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Abstract*— The objective of the research was to analyze the wastewater of Amaris hotel and Restaurant Centre , Denpasar Bali Indonesia using conventioal technology and to study the carakteristik. to the product material for fertilizer. The research was conducted from 5 May 2010 to 23 June 2013. Results of the research indicated that the technology using 3.8 hours/day aeration could reduce BOD level to 92%, but increased the F/M ratio to 12.93 g/BOD/day/g/MLSS, shortened sludge age to 22.44 hours, lowered sludge recirculation to 23,25%, decreased pollutant to 0.6% MLSS and 88% TSS. Those results had met the quality standard for wastewater processing technology and for irrigation water respectively of Department of Health (1990) and Department of Environment (1998) of Republic Indonesia. The characteristics of the wastewater (containing 2.87% N, 0.78% P, 0,43% K, 0,48% Ca, 0.33% S, 0.19% Mg, 326 ppm Fe, 211 ppm Al, 8.8 ppm Mn, 2.18 ppm Mo), had also met the quality standard for fertilizer materials (Hammer, 2001). The products of the technology have been proven to be safely used for fertilizer materials as indicated by no heavy metals contained. Based on the calculation (eq. 1) it was found that the TSS in the effluent (as the material for fertilizer) was 6.6 kg/day, which was originated from 230 m^3/day hotel discharges collected in a 89 m^3/hr aeration pond with 500 mg MLSS/l influent, 100 mg TSS/l influent, 203 mg BOD/l and 47,41 mg MLSS/l. From nutrient microorganisms demand equation value of BOD:N:P = 100:5:1 (eq.2), it was calculated that the conventional products could provide 4.750 kg N/day and 1.35 kg P/day.

***Keywords*— Conventional technology, Domestic Hotel Wastewater, Produces Materials for Fertilizer.**

I. INTRODUCTION

Wastewater is one of alternative resource for fertilizer due to high contents of protein, carbohydrates and other minerals needed by plants. Besides, the wastewater is available abundantly. Liquid wastewater contains 99.0% water and 0.9% solid which consists of 65% protein and 25% carbohydrates and the rests are fats and several minerals (such as N,P, K, Mg, Ca, S, Na, Fe, Mn, Zn, Cu, B, Al, Mo). In addition, amino acids, hormones and microorganisms are found in liquid wastewater [9]. According to [2] the materials for a save fertilizer should contain high proteins and carbohydrates. The processing of hotel wastewater like others will produce sludge. Sludge can be reused as soil conditioner and as a fertilizer in agriculture [14].

The technology for processing domestik liquid wastewater has been generally aimed at eliminating the pollutant only, but ideally it is supposed to maintain the beneficial components in it to be reused for other purposes. The Amaris Hotel and restaurant located in Denpasar, Bali Indonesia has recently been using the conventional technology for processing its wastewater, however there has been no study to prove that the technology has met the standard for the wastewater processing operational and the product has not been confirmed to meet the quality standard for fertilizer materials to be safely used for fertilizer.

The existence of organic materials in hotel wastewater indicated by parameters such as biological oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solid (TSS) [15]. The organic materials consist of bacteria, fungi, algae and protein and nitrogen rich solid materials. Ammonium, nitrates and nitrites are included in the wastewater as well. The contents of plant growth hormones (gibberellins, zeatin and IAA) that derive from fungi and higher plants are the other positive aspects of the hospital wastewater compared to the other organic fertilizers.

