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# The effectiveness of biopore technology on infiltration rate and organic waste processing

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**Abstract.** An environmental problem that often occurs during the rainy season is standing rainwater. Therefore, some water catchment areas are needed to reduce standing water that will minimize environmental damage instead. In densely populated urban areas the available space for water infiltration is very limited. Using biopore infiltration holes' technology which uses organic waste to increase the rate of water infiltration into the soil can be an alternative solution. This study aims to determine the effectiveness of biopore infiltration holes with organic waste treatment to increase the rate of infiltration of soil. The methodology used in this study is the Horton test, in which biopore infiltration holes are using PVC pipes with various diameter 3 in, 4 in, and 5 in. The measurement of the infiltration rate observed by decrease in water level every interval of 5 min, 10 min, 15 min, 20 min, 25 min, and 30 min continually. The results show that the effectiveness of biopore infiltration holes using PVC pipe with a diameter of 3 in, 4 in and 5 in are increasing 62.92%, 70.60%, and 54.11% respectively.

## 1. Introduction

Research on biopore infiltration holes can be carried out by observing a number of predetermined standards, so that this technology can be maximally utilized and is able to minimize environmental damage. This standard specifies how to plan rainwater infiltration wells for yard land including general and technical requirements [1]. Measurement of the infiltration rate can be carried out at ground level, at a certain depth, on vacant land, or on vegetated land [2]. The increase in development activities results in reduced water catchment areas which cause environmental damage [3], the Biopore Infiltration Hole Technology is the solution. The hole is made perpendicularly (vertically) into the ground, with a diameter of 10-25 cm and a depth of about 100 cm or not exceeding the depth of the ground water level [4] by taking into account the measurement of soil permeability is very important for several purposes, for example the entry of air into the soil, motion of water to plant roots, drainage water flow, air evaporation at the soil surface [5]. Biopore Infiltration Hole (LRB) is a simple and effective technology but it effectively increases the in-situ permeability coefficient [6]. The type of silt clay soil that has soil permeability is included in the slow class, so that during the rainy season, run off occurs which results in a reduced area of rainwater infiltration [7]. The biopore infiltration holes are "activated" by providing organic waste. This trash will be used as an energy source for soil organisms to carry out its activities through the decomposition process [8]. The hole infiltration biopori serves to reduce storm water runoff by applying them to the ground so as to minimize the possibility of floods [9] is an important and



effective for technique applying biopore holes in tackling flood problem so that it can increase water catchment areas [10].

## 2. Methods

This research was conducted at Jalan Jati Tengah Raya, Bekasi City, Indonesia. The test point is divided into three samples, namely Sample 1, Sample 2, and Sample 3 at one location. In this study, using Pvc pipe with a diameter of 3 inches, 4 inches, and 5 inches. and Compaction testing was carried out at the Laboratory of Soil Mechanics, Christian University of Indonesia, Jakarta. The discussion in this research includes testing soil density and soil water content, testing the biopore infiltration holes before adding organic matter, testing the biopore infiltration holes after adding organic matter, and observing the degradation activity of organic waste.

## 3. Results and Discussions

In the discussion, following the standards set for the manufacture of biopore infiltration holes such as PERMENLH Number 12 of 2009 [1] and SNI-03-2453-2002 [2].

### 3.1. Soil density and water content

Based on the results of the soil density test, it can be concluded that a high level of soil density occurs in soil holes with a diameter of 4 in, and soil holes with a diameter of 5 in, this results in a longer infiltration rate. Soil physical properties affect the spread of soil pores which in turn can affect the infiltration rate. and soil sampling for checking the moisture content is carried out after soil density inspection. It was concluded that the highest level of groundwater content was found in PVC pipes with a diameter of 3 in, followed by PVC pipes with a diameter of 5 in. while the lowest water content was found in the 4' inch diameter PVC pipe which was 23.37%. So that water content is a determinant of the infiltration rate, where if the level of soil water content is high, the soil density is low, the soil water content and soil density affect the infiltration capacity.

### 3.2. Infiltration rate without biopore hole

In this study, using a 100cm ruler and stopwatch, the PVC pipe is inserted into the ground 40cm. This test is carried out on a pipe with a pipe diameter of 3 in, 4 in, and 5 in. The test was carried out twice. The measurement of the infiltration rate in the biopore infiltration hole was carried out before the addition of organic material. Below are the results of the infiltration rate measurement. The following are the data on the results of the infiltration rate testing on each PVC pipe, using a 100 cm ruler and a stopwatch (03-2453-2002, SNI).

