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GRATIS (Gravity-Fed Biofiltering System) : Application of The Water Treatment Technology for Cibaten River in Indonesia

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ABSTRACT

River is one of the resources for water because it is popular for human necessary, especially used in washing, bathing and cooking activity. At this era, the pollution is desecrated by industrial and domestic waste. Hence, the quality of water on rivers has decreased. Cibanten river located in Banten Province-Indonesia country is one of the river, whose water quality is decreased by pollution. The characteristics of Cibanten river is Total Dissolved Solid (TDS) of 416 ppm, Total Suspended Solid (TSS) of 100 - 900 ppm, pH level of 6-8. Therefore, watertreatment must be done before the water is used. Biofiltering technology with gravity system was chosen, It utilized the combination of coconut fibrous and zeolite active (activation without chemical). This Equipment called GRATIS (Gravity-fed Biofiltering System). Result from this treatment, TDS decreased to 249 ppm (sample 2) and 185 ppm (sample 3), pH increased to 7.23 (sample 3) and 8.5 (sample 2), TSS decreased to 9-115 ppm with fed water of TSS about 1048 ppm. Turbidity point decreased about 99.5 % (sample 2) and 99.7% (sample 3). BOD (biological Oxygen Demand) decreased about 83.9% (sample 2) and 87.1% (sample 3) and COD (Chemical Oxygen Demand) decreased about 30.8% (sample 2) and 38.5% (sample 3).

Keywords: *activation, biofiltering, cibanten, quality*

1. INTRODUCTION

Industrial sector in Banten develops so fast with strategic geography position of Banten. This condition leads to immigration's level. Immigrant from others region come to Banten. Hence, many people stay and live in Banten time to time. In compliance with that condition, the need of clean water increases. Province of Banten has amount of population about 9.3 million people using clean water about 164 million m^3/years. In prediction, this value will increase to be 175 million m^3/years. Industrial sector in Banten uses water about 110 million m^3/years and fifth years later will increase to be 120 million m^3/years.

River is one of water resource by which it is used for washing, bath and moreover for cooking. Banten has many conduit of river. There are Ciujung river, Cidurian, Cisadane, Cidanau, Ciliman, Cilemer and Cibanten. Cibanten's river crosses many cities with upper course in Karang mountain in Pandeglang region. It crosses from Serang city with length 35.89 km and width 194.1 km^2. Cibanten river is usually used for agriculture, city and industry.

Fig. 1. Cibanten River

Water of Cibanten river has brown color and its water quality has decreased, however many people around the river aren't thinking about this condition (Fig. 1). In a research of BLHD (Badan Lingkungan Hidup Daerah)-Serang city, TDS (Total Dissolved Solid) of Cibanten river was about 416 ppm with sample from kasemen district. In another research which is from

DSDAP (Dinas Sumber Daya Air dan Pemukiman), TSS (Total Suspended Solid) of this river is in range 100 ppm – 900 ppm and pH 6-8. Therefore, water from Cibanten river need to special treatment in order that it is safe for the people and environment.

2. METHODS

2.1 Application Techniques

The biofilter (GRATIS) used a special application technique in which natural ingredients coconut fibers and zeolite was used as a biofilter. This application technique was in accordance with the following application procedure:

2.1.1 Application Techniques of Coconut Fiber

Coconut fiber obtained from coconut trees were taken directly. It was cut and soaked in aquadest for a week to remove impurities. After that, the forming a tube from coconut fibers (Spiral Wound) was done. It surrounded the hollow pipe (0.4 – 0.5 cm). Finally, coconut fiber was used as first stage of the filter (Fig. 2 (a)).

2.1.2 Aplication Techniques of Zeolite

The zeolite was derived from Bayah, Banten, Indonesia. In order to expand the zeolite surface, zeolite was crushed by using hammer or crusher. After that, it was sieved by a sieve (Screener) with size of 40 mesh. Afterwards, it was washed by using aquadest and then it was heated at temperatures of 80-100^{o}C by using oven. After that, it was boiled in aquadest for 45 minutes for the first variation and 90 minutes for the second variation. The zeolit was used as second stage of filter (Fig. 2 b)).

2.1.3 Application of GRATIS

Biofilter equipment (GRATIS) was ready to be used to improve water quality by feeding water from Cibanten's river into the appliance. Finally, clean water was produced at appliance outlet.

3. SHAPE OF GRATIS

Gravity-fed Biofiltering System or GRATIS was a Biofilter. which is described in Fig. 2.