Hotel wastewater also contains hormones, which are in the human and animal urines, that contain indoles. The combination of indoles with acetic acids becomes indole acetic acids with the role of promoting new shoots [3]. The wastewater could be originated from medical and non-medical activities of the amaris hotel. It has been well known that microorganisms involved in wastewater are Azotobacter sp., Azospirilium sp., Mycorrhiza sp., Rhizobium sp., Aspergillus sp., and Saccaromyces sp. [8]. The criteria was also set up for the wastewater quality guidelines for agricultural use [4]. To be safely used, the hospital wastewater should meet the standard set up for its usage [12]. Therefore, a technology is required to process the wastewater biologically to produce fertilizer materials with biological and other safe contents for plants and environment. Amaris hotel and restaurant located in Bali Province of Indonesia, have been using biological technology to refine its wastewater. The Conventional technology uses biological principles as specific method, which is different from other technologies used in other hotel in Indonesia. This objectives of the technology are to maintain the important_mineral components and to simplify components particles, besides to eliminate the pollutants in the wastewater. The product of that technology in the Amaris Hotel has not been used so far for any particular purposes.

In the Conventional technology there are four levels of processes involved viz. pre-treatment (in A pond), treatment (in B pond) and stabilization (in C pond) and disposition (in D pond) but the first three of them are very important in the technology (Figure 1). Decompositon, fermentation and mineralization activities occurred in each of level of the process and several types of microorganisms are involved in the activities, therefore biological treatments are needed to maintain the processes. Those treatments consist of adding

oxygen (to promote the biodegradation process of organic materials), nutrients (to increase the growth and activities of microorganisms) and water pressure (sludge recirculation) (to optimalize pH, temperature and oxygen of the environment) [13]. Giving an aeration treatment (250 HP aerator) of 10- 20 hr/day on wastewater of 5,000 m^3/day with pH of 5.4, BOD of 500 ppm and COD of 900 ppm could maintain BOD of 2000-5000 ppm [11]. Meanwhile, [10] indicated that aeration treatment of 0.8-4.0 mg/l could increase the activities of microorganisms in the degradation process of pollutants and decrease the existence of methane, H_2S and CO_2 by 40%-80%.

The feasibility of Amaris Hotel wastewater to be used as an alternative resource of fertilizer materials, could be determined through laboratory analysis of quality and characterictic of the Conventional technology products and the results are then compared with the quality standard for wastewater set up by the Department of Health of Republic Indonesia (Permenkes RI No. 416/MENKES/PER/IX/1990), the quality standard for irrigation water (D Classification) of Department of Environment of Republic Indonesia (Kepmen KLH No.02/MENKLH/I/1998. Gol.D) and quality standard for fertilizer materials [6]. The conventional technology is expected to be used as the safe method to refine the hospital wastewater and to use the products as materials for fertilizer.

II. MATERIALS AND METHODS

A. Objective, steps of experiments, location and time

The research was conducted to study and analyze Hotel wastewater using Conventional biological technology and its potential to be a resource of materials for fertilizer; and to study the characteristics to the product material for fertilizer. The research consisted of three steps of experiment.

Study on the process of the Conventional technology (the experiment 1) was conducted to confirm that the Conventional technology meet the standard criteria for wastewater processing, while the study on the quality and characteristics of the Amaris Hotel (the experiment 2) was to prove that product meet standard criteria for irrigation water and fertilizer material qualities. Both experiments were conducted in the Amaris Hotel. Surveys and field observations at Amaris Hotel and sample collection was conducted from August 2012 until June 2013 and the wastewater analysis conducted at the Faculty of Mathematics and Natural Resource Sciences Laboratory, Gadjah Mada University, Yogyakarta 20 January to 20 April 2013.

B. Study on the operational process of conventional technology

There were four levels of processes but three important ones involved viz. pre-treatment (in A pond), treatment (in B pond) and stabilization (in C pond). The fourth level was disposition level (D pond)