**Table 1.** Hole infiltration rate without biopores on 3' PVC pipe.

T (Min)	Infiltration Rate (cm/min)		
	Stage 1	Stage 2	Average
5	1.150	0.600	0.875
10	0.920	0.470	0.700
15	0.760	0.380	0.565
20	0.600	0.200	0.410
25	0.400	0.200	0.300
30	0.400	0.200	0.300

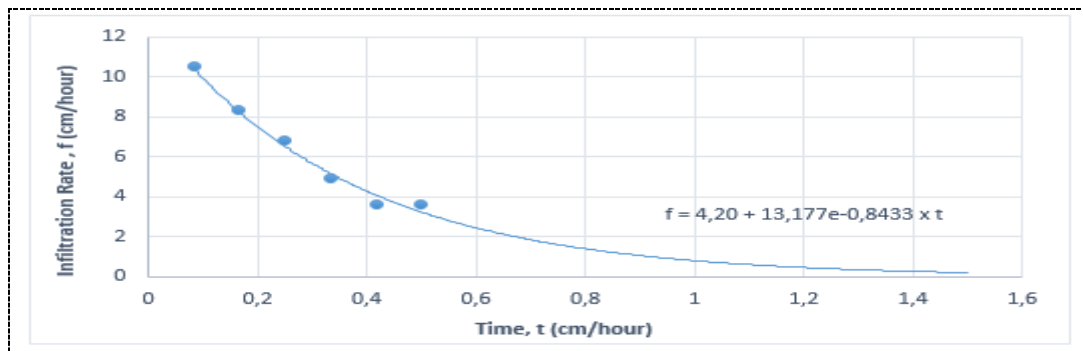
**Table 2.** Hole infiltration rate without biopores on 4’ PVC pipe.

T (Min)	Infiltration Rate (cm/min)		
	Stage 1	Stage 2	Average
5	1.430	1.300	1.370
10	1.250	1.160	1.210
15	1.140	1.000	1.070
20	1.070	0.940	1.005
25	1.000	0.750	0.875
30	1.000	0.750	0.875

**Table 3.** Hole infiltration rate without biopores on 5’ PVC pipe

T (Min)	Infiltration Rate (cm/min)		
	Stage 1	Stage 2	Average
5	1.580	1.200	1.390
10	1.300	0.000	1.150
15	1.220	0.820	1.020
20	1.000	0.650	0.825
25	0.850	0.500	0.575
30	0.850	0.500	0.575

To get the initial infiltration rate (fo) is to make a fitting curve infiltration from time data (t) and infiltration rate (f). making this infiltration fitting curve as shown in Figure 1.

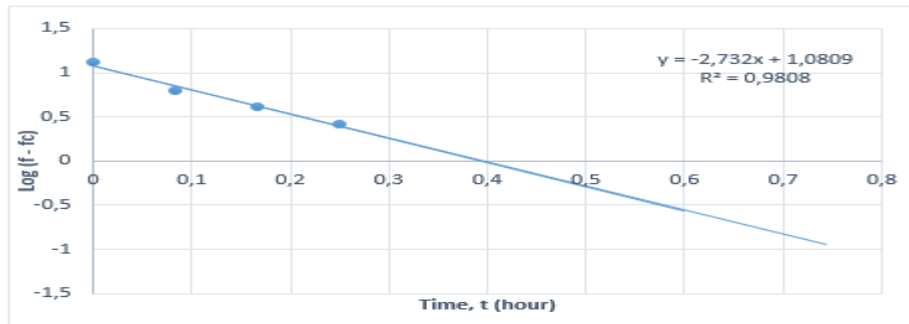


**Figure 1.** Horton method infiltration fitting curve on 3’ PVC pipe.

Calculation of infiltration parameters on a 3 in diameter PVC pipe with  $f_c = 0.35$  at time (t) 5 minutes or 0.0833 hours. The results of the calculation of infiltration parameters on a 3 in diameter PVC pipe can be seen in the following Table 4. as follow:

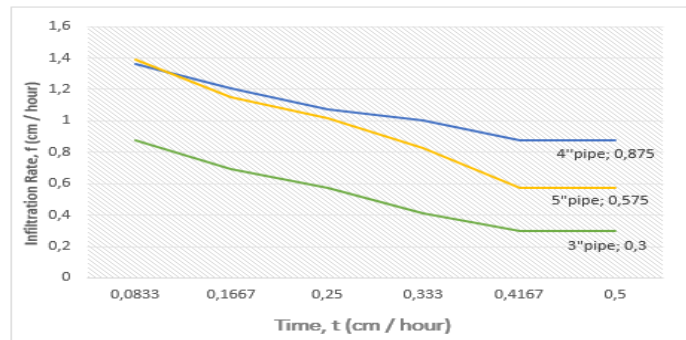
**Table 4.** Calculation of the infiltration parameter point I.

