

INFLUENCING PARAMETER OF SELF PURIFICATION PROCESS IN THE URBAN AREA OF CIKAPUNDUNG RIVER, INDONESIA

* Yonik Meilawati Yustiani¹, Mia Nurkanti², Neneng Suliasih³ and Annisa Novantri¹

¹Dept of Environmental Engineering, Engineering Faculty, Universitas Pasundan, Indonesia; ²Faculty of Education, Pasundan University, Indonesia; ³Faculty of Engineering, Pasundan University, Indonesia

*Corresponding Author, Received: 31 May 2017, Revised: 15 Aug. 2017, Accepted: 1 Dec. 2017

ABSTRACT: Self-purification process is an important process in the effort of recovering the river condition itself. This process usually takes place naturally. However, several inhibitions might disturb the process. It was indicated by the slow deoxygenation rate and unhealthy river condition. This research aims to identify the influence parameters responsible for the slow of self-purification in the Cikapundung River, which is located in the urban area of Bandung City, Indonesia. The river water samples were taken and analyzed in the laboratory to obtain the water quality. The deoxygenation rate was also calculated based on the Slope Method after data was acquired from 10 days daily observation. Research showed that the value of urban river deoxygenation rate is relatively low. The low value of the rate of deoxygenation led to the difficulty in rivers to purify themselves. Pollutants inhibiting the process include phenol, detergent, and heavy metals, which are contaminating the river over the maximum standard. Biologically, the decomposer consists in the river is few. It leads to a slow organic degradation rate. The condition is representing the low capacity of self-purification of the Cikapundung River which is caused mainly by chemical and biological parameters.

Keywords: Deoxygenation Rate, Self-purification, Urban river, Water quality

1. INTRODUCTION

Cikapundung River is a river that passes through Bandung. As the capital of West Java Province, Bandung City is a city with a large population, which is more than 2.4 million people. The rapid development of the population stimulates the growth of settlements on the banks of the Cikapundung River without adequate sanitation facilities. Cikapundung River becomes a place of disposal of liquid waste from the activity around the river banks.

Rivers in urban areas, including Cikapundung, have various functions, such as drinking water sources, recreational locations and main drainage canal [1]. The river is the main natural and ecological site from a water management perspective [2]. Some parameters are set in the quality standards to maintain the health of the river.

The organic pollutant can be removed naturally in rivers. The process is performed by microorganisms. Several physicals, chemical, and biological activities involved in the river water organic pollutant degradation. Many of these physical and chemical activities are influenced by the biological condition. The removal of pollutants from a water body without any artificial controls is called self-purification, or natural purification [3].

Many urban rivers in Indonesia suffer from heavy pollution. Their capabilities to perform self-purification appear relatively low and resulting in

the deterioration of the water quality, physically, chemically and biologically.

Degradation of organic pollutants is primarily affected by the river water characteristic. Contaminants generated from industries can threaten river capability of self-purification. Several indicators can be used to explain how the natural remediation of the river cannot be carried out. This research was conducted to investigate the influencing parameter of self-purification process in the urban area of Cikapundung River. The result can be useful to track the pollutant sources and handle the issue from the initial causes.

BOD (biochemical oxygen demand) and COD (chemical oxygen demand) are 2 essential parameters of water quality to describe the organic pollutant condition of rivers. Thus BOD and COD are two widely used parameters for organic pollution measurement [4].

BOD (Biochemical Oxygen Demand) has a strong relationship with DO because it indicates the need for oxygen to decompose organic matter in the waters. Therefore, BOD becomes an important factor to evaluate the level of pollution of organic matter in the river [5]. Deoxygenation is the process of decreasing the amount of oxygen that occurs due to the use of oxygen by microorganisms to decompose pollutants into the aquatic bodies [6]. The deoxygenation process is an important process in the effort of the river to self-purification process, i.e. degradation of bio-

degradable organic pollutants to re-clean the water. The rate of the deoxygenation process affects the sooner or later self-purification takes place. The rate of deoxygenation rate is also an important tribe in the Streeter-Phelps equation which is always used to model the quality of river water. The rate of deoxygenation rate can be specific if it is in an area with different temperatures. In addition, the quality of the river, the presence of matter and pollutants in the river will affect the rate of deoxygenation. Research on deoxygenation is very rare in Indonesia.

