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A Study of the Treatment Efficiency for the Ozonation Effluent Recycling Process in Cassava Starch Factory

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Abstract

The research was to determine the treatment efficiency for the ozonation effluent recycling process in cassava starch factory. Also, the flow rate entering the process was measured continuously during operating the process. In the process, there were mainly four major components: Section 1, effluent storage pond, Section 2, algae filtration system, Section 3 ozone tank and decomposing pond, Section 4 sedimentation tank and sand filter pond. From study results, it was found that the average flow rate entering the process was 197.86±5.23 m^3/hr. Effluent characteristics (before and after) of the ozonation effluent recycling process found that the average pH, total dissolved solid (TDS), chemical oxygen demand (COD) and the suspended solids (SS) were 9.19±0.03 and 8.13±0.03, 2,344±15.00 and 2,445±13.00 mg/l, 213±2.21. and 83±6.31 mg/l, and 112±5.87 and 15±4.39 mg/l, respectively. For COD and SS removal efficiency, the averaged percentages were equal to 61% and 87%, respectively. Overall, all parameters of the treated effluent passed the industrial effluent standard. However, the treated effluent was only used for washing raw cassava due to a quite high TDS. Therefore, a further study on a quality-improvement of the treated effluent, especially TDS, needs to be considered.

Keywords : recycling effluent; cassava; ozonation; starch factory; algae

Introduction

Water is an important resource that is necessary in the industrial sector. Therefore, it should be used for a maximum benefit. A tapioca starch factory is a type of a factory that produces a lot of wastewater (10-20 m^3/ton of starch production) [1]. A tapioca starch factory with the production capacity of 650 tons per day in Nakhon Ratchasima province has foreseen the importance of wastewater that occured. Within factory activities, various experiments have been conducted on reducing unnecessary wastewater as well as reusing the collected effluent. Typically, the factory has a wastewater treatment system using natural ponds (area of 1000 rai or 160 hectares) with no effluent drainage from the system. The factory intends to recycle the effluent collected from natural ponds back to use in the factory. In the natural wastewater treatment system, the effulent collected was from the last pond called C 6. There was a lot of algae (also algae smell) as shown in Figure 1. For laboratory-scale experiments, the factory tried to treat the effluent with a chemical oxidation method, in which the used of oxidizing agents such as chlorine compounds, ozone, and hydrogen peroxide. From the experimental results, it was found that the addition of ozone could treat the effluent satisfactorily and it did not produce any harmful residues according to other research papers [2-5]. Most of algae (represented in term of SS) in the effluent was significantly removed after ozonation and sedimentation (as well as its smell). Therefore, the factory conducted the ozonation effluent recycling process to treat the effluent from the final pond (C6) as shown in the overall flow diagram in Figure 2. The treated effluent characteristics were continuously analyzed and monitored.

Figure 1 Effluent Characteristic in C 6 Pond

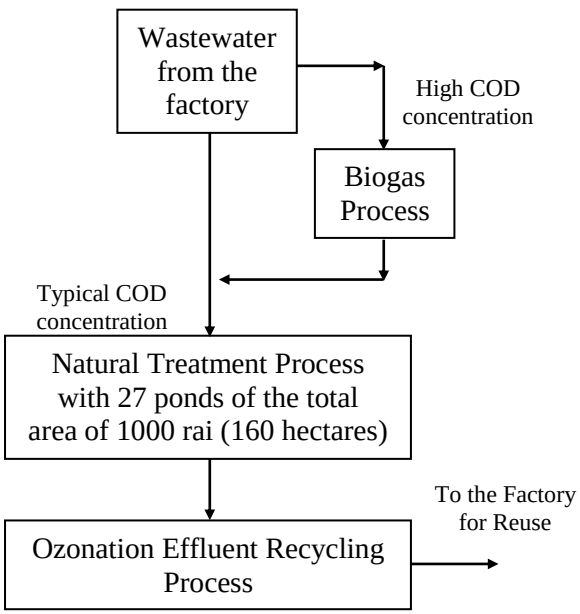

Figure 2 Overall Wastewater Flow Diagram of the Factory

Methodology

In the Ozonation effluent recycling process, there were mainly four major components: Section 1, effluent storage pond, Section 2, algae filtration system, Section 3 ozone tank and decomposing pond, Section 4 sedimentation tank and sand filter pond as shown in Figure 3.

