; After SS treatment. wastewater is entered into biological aerobic treatment. Research results show with a biomass content of 3000mg/L, retention time 6 hours, the efficiency reached 84.0-89.3%; The biomass growth rate increased from 19.72-21.98%; SVI is in the optimal range of 105-127 ml/g.

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TÓM TẮT

NGHIÊN CỨU XỬ LÝ NƯỚC THẢI SẢN XUẤT MIẾN DONG BẰNG CÔNG NGHỆ HIẾU KHÍ BÙN HOẠT TÍNH

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Nước thải sản xuất miến có thành phần ô nhiễm cao; BOD_5 từ 209-325 mg/L; COD 460,8-891,0 mg/L; SS 625-766 mg/L; đặc biệt pH rất thấp 2,48-3,0. Nghiên cứu này thực hiện nhằm xác định các thông số tối ưu cho thiết kế hệ thống xử lý sinh học đối với nước thải sản xuất miến. Kết quả nghiên cứu cho thấy: Với nồng độ PAC là 200 mg/L hiệu quả xử lý SS lên tới 95-97% SS; Hàm lượng sinh khối 3000 mg/L; thời gian lưu 6 giờ hiệu quả xử lý đạt từ 84,0-89,3%, nước thải dòng ra đạt tiêu chuẩn thải; Tốc độ sinh khối tăng từ 19,72-21,98%; SVI đều nằm trong giải tối ưu từ 105-127 mL/g.
Từ khoá: *Aeroten, nước thải, xử lý nước thải, nước thải sản xuất miến, bùn hoạt tính.*

Ngày nhận bài: 01/11/2017; Ngày phản biện: 18/11/2017; Ngày duyệt đăng: 05/01/2018

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