T (Min)	Research location 3’PVC Pipe				
	$\Delta H$ (cm)	F cm/hour	$f_c$ cm/hour	$f-f_c$ cm/hour	Log (f- $f_c$ )
0	0.000	17.377	4.2	13.177	1.1198
5	0.875	10.500	4.2	6.300	0.7993
10	0.695	8.340	4.2	4.140	0.6170
15	0.570	6.840	4.2	2.640	0.4216
20	0.410	4.920	4.2	0.720	-
25	0.300	3.600	4.2	-	-
30	0.300	3.600	4.2	-	-



**Figure 2.** Graph of the relationship between time (t) and log (f - fc).

From the results calculation of the infiltration capacity that has been carried out on PVC pipes with a diameter of 3 in, 4 in, and 5 in. it can be explained that the 3 inch PVC pipe has the greatest infiltration capacity, which is 12.844 cm/hour than the 4 inch PVC pipe and 5 inch PVC pipe, this is because the faster the infiltration rate, the greater the infiltration capacity.



**Figure 3.** Graph of the infiltration rate of the research location Point I, Point II, Point III.

From Figure 3, it can be explained that the initial infiltration rate moves quickly and the longer the infiltration rate becomes smaller and slower. This infiltration rate is mediated by time, where if the time is longer, the infiltration rate will be slower. The calculation of the total volume of infiltration water is assumed to be in an area of 1m<sup>2</sup> for 30 minutes (half an hour). The following is an example of calculating the total infiltration water on each PVC pipe with a diameter of 3 in, 4 in, and 5 in.

**Table 5. Total volume of infiltration water**

Parameter	Type of Land Cover		
	3 in pipe	4 in pipe	5 in pipe
Location			
Infiltration Capacity, F (cm/hour)	8.7091	16.296	10.9716
Infiltration Water Volume Area 1 m <sup>2</sup> , Vt (m <sup>3</sup> )	0.87091	0.16296	0.109716

From the calculation of the total infiltration water volume on a PVC pipe with a diameter of 3 in, 4 in, and 5 in, it can be concluded that the largest water volume is in a pipe with a diameter of 5 in, which is 0.87091 m<sup>3</sup>. Meanwhile, the 3-inch and 4-inch pipes have the smallest infiltration water volume value. so the faster the infiltration rate, the greater the total volume of infiltration water. The infiltration capacity is the maximum infiltration rate value. From the infiltration capacity value in this study, it can be discussed about the relationship between soil water content and the relationship between soil density and the amount of infiltration capacity. In the biopore infiltration hole research, the 3 inch PVC pipe

has the smallest value of infiltration capacity and the total volume of infiltration water. This is because the 3 inch PVC pipe biopore infiltration hole has a low soil density value and has a high groundwater content. causing the infiltration rate to accelerate.

### 3.3. Examination infiltration rate with biopore

In this study, using a 100cm ruler and a stopwatch, the PVC pipe was inserted into the ground 40cm. This test is carried out on pipes with a pipe diameter of 3 in, 4 in, and 5 in. The test is carried out twice. The measurement of the infiltration rate in the biopore infiltration holes was carried out after the addition of organic matter. Following are the results of the measurement of the infiltration rate. The following is the data on the results of testing the infiltration rate on each PVC pipe using a 100cm ruler and a stopwatch. (7752-2012, SNI.). Based on SK SNI 03-3449-2000 of a light weight concrete compressive strength system for normal structure, test results met the standards. Comparison of the infiltration rate of holes without bio-pores and holes with bio-pores can be seen in Figure 4,5,6 below:

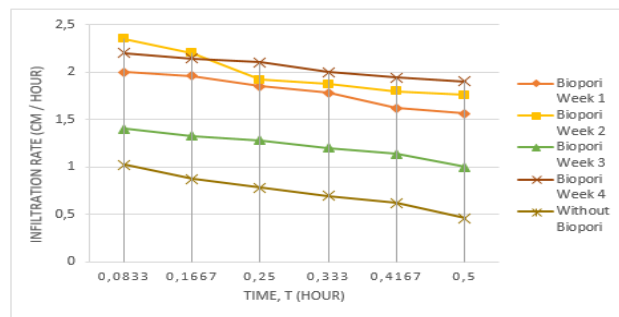


Figure 4. Comparison of infiltration rates with and without bio-pores 3' PVC pipe.

