LOGIC
Jurnal Rancang Bangun dan Teknologi
Vol. 18 No.3 November 2018 ; p. 103 - 108

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs.pnb.ac.id/index.php/LOGIC

WASTE PROCESSING WITH PLANT MEDIA IS A PATH TO SUSTAINABLE TOURISM IN NUSA LEMBONGAN TOURISM AREA

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Abstract. This research was conducted in Nusa Lembongan Island, Bali, with the aim to know the waste management model which using model of pond with plant media, in accordance with Government Regulation No. 82 Year 2001 on the management of water quality and air pollution control. In maintaining the environment (*green tourism*) since 2000, Bali has developed *Tri Hita Karana* Award and Accreditation Program (THK Awards Program) to hotels in Bali. Water recycling process is one of the conditions that must be possessed by hotel industry with environmental vision. The tourism industry in Bali has a positive impact on economic growth but is suspected as a polluter of the environment. Tourism industry activities cannot be separated from the need to water. Disposable waste discharges cannot cause contamination of the environment itself. Result of physical, chemical and biological quality parameter analysis either *in situ* (in location) or laboratory. Quantitatively, the manmade pond has potential to become an alternative water resource and needs some process. One method of pond treatment in Indonesia are *constructed wetlands* due to the diversity of vegetation, the simple construction, flexible, easy and inexpensive operation and maintenance and has aesthetic value. The pollutant reducing vegetation in the pond at this research is jasmine because it is easy to grow, doesn't need special maintenance, and from some studies it was proofed to be effective in reducing BOD and COD at average of 73%.

Keywords : Water Quality, Waste, Contamination, Water Jasmine

1. INTRODUCTION

One problem which is faced by Bali as a tourist destination in Indonesia is in realizing sustainable development which includes three aspects, namely economic, social and cultural and environment sustainability. Besides that, increasingly complex environmental problems today, originated from biased development planning between prioritizing local revenues (PAD) rather than ecology. This causes accumulation into environmental pollution, so that the cost of environmental impacts that must be paid by the community and government is much bigger than the economical benefits.

One industry in Bali that is able to give a positive impact on economic development (± 75%) is the tourism industry [1]. Ironically, besides being the largest contributor to local revenue, the tourism industry is also suspected of being the most dominant environmental polluter in Bali. Tourism industry activities will not be separated from the need for water, because water is used for bathing, washing and toilet activities, laundry, kitchen / restaurant activities and others. Household waste from tourism industry activities must undergo a recycling process before being disposed, so that it can be reused, for example for watering gardens and irrigating fish ponds, or returning the environment without causing environmental pollution (Government Regulation No. 82 Year 2001) [2], and Article 18 paragraph (1) Law No. 32 Year 2009 concerning Environmental Control and Management.

Since 2000 the Bali Provincial Government has launched the Tri Hita Karana Awards and Accreditations (THK Awards) program to the hotels in Bali. Where one of the requirements that must be met by the hotel is the problem of the recycling process of industrial waste or Water Treatment Recycle Process is one of the requirements that must be owned by industry which has environmental concern. sound industry [3]. This is to encourage the hotel management to apply THK optimally [4], so that there will be no conflict with the surrounding community in the future, and thus, the hotel activities will continue sustainable.

2. METHODS

a. Research Design

Wastewater has three characteristics [5], namely: physical, chemical and microbiological. Therefore, the management of household waste that is disposed directly to the environment will contribute waste material that requires oxygen consumption for removal by the microorganisms. This can decrease the amount of oxygen that dissolved in the water quickly and which will disturb the ecosystem in the environment.

Household waste management needs to be carried out before being discharged into the water so that it doesn't disturb the creature's life. The manmade pond model is simple technology with very cheap and easy application to treat household wastewater. To determine the effectiveness of the manmade pond system in reducing the pollutants, it is necessary to measure the decrease pollutant in every step of the process.