The Hotel wastewater with high BOD loads was drained to the equalization collection pond where physical (flotasi, flocculation and sidementasi) and chemical (chlorination) treatments were imposed to homogenize and to eliminate the pollutants. From this pond, the wastewater was then continually drained into A pond for the pre-treatment to be imposed. In this pond the separation of wastewater components (i.e. to simplify of the form and size of components) by microorganisms was occurred. In the treatment level, the wastewater from the A pond drained into B one or aeration (open) pond, in which treatments of temperature, pH, oxygen, Food/Microorganism (F/M) were given to maintain the activities of microorganism to change organic into inorganic components through fermentation process, to eliminate the pollutants (such as H_2S, CH_4 and NH_3) and to decrease the amount of CO_2 and odor-related volatile organic compounds as well. Sludge was recirculated from the B into A pond to even more refine the wastewater. In the stabilization level, the smaller components form of pollutant free-wastewater was drained from the B into C pond. In this stagnant pond, the wastewater components became more stable and gave the opportunity to the microorganisms (algae, fungi, protozoa and bacteria) degraded the components into even smaller forms to be available for plants.

C, Study on quality and characteristics of Amaris Hotel wastewater

The quality (physical, chemical and biological) of the wastewater measured in pre-treatment, treatment, stabilization and disposition levels (in A,B,C and D ponds). The characteristics of Amaris Hotel wastewater were analyzed from the stabilization level (in C pond).

D. Data collection

Samples were taken from four points inside each of the four level of process (four ponds of hospital wastewater installation) to be analysed in the faculty of Mathematics and Natural Resource Science laboratory of Gajah Mada University, Yogyakarta to determine the quality, characteristic and number of nutrient components in the samples. Variables of leaf number, leaf area, leaf and total fresh weight $plant^{-1}$ were measured in the glasshouse experiment.

E. Data analysis

The physical (TSS and MLSS) characteristics of wastewater were analyzed using the method of spectrophotometry and gravimetry respectively. The methods of Kjeldhal, Brucin and sulfanilate spectrophotometries were respectively used to analyze the chemical (ammonia, nitrates and nitrites) characteristics. The Winkler and Bicromate tritimatries were used to analyse BOD and COD [5].

The production of fertilizer was calculated using the equation ([1], [7], [11]):

$$\frac{\text{the installation wastewater capacity } (m^3/day)}{\text{the discharged wastewater } (m^3/hr)} \quad \ldots\ldots\ldots(1)$$

While the production of nutrients was determined from the nutrient microorganisms demand equation ([7], [11]) of :

$$BOD:N:P = 100:5:1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

III. RESULTS AND DISCUSSION

The Amaris hotel discharged wastewater of 230 m^3/day and only used 9.89% of the hotel instalation plant capacity of 57 m^3/hour. Laboratory analysis indicated that the Amaris Hotel wastewater was categorized as domestic wastewater dominated by organic matter such as proteins, carbohydrates and fats as indicated by parameters of TSS (Figure 2b), ammonia (Figure 3b), nitrates, nitrites (Figure 3c), DO (Figure 4a), BOD and COD (Figure 4b).

A. The operational process of Conventional Technology

The conventional technology used in Amaris Hotel and restaurant had met the standard operational criteria for biological processing of wastewater. The steps of process of Conventional technology showed that the technology had met the operational standard, due to focussing on biological principles with the concept of usage and quality of safe, efficient and environmental friendly wastewater. This was proved by the quality of wastewater produced in stabilization level or step (C pond) and in the disposition level (D pond) (Table 4.1) that already met the quality standard and safely used (Permenkes RI Nomor 416/MENKES/PER/IX/1990) and water quality standart for Class D Kepmen KLH No - 02/MENKLH/1/1988, [11] and [6]. In addition, the characteristic of the wastewater produced in stabilization level had also met the quality standard for fertilizer materials [6].

B. The Quality of Amaris Hotel wastewater

In the conventionl technology with the BOD load of 203 g/m^3/day, the aeration period employed to the wastewater was 3.0 hour less than does in the operational standard (Table 1). Given F/M ratio of 0.20-0.50 g/BOD/day/g MLSS and 89% sludge recirculation, the MLSS and TSS were far less than those in the the operational standard. The conventional technology resulted in the sludge age even shorter than in the operational standard and resulted in 92% BOD efficiency (Table 1).