The non-optimization of the work of decomposing microorganisms is also one of the factors that influence the process of self-purification in the river. Therefore, in this study, the condition of decomposer microorganisms becomes one of the components to be studied.

2. METHODOLOGY

2.1 Research Location

Cikapundung River is chosen to represent the urban city river. Figure 1 shows the location of the Cikapundung River.

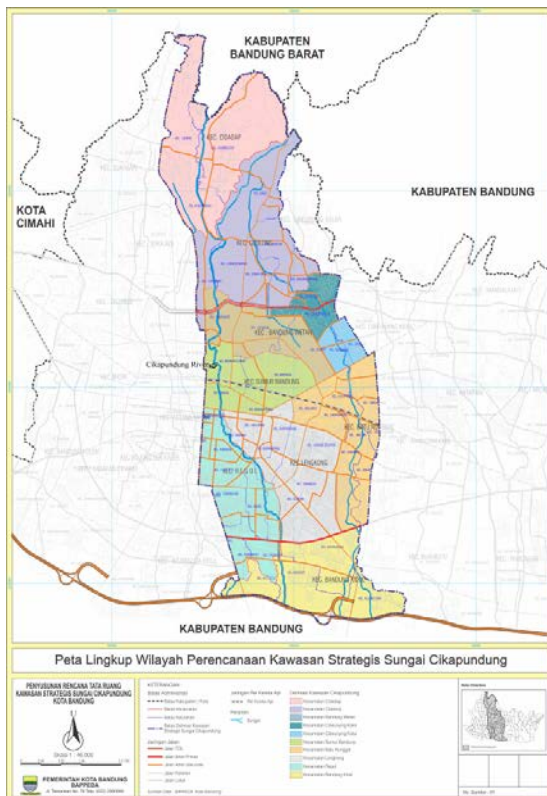


Fig.1 Research location and sampling points [10].

The rivers pass through Bandung City's most crowded area [7]. The Cikapundung river water quality suffers from the wastewater that being

disposed of directly without prior proper treatment. The condition stimulates the worse quality of the river water. Not only polluted by the untreated wastewater, the river is also suffering from the solid waste. Cikapundung River plays a very strategic role as one source of water supply for Bandung, but its water quality decreased for several years [8]. Besides that, the Cikapundung river basin is one of the sub watershed Citarum that serves as the main drainage channel of Bandung [9].

2.2 Data Collection

Data was collected from previous research and also from the government agency that performs periodic monitoring on the rivers. Measurement of river water quality is conducted regularly by the Environmental Protection Agency of Bandung City and West Java Province. Several points were appointed as sampling locations. The data were then being calculated to have average values.

Primary data was also obtained by laboratory analysis of the river water samples to investigate the type of microorganisms living in the water.

2.3 Parameters

The investigated parameters to determine the self-purification process in the urban river are including deoxygenation rate, BOD/COD ratio, heavy metals and surfactant concentration. The deoxygenation rate will indicate the degradation process of organic matter. BOD/COD ratio can describe the biodegradation capacity of the river [3]. Heavy metals and surfactant were considered as the inhibitors of decomposition process by microorganisms.

3. RESULT AND DISCUSSION

3.1 Deoxygenation Rates

Table 1 shows the deoxygenation rate of Cikapundung River water located in the upstream and downstream of Bandung City area.

Table 1 Deoxygenation rates of Cikapundung River

Year	Deoxygenation rate			
	Upstream		Downstream	
	Dry Season	Rainy Season	Dry Season	Rainy Season
2011	0.146	0.190	0.023	0.260
2012	0.016	0.100	0.080	0.010
2013	0.240	0.240	0.030	0.370
2014	0.130	0.120	0.190	0.290

The deoxygenation rate obtained from the studies ranged from 0.010 to 0.370 per day. It was found that deoxygenation rate value was relatively low at several times. This low rate of deoxygenation causes the slow recovery of organic pollution in the river. Seasons do not appear as an influencing factor for the deoxygenation rate value. Generally, there is no significant trend that differentiates between dry season and rainy season [7].