The results from the parameters of physical, chemical and water biological quality of water, in location *(in situ)* and laboratory compared with the maximum limit of water quality in tourism area, and Determination of Pollution Index in accordance with the Decree of the State Minister of Environment No. 115 Year 2003, about Guidelines for Water Quality Determination.

b. Research Design for Manmade Pond Models

Wastewater of hotel such as toilet waste, kitchen waste, laundry waste will be flowed to pond A which contains charcoal, gravel and sand, and under the pond is put a pipe with a diameter of 3 ", and the pipe installation follows the flow of the pond, and the below pipe is given 3 mm hole in every 10 cm. Waste water such as soap and oil will float on the surface of the pond because it has a lighter density than the water. Pipes under the pond will flow the water to pond B, where in pond B contains some sand, coral, coconut shell charcoal and planted with Jasmine plants, and beside and under the pond is put pipes with a diameter of 3 ". The planted pipe on the bottom of the pond is given a hole in 3 mm in every 10 cm. Pipes that are planted in the bottom of pond B will drain water to Pool C or control tanks. In pond C is planted with Eichhorniacrassipes (Water hyacinth). It functions to clear the water. In pond C (sediment) functions to separate the smooth sediment from the water in the pond. Finally the treated water is stored in pond D, which is a fish pond.

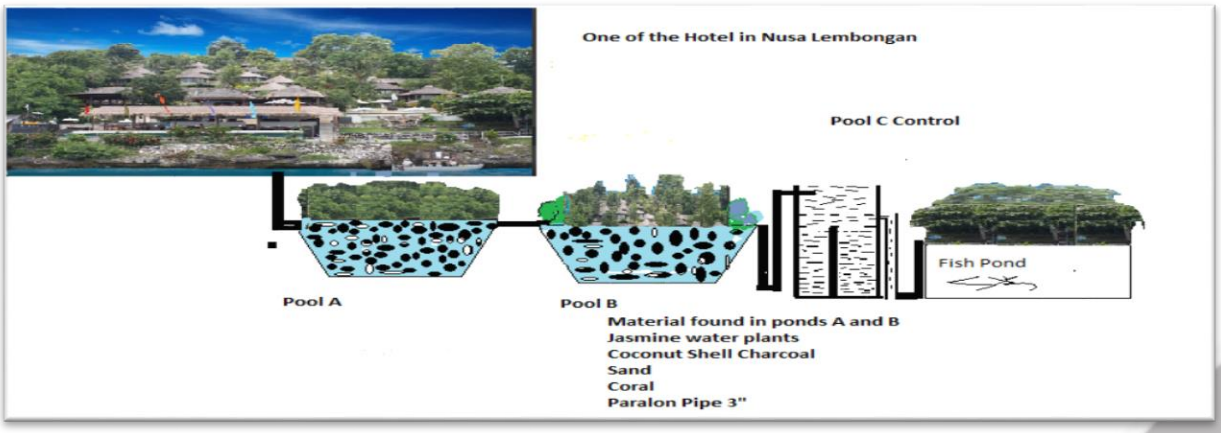

Figure 1 Manmade Pond Model

c. Sampling Techniques

Sampling technique at the water treatment installation is done twice, first before the entry of waste, second after the water comes out from the pond C. The sampling technique is the same as the first model. There are eight parameters of water quality and two parameters of microbiology, so there are ten water quality parameters.

d. Variables

The variables and the equipment used in this research can be seen in Table 1

Table 1 The variables and the equipment used.

No	Variabel	Unit	Equipment
A	Fisik		
1	Temperature	^{0}C	Thermometer
2	TDS	ppm	Analitic scales
B	Kimia		
1	DO	ppm	DO meter
2	pH	-	pH meter
3	BOD_5	ppm	Spektrofotometer
4	COD	ppm	Spektrofotometer
5	NO_3	ppm	Spektrofotometer
6	NO_2	ppm	Spektrofotometer
C	Biologi		
1	E.Coli	MPN/100 ml	Test tube
2	Coliform	MPN/ 100 ml	Test tube

e. Variables Measurement

Fair, at al. in Ardana [6] stated that in a research of water quality, not all parameters of water characteristic be examined. It depends on the purpose of the research. For water quality analysis can be done in 2 ways, namely directly in the location *(in situ)* and preservation methods carried out in the master laboratory for the water that can last a long time.