C. Physical quality

This quality was indicated by a) temperature, b) turbidity, c) TSS, d) MLSS. The temperature increased from the lowest of 27.17 °C in pre-treatment level (A pond) to the highest of 28.90 °C in stabilization level (C pond). Those temperatures were in the range of allowed temperatures (26.00°C-29.00°C) according to the standard for Class D water quality (Kepmen KLH No.02/MENKLH/I/1988) and were less than 30 °C (safe for fish and other microorganism - according to PP Republic Indonesia No.20/1990). The increases in temperatures up to the stabilization level indicated the occurrence of biological process and changes in wastewater condition.

TABLE 1.
THE MEASUREMENTS IN CONVENTIONAL-TREATED WASTEWATER OF AMARIS HOTEL COMPARED TO OPERATIONAL STANDARD OF WASTEWATER TREATMENT

	Parameters	Units	Conventional technology	Operational standard of wastewater treatment [6]
1.	Aeration period	hr/day	3,8	6-9
2.	BOD load	g/m^3/day	203	500-800
3.	F/M ratio	g/BOD/day/g MLSS	0.2-0.5	0.2-0.5
4.	Sludge Recirculation	%	35	95
5.	MLSS	%	18	25
6.	TSS	%	6,6	82
7.	BOD efficiency	%	92	85-95
8.	Sludge age	Day	2-4	5-10

Turbidity value decreased from the highest of 818.30 NTU measured in the pre-treatment level (A pond) to the lowest of 185.68 NTU in the disposition (level D pond). (Figure 2a). TSS and MLSS values decreased as well from the highest 57.43 mg/l and 695.97 mg/l respectively measured in the pre-treatment to the lowest of 17.85 mg/l and 70.58 mg/l in the disposition level. (Figure 2b). The values are higher than the lowest value safe for water biology organism life (100 NTU) (Permenkes RI No.416/MENKES/PER/IX/1999).

The decreased in turbidity value explained that the separation between TSS, colloids, MLSS and effluent had occurred. The changes in physical quality due to solid degradation by microorganism, also occurred as indicated by the decreases in TSS and MLSS.

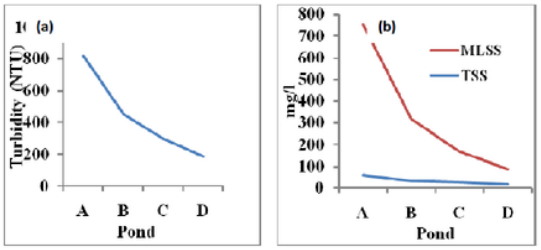

Fig 2. The values of turbidity (a) TSS and MLSS (b) measured in the amaris hotel wastewater

D. Chemical quality

The acidity (pH), nitrites (NO_2) and nitrates (NO_3), DO, BOD, COD, oil and detergents identified the chemical quality. The acidity was steady (pH of 7) from the pre-treatment until the stabilization but increased sharply to the disposition levels , but on the other hand ammonia (NH_3) decreased sharply from 86.81 mg/l in the pre-treatment to 0.06 mg/l in the disposition level. The value of pH was in the range of 6.0-8.5 and considered safe for irrigation water (Standard for water quality according to Kepmen KLH No.2/MENKLH/I/1988).

Although nitrates were always lower than nitrites , both components sharply increased from 1.62 mg/l and 0.19 mg/l respectively in the pre-treatment to 4.42 mg/l and 3.32 mg/l in the treatment levels but decreased afterward to the stabilization (4.00 mg/l and 0.20 mg/l) and finally increased slighltly again (4.42 mg/l and 0.20 mg/l) to the disposition level.

The DO, BOD and COD concentrations were also indicators of the existence of microorganisms and organic materials in amaris hotel wastewater. The DO concentration

increased from 3.8 mg/l in the pre-treatment to 4.2 (in the treatment level) and 6.6 mg/l (in the stabilization level) and finally to 7.0 mg/l in the disposition level (Figure 4a). On the other hand the BOD and COD concentrations were continued to decrease from 80.43 and 168.0 mg/l respectively in the pre-treatment to 17.50 and 48.6 mg/l in the disposition level (Figure 4b).