The typical range of the deoxygenation rate for the surface water is 0.10-0.23 mg/L [11]. As a comparison, the rates of deoxygenation of rivers outside Indonesia are found in the typical range such as Ravi River in Pakistan has 0.14-0.27 per day [12], and Gomti River in India has 0.45 per day [13].

The low rate of deoxygenation is typically found in the clean water without organic matter and microorganisms. The low of deoxygenation rate can also be caused by the turbulent condition of river flow [14].

3.2 BOD/COD Ratio

The Fig. 2 depicts the calculation of BOD/COD ratio of Cikapundung River water during 2012-2014. The values were determined based on the periodical data of the river water quality.

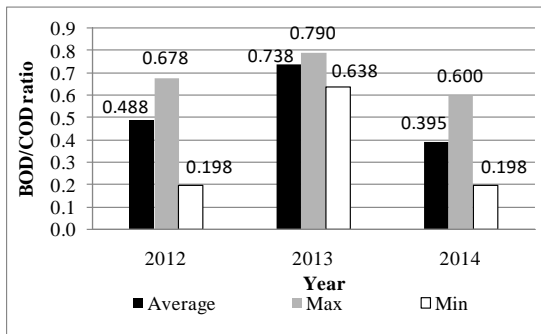


Fig. 2 BOD/COD ratio observed.

The range of BOD/COD ratio is 0.198-0.790. A value of more than 0.5 of BOD/COD ratio indicates rapid biodegradation, and a range of 0.2-0.4 specifies biodegradation only in favorable thermal condition [15]. The ratio of Cikapundung River water mainly denotes the rapid biodegradation process. It probably occurred in the anaerobic condition.

Considering the processes indicated by the deoxygenation rate, i.e. oxidation of organic material and aquatic plants respiration, the low value of the rate can probably denote a non-optimal condition of the processes. Decomposition of organic matter by the microorganism can be

inhibited by several conditions, such as toxic material and heavy metals. The river quality data of Cikapundung show that several heavy metals were detected above the concentrations standard, i.e. Cr+6, Zn, Mn, Cu, and Pb. Research on the impact of the heavy metal on the biodegradation of organic matter is not generally explained, however, the metals have potency on inhibiting biodegradation of pollutants under both aerobic and anaerobic conditions [16]. Heavy metals form complexes with protein molecules that causing inactivation of cells [17].

In the surface water, heavy metals consider as toxic substances to the mixed culture of microorganisms responsible for the decomposition of organic matter [18]. The decomposing microorganisms play an important role in the self-purification of a polluted river, thus heavy metals pollution might weaken the capability of the river to purify itself.

Based on the laboratory analysis for identification of living decomposer microorganisms in the water, it was found that the only living bacterium was Bacillus sp type. This bacterium is the most active decomposer of organic matter in the river water. Consortiums of the Bacillus sp can effectively reduce organic pollutants [19]. Bacillus sp is non-pathogenic organisms [20]. Fungi that were existed include Penicillium sp, Aspergillus sp, and Cladosporium sp. Several of the species in genus Penicillium and Aspergillus are known to produce mycotoxins in other substrates [21]. Those fungi are usually found in the treated and untreated water. Aspergillus and Penicillium spores are the most widespread aeroallergens in the world [22].

The activity of washing can also pollute the river, especially with the surfactant contaminant. It can affect the deoxygenation rate. An experimental substantiation was given to the potential environmental significance of the effect caused by the influence of synthetic surfactants on hydrobionts and the relationship between these effects and the hazard of anthropogenic impact on the processes of water self-purification [23]. Surfactants are diverse and amphiphilic compounds which can reduce surface and interfacial tensions [24].

4. CONCLUSION

The deoxygenation rate of Cikapundung is quite low, indicating the slow process of self-purification. However, the ratio of BOD/COD shows that the water has potential rapid biodegradation rate.

The existence of heavy metals, synthetic surfactant, antimicrobial substances, indicate the

unhealthy condition, especially in considering the self-purification process. Toxic pollutants from various activities would inhibit the microorganism to live in the river water and to decompose the organic pollutants.

5. ACKNOWLEDGEMENTS

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