Water quality parameters which is changing quickly must be measured directly, its temperature and pH. The water quality parameters that can be frozen are directly put into the dark bottles and sterile bottles then transported to the laboratory.

f. Method Analysis

1) Method analysis of water quality

In this study the method of water quality analysis shown in table 2

Table 2 Water quality analysis methods

No	Variabel	Unit	The analytical method used
A	Fisik		
1	Temperatur	^{0}C	Mercury expansion
2	TDS	ppm	Gravimetri
B	Kimia		
1	DO	ppm	Electochemistry with DO meters
2	pH	-	pH meter
3	BOD_5	ppm	Spektrofotometrik
4	COD	ppm	Spektrofotometrik
5	NO_3	ppm	Spektrofotometrik
6	NO_2	ppm	Spektrofotometrik
C	Biologi		
1	E.Coli	MPN	Most Probably Number
2	Coliform	MPN	Most Probably Number

2) Statistical Analysis Method

The t- test for testing hypotheses is the difference between two average parameters if the sample size is small (n <30) and the standard deviation of the population is unknown, but is considered the same ($\sigma 1 = \sigma 2$)

$$t\text{-test} = \frac{(X1 - X2) - Do}{Sp\ V\left(\frac{1}{n1} + \frac{1}{n2}\right)} \quad \text{..... (1)}$$

$$Sp\ V\left(\frac{1}{n1} + \frac{1}{n2}\right) \quad \text{..... (2)}$$

$$Sp = V \frac{(n1 - 1)S^2 1 + (n2 - 1)S^2 2}{n1 + n2} \quad \text{..... (3)}$$

Information:
Critical values are seen from t-student tables with v = n1 + n2 - 2
When two-sided tests: Ho: μ = μo Ho: μ ≠ μo
The critical value is t (α, v) Reject Ho when t-count> t ((α / 2, v)

3. RESULTS AND DISCUSSION

The quality of wastewater is the conditions of material of DO, pH, BOD_5, COD, NO_2, and NO_3 that contain in the water. The results of the research is shown in Tables 3 and 4.

Waste Management of Manmade Pond Models.

Taking sample at the water treatment is done twice, before the entry of waste and in the water reservoir. The results of the sample analysis of water can be seen in Table 3

Table 3. Measurement results before and after processing of Manmade Pond models

No	Variabel	Unit	Before processing	After processing
A	Fisik			
1	Temperatur	^{0}C	30,31	21,20
2	TDS	ppm	399,10	229
B	Kimia			
1	DO	ppm	1,80	4,50
2	pH	-	9,10	6,07
3	BOD_5	ppm	3,25	2,92
4	COD	ppm	40,02	24,65
5	NO_3	ppm	22,21	5,9
6	NO_2	ppm	0,80	0,5
C	Mikrobiologi			
1	E.Coli	MPN/ 100 ml	989	96
2	Coliform	MPN/ 100 ml	900	388

The results of the waste water are then compared to the second class water quality standard, because the waste water will be used for fish ponds and watering plants. Second-class water quality standard is water which can be used for water recreation, fish cultivation, veterinary, irrigation and others.

Temperature and TDS

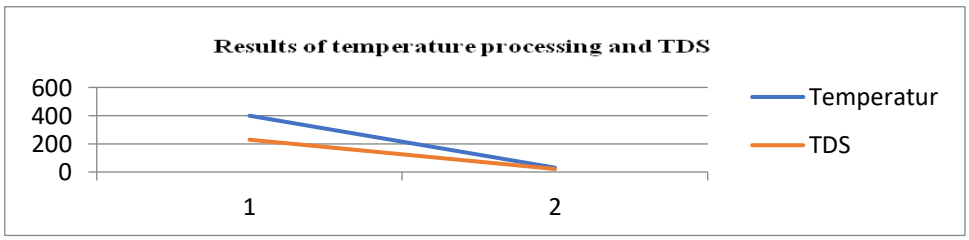

Figure 2. Results of temperature processing and TDS

The results showed that the manmade pond system is efficient enough to reduce the physical oxygen demand of 69.9% and TDS 57%.

DO and pH

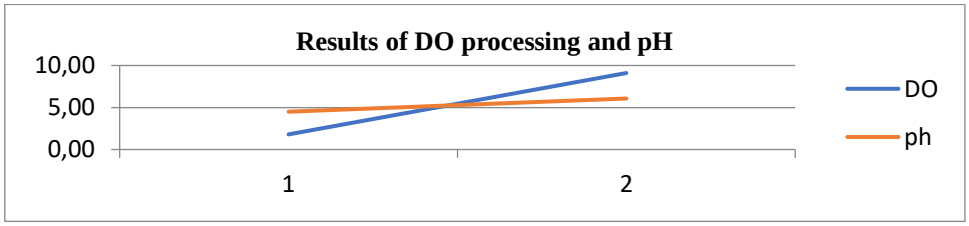

Figure 3 Results of DO processing and pH.