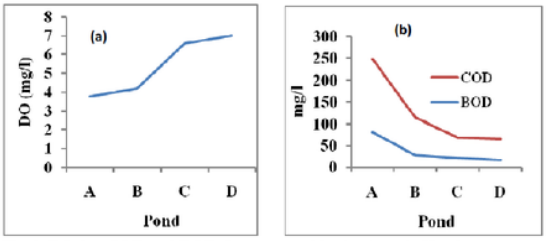

Fig 4. DO (a), COD and BOD (b) measured in the Amaris Hotel wastewater

E. Biological quality

The non-coliform biofilm slime detected in the wastewater, indicated the existence of coliform bacteria in the wastewater (Figure 5). The slime was assumed as the production of the coagulation resulted from chlorination process.

F. The characteristics of Amaris Hotel wastewater

The characteristics of Amaris Hotel wastewater analyzed from the stabilization pond was indicated by the parameters presented in Table 2. The BOD was 2.63 mg/l higher but COD was 3 mg/l lower than in the quality standard for fertilizer materials. Although the ammonia was far less but phosphates were extremely higher than it is supposed to be in the standard. There was no heavy metals measured in the Amaris Hotel wastewater. On the other hand, the total bacteria found was 24.00 MPN/100 ml wastewater. The product of Conventional technology on Amaris Hotel wastewater resulted in the characteristic that met the standard criteria for irrigation water quality and for fertilizer materials.

TABLE 2
THE CHARACTERISTICS OF THE AMARIS HOTEL WASTEWATER ANALYZED FROM THE STABILIZATION LEVEL AND THE QUALITY STANDARD FOR FERTILIZER MATERIALS

Parameters	Units	Measurement results	The quality standard for fertilizer materials [6]
1. Temperature	°C	28.90	30
2. Ph	-	7.0	6.0-9.0
3. TSS	mg/l	25.83	5-50
4. BOD	mg/l	22.63	10-20
5. COD	mg/l	47	50-100
6. Ammonia	mg/l	0.17	42.11
7. Phosphates	mg/l	74.82	0.1-30
8. Heavy metals (Hg, Cd, Ni)	-	0	Hg<0.001; Cd<0.01; Ni<0.02-0.1
9. Total Bacteria	MPN/ 100 ml	24.00	10,000 colony/100 ml

G. Nutrient Content of the Conventional Treated-Hotel Wastewater

Laboratory analysis indicated that the product conventional-treated hospital wastewater contained 2.87% N, 0.78% P, 0,43% K, 0,48% Ca, 0.33% S, 0.19% Mg, 326 ppm Fe, 211 ppm Al, 8.8 ppm Mn, 2.18 ppm Mo. Additionally, amino acids, hormones and microorganisms were also found in the product [5].

H. Production of Fertilizer Materials and Nutrients

Based on the calculation (eq. 1) it was found that the TSS in the effluent (as the material for fertilizer) was 6.6 kg/day, which was originated from 230 m^3/day hotel discharges collected in a 89 m^3/hr aeration pond with 500 mg MLSS/l influent, 100 mg TSS/l influent, 203 mg BOD/l and 47,41 mg MLSS/l (Table 1). From nutrient microorganisms demand equation value of BOD:N:P = 100:%:1 (eq.2) ([1], [7], [11]), it was calculated that the conventional products could provide 4.750 kg N/day and 1.35 kg P/day.

IV. CONCLUSION

The conventional technology used in Amaris Hotel Center Denapasar Bali had met the standard operational criteria for biological processing of wastewater. The product of Conentional technology on Amaris Hotel wastewater resulted in the characteristic that met the standard criteria for irrigation water quality and for fertilizer materials.

The product of Coventional technology of Amaris Hotel and restaurant center was categorized as safe as commercial organic and higher total fresh weight of the crop compared to those other two fertilizers.

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