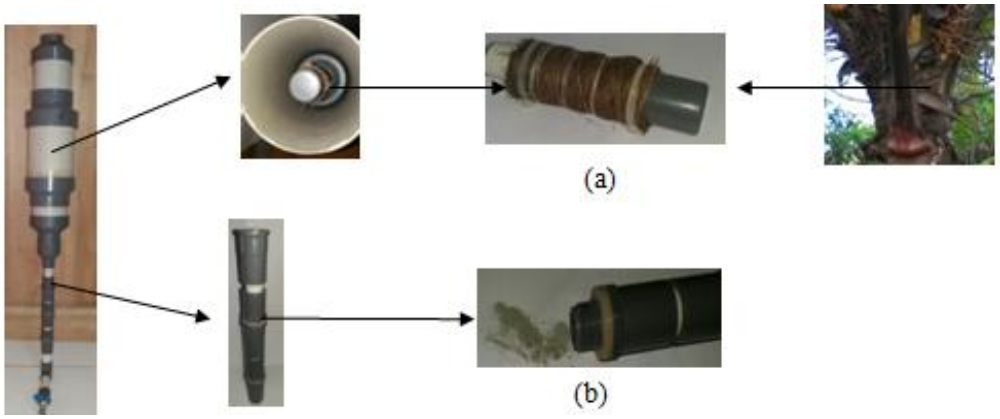

Fig. 2. Shape of GRATIS

4. RESULTS AND DISCUSSION

The results of this study can be seen in Table 1. Gravity-fed appliance of biofiltering system had two stages of filtration. First Stage, coconut fiber which served as macrofiltration. This stage could reduce the charge of second stage (±5-10%). Filter zeolit underwent several steps of processes in order to become active zeolit. The physical treatment in the form of downsizing was a step to enlarge the surface of zeolite. Zeolite with a size of 40 mesh was most effective. This size was an effective measurement (Poerwadio *et al*, 2004). When heated at temperature of 80^{o}-100^{o}C, unbound water contained in zeolite can be vaporized. Water vapor will bring impurities attached to the surface of the zeolite. The zeolite, which was heated, was as a gas or liquid absorbent (Khairinal, 2000). Furthermore, the boiling was done to reduce/eliminate Ca^{2+} and Mg^{2+} in the zeolite structure with the substitution of Ca^{2+} and Mg^{2+} in the crystal structure with H^{+} ions (from H_2O) to neutralize the structure. Activation technique by heating combined with boiling was the latest innovation in the activation of the zeolite. Acid activation can be done by using HCl or H_2SO_4 (Suryatono *et al*, 1991) while alkaline activation can be done by using NaOH or KOH (Kurniasari *et al*., 2011). Mechanism reaction during boiling activation was represented below:

$$CaO + H_2O \rightarrow Ca(OH)_2$$

$$Ca(OH)_2 + CO_2 \text{ (from air/dissolved in water)} \rightarrow CaCO_{3(s)} + H_2O$$

$CaCO_3$ was hardened in wall pan as a result of high temperature which decreased $CaCO_3$ solubility in water, White crust was formed. This was in accordance with the view expressed by Muryanto (2014) and M. Drajat (2012) which was CaCO3 solubility decreased at high temperatures. As shown in fig 3.

The crust

Fig. 3. White Crust in wall of pan

Function of active zeolites was as ion exchange (adsorben). Zeolite was capable of converting Ca^{2+} and Mg^{2+} in water with ion Na^{+} an K^{+} (Khairinal, 2000).

Table 1. Water Quality

No	Parameter	Unit	Before Treatment (sample 1)	After Treatment	
				(Boiling of zeolit for 45 minutes) Sample 2	(Boiling of zeolit for 90 minutes) Sample 3
1.	TDS	mg/L	406	249	185
2.	pH	-	6.9	8.5	7.23
3.	TSS	mg/L	1048	115	9
4.	Turbidity	NTU	1305	7	5
5.	COD	Ppm	130	90	80
6.	BOD	Ppm	93	15	12
7.	Color	-	Yellow-Brown	pure	Pure

5. CONCLUSION

Water treatment was one of important thing for necessary daily activities. So we needed simple technology with cheap and efficient installation and that technology is Gravity-fed Biofilterng System. The boiling of zeolit for 90 minutes was better than that for 45 minutes. With boiling for 90 minutes, TDS decreased from 406 to 185 ppm, pH increased from 6.9 to 7.23, TSS decreased from 1048 to 9 ppm. Turbidity point decreased about 99,5 %. BOD (biological Oxygen Demand) decreased about 87,1% and COD (Chemical Oxygen Demand) decreased about 38,5%.

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