The results of chemical parameter analysis showed DO and pH did not exceed the maximum and minimum limit of quality standard of the water. DO has a significant change of 250 % and pH of 66.7%.

COD_5 and BOD

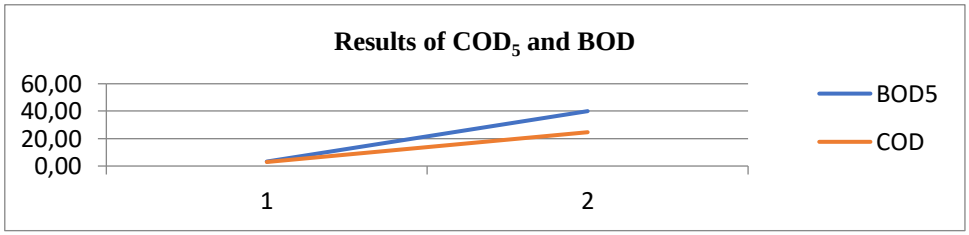

Figure 4 Decrease of COD_5 and BOD

The results showed that manmade pond system is efficient enough to reduce biological oxygen demand (BOD). The efficiency of BOD_5 reduction reached an average of 89.8% and COD is 61.6%. According to Kadlec and Knight [7], the mechanism of reduction of BOD and COD in manmade ponds is as follows: Jasmine and water hyacinth plants that grow in wetlands play a role in supplying the oxygen needed by microorganisms to remove organic and household waste. The oxygen is obtained from photosynthesis carried out by the aquatic plants which are then transformed through plant roots into the water.

NO2 and NO3

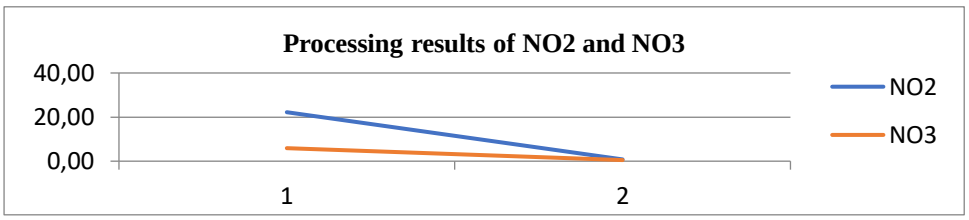

Figure 5 Decrease of NO_3 and NO_2

NO3 parameter decreased ± 26.6% but from the results of parameter processing it was over the quality standard limit for the class I, II, III quality criteria, where the NO3 parameter level was 5.9 ppm. but the standard quality criteria for class I, II and III water is 0.06 ppm. On the other hand, NO3 does not exceed the standard quality for all water classes.

Table 4. Result of t-test analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	332.021	257.985		1.287	.230
	VAR00002	1.400	.325	.821	4.313	.002

Comparison of the chemical content of the water of manmade pond models between before and after treatment using the t-test, it was found that the average water content between before and after treatment was not significantly different at the 5% of significance level. But when using a significance level of 20% between before and after the treatment, it is significantly different. This shows that after the treatment there is a decrease of the chemical content between t-test and t-table, where t-test is greater than the t-table which means a significant effect.

4. CONCLUSION

Based on the discussion and results of the research above, it can be concluded that the quality of the wastewater from the hotel which is treated using manmade pond with some plants and material such as coconut charcoal, sand and coral has advantages and disadvantages. In terms of the place manmade pond requires a rather wide place, but in terms of the environment this model is very well developed, because it has two functions (1) as a waste processor (2) as a park and a waste disposal site. Quality of wastewater from the hotel compared with the Decree of the Minister of Environment Year 1995 has not exceeded the threshold, but one parameter that has exeed the threshold is NO2 from water class I, II and III, which was low polluted. From the manmade pond model is very good because it can reduce the physical, chemical and biological variables in average of 73%.

5. SUGGESTION

Based on the conclusions above, it can be suggested that:

1. The hotel wastewater treatment process needs to be sustainable to get better results, especially in the waste process, so that no pollution.
2. Using appropriate waste treatment model and environmentally oriented to get multiple good results.

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