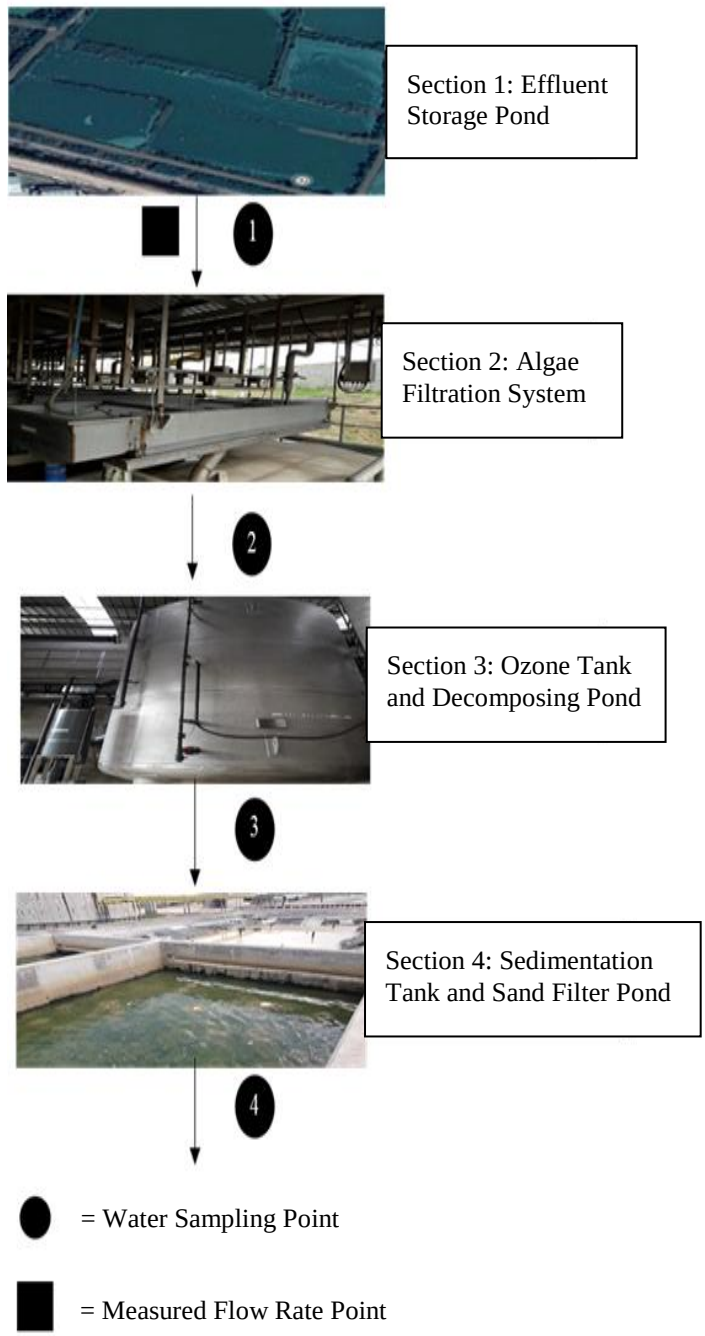

Figure 3 Effluent Recycling Process Components and Sampling Points

From Figure 3, Section 1: effluent storage pond (C6) has a volume capacity around 100,000 m^3 with < 2 m of depth. Typically, sunlight can shine through the bottom of the pond. There is a lot of algae in the pond as mentioned in Figure 1. Section 2: in order to get rid of algae initially, there are 20 units of algae filters using 60-80 µm nylon filter cloths (local material). Each filter unit has a dimension (width x length x height) of 1.20×3.40×0.45 m with controlled filtering velocity < 8 m/hr. Section 3: the ozone tank and decomposing pond (as shown in Figure 4) have volumes of 42 m^3 (contact time > 10 min.) and 192 m^3 (contact time > 30 min.), respectively. There are 2 units of ozone