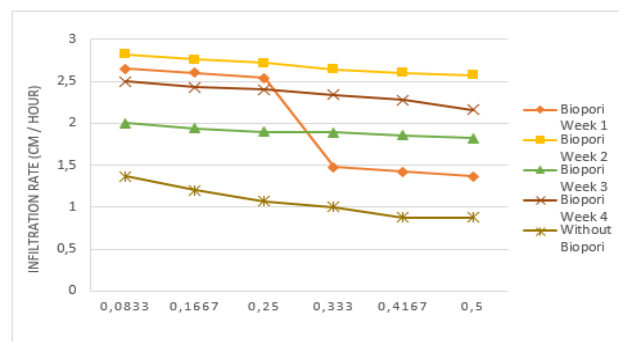


Figure 5. Comparison of infiltration rates with and without bio-pores 4' PVC pipe.

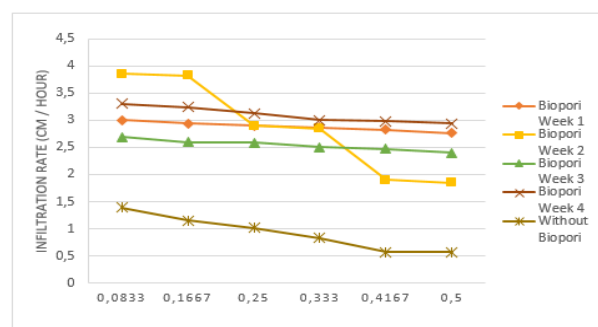


Figure 6. Comparison of infiltration rates with and without bio-pores 5' PVC pipe.

The infiltration rate graph above shows that LRB with household waste content has the highest infiltration rate value compared to LRB without organic matter, this is because the amount of water that infiltrates depends on the biopore formation process in each type of waste. These bio-pores are formed as a result of the activity of microorganisms in decomposing or degrading waste, household organic materials are greater in absorbing water that is poured into the biopore hole. Provision of organic matter has been shown to increase the activity of organisms in the soil. The influence of soil organisms on the infiltration rate is mainly related to the formation and stabilization of soil texture, as well as the formation of pores so as to increase porosity in the soil both by animal activity (macro and micro), so to increase pore formation, organic matter must be available as an energy source for organisms.

#### 3.4. Degradation activity of organic waste

The results of field observations on the texture of waste, it can be concluded that changes in the texture of waste are being regenerated by microorganisms that live during the composting process. The texture of the garbage at the beginning of the observation has a coarse texture, and over time and the influence of the activity of microorganisms, the texture of the garbage changes to become smooth, resembling the texture of the soil. The results of the observations made on the color of the garbage were that the color of organic waste stored in the biopore hole did not resemble the color of the soil. The color change that occurs shows quite good results, the activity of microorganisms in active soil changes the color of the waste over time. The results of observations on the smell of the treated organic waste have various odors, some smell and some have no smell, this is due to the imperfect composting process.

#### 4. Conclusion

The results of the analysis of the effectiveness of biopore technology in each infiltration hole using PVC pipe with a diameter of 3 in have a value of 62.92%, a diameter of 4 in has a value of 70.60%, and a diameter of 5 in has a value of 54.11%. So it can be concluded that the most effective use of PVC pipes is on pipes with a diameter of 4 in, and the standard for using PVC pipes for biopore infiltration hole technology is a minimum diameter of 4 in, which has been regulated in according to the Regulation of the Minister of the Environment Number 12 of 2009. It can be concluded that biopore infiltration holes are very effective in tackling floods, accumulation of garbage, and various diseases, biopore technology plays an important role in minimizing environmental damage.

#### Acknowledgment

This paper is purely my final project research, which I have defended during the trial and has been summarized so that it is easier to understand, with several citations from several sources that support the completeness of the required material.

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