generators (Prominent, Germany) with a capacity of 630 gO_3/hr for each unit. Ozone dosage was automatically control using ORP controller (> 200 mV with pH of 6.5). Section 4: the sedimentation tank (as shown in Figure 5) has a volume of 4,000 m^3 (controlled overflow rate < 2 m/hr) and the sand filter with 100 m^2 of filtration (controlled filtering velocity < 8 m/hr).

For the ozonation effluent recycling process, flow rate entering the process and water characteristics of each section were determined every day for 7 weeks as shown in Figure 3. Analysis of water characteristics were performed followed the mothods as shown in Table 1 [6]. Due to focusing on algae removal, the parameters used to calculate the efficiency were focused on COD and SS only.

Results and Discussions

For the ozonation effluent recycling process, the average effluent flow rate (Qavg) were measured equalt to 197±5.23 m^3/hr (4,728 ± 125.52 m^3/day) as summarized in Table 2.

Figure 4 Decomposing Pond

Figure 5 Sedimentation Tank

Table 1 Analysis of Wastewater Characteristic Parameters and Methods

Parameters	**Method**
1. pH	pH Meter
2. COD (mg/l)	Close Reflux, Colorimetric Method
3. Suspended solid; SS (mg/l)	Gravimetric Method
4.Total dissolved sold; TDS (mg/l)	Gravimetric Method

Table 2 Flow Rate Entering to the Ozonation Effluent Recycling Process

Qavg, m^3/hr	Qmax, m^3/hr	Qmin, m^3/hr
197.86±5.23	254.25±9.84	71.37±3.78

Form Table 2, the effluent flow rate varies within a range of 71.37±3.78 m^3/hr (1,712 ± 90.72 m^3/day) to 254.25±9.84 m^3/hr (6,102 ± 236.16 m^3/day) during 7 weeks of operation. For each water sampling point (as shown in Figure 3), analytical parameter results were summarized as shown Table 3

Table 3 Analytical Parameter Results

Parameters	Water sampling point				Standards [3]
	1*	2*	3*	4*	
pH	9.19±0.03	7.79±0.20	7.84±0.09	8.13±0.03	5.0-9.2
TDS, mg/l	2344±15.00	2407±27.59	2412±12	2445±13.00	<5,000
COD, mg/l	213±2.21	164±19.75	133±7.7	83±6.31	< 120
SS, mg/l	112±5.87	71±11.72	68±17.00	15±4.39	<30

From Table 3, it was found that the pH, TDS, COD and SS of treated effluent after the ozonation effluent recycling process were about 8.13, 2,445 mg/l, 82.83 mg/l, and 14.83 mg/l, respectively. All these parameters passed the industrial effluent standard [3]. There was no significant difference between TDSs (before and after) of effluent recycling process due to no TDS-removal units in the process. Therefore, there were no efficiency calculations for TDS. Removal efficiencies of COD and SS were calculated to be around 61% and 87%, respectively. This indicated that there was slightly amont of algae (also algae smell) in the treated effluent as expected. The treated effluent was fairly clear and had very little smell. However, it had a bit high concention of TDS due to a high concentration of the effluent at the beginning. Therefore, this treated effluent was only used for a general purpose such as washing raw cassava (this treated effluent can replace 100% of the original tap water used). On the basis of electricity cost, the operating cost of the treated effluent produced is approximately 5 baht per cubic meter. Although this operation cost is higher than the cost of production of the factory's own water supply. However, this ozonation recycling process can be used as an alternative to prevent flooding of stored effluent.

Conclusion

After the ozonation effluent recycling process, the treated effluent can be used back to the raw cassava washing step in the factory due to a bit high concentration of TDS and no direct disinfection unit. However, a further improvement of the treated effluent quality, especially for TDS and disinfection technology, needs to be conducted for factory's activities that use higher water quality.

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