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CORRELATION BETWEEN QUALITY AND QUANTITY FROM POLLUTANTS ABSORPTION BY SOIL TO THE APPLICATION OF INFILTRATION GALLERY

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ABSTRACT

Water treatment with conventional system is unable to produce drinking water. Therefore, it takes a treatment that serves as pretreatment in water supply system by using soil filtration. The soil used as a filter is the type of soil from each case study area. This soil filter is called by infiltration gallery, that using a soil purification system which is collected in a perforated pipe and flow to the collecting well. The analysis method of this study uses water content, porosity, permeability, specific gravity, and soil weight. The results showed that soil characteristics of sandy loamy have good ability to infiltration gallery media around riverbanks.

KEY WORDS : Infiltration gallery, Water treatment, Soil.

INTRODUCTION

The infiltration gallery method utilizes a natural soil filtration system to collected in a perforated pipe and flow to the collecting wells (Asare and Bosque-Hamilton, 2004; Barbiero *et al*., 2008). There are two types of infilration gallery, mounted below and parallel to the riverbanks. Installation of pipe gallery has a certain distance from the edge of the river/ lake (Asare. EB and Bosque-Hamilton, 2004), And also the depth, diameter of the pipe, and the specific perforated diameter. Infiltration gallery is installed with a depth of 3-5 m to collect percolated water and can be installed across the river (Bhattacharya, 2010). Infiltration gallery is installed in the vadose zone. Vadose zone is is not saturated water zone, so that the type of soil can be passed by water. The vadose zone is divided by two based on different diameters of sand and the ratio of sand- clay. Appointment of vadose zone by comparing the rate of groundwater, water level, and soil moisture (Bekele *et al*., 2009). River bank and infiltration gallery are capable of reducing organic, pharmaceutical, microbiological, and toxic substances from algae (Jekel and Heinzmann, 2013). Application of infiltration gallery in South Nassau City New York is capable to process 770 kg/day nitrate, 3800 kg/day cloride and 24800 kg/day TSS Sulam and Ku, 1977. Infiltration gallery can decrease schistosoma mansoni and *E. coli* in tap water of the people in St Lucia West India (Davies, Cheryl *et al*., 1991; Touil *et al*., 2014). Biological parameters treated by infiltration gallery in Goviefe-Agodome showed that the total coli could be filtered 94% of influents of 388/100 mL to 24/100 mL. According to WHO the allowable is 0 - 10/100 mL. Fecal Coliform decreased by 91%. Water treatment by river bed infiltration gallery method can provide additional mineral in drinking water (Barbiero *et al*., 2008). Australia install infiltration gallery at 0.5 m to 10 m in an unsaturated zone of water (Rummler *et al*., 2015). Infiltration gallery is quite cheap, simple, can

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increase the rate of filtration, and hydraulic gradient. The lack of infiltration gallery is the presence of water loses due to evaporation Martin and Dillion, 2002. River bed can decrease turbidity parameter by 96% and Total Kjeldahl Nitrogen (TKN) by > 99% (Wiese *et al.*, 2016). Infiltration galery can reduce nitrite with variation of soil type and water level depth (Asare. EB and Bosque-Hamilton, 2004). Infiltration gallery is less effective in reduce Nitrate and Phospor. Therefore the installation should be kept away from the agricultural area. Thus, a preliminary research on soil characteristics in eastern Java is required as a discourse for the application of Infiltration Gallery.

LITERATURE REVIEW

Soil Characteristics

Soil is defined as a material consisting of grains of solid minerals not chemically bound to each other and from decayed organic materials accompanied by liquids and gases that fill the empty spaces between solid particles. Soil ingredients consist of three soil components: soil particle (solid), water, and air. The tendency on the soil mutually bound and form what is called the soil structure. In general, soil is divided into two types, namely coarse and fine grained soil. Coarse graines soils are usually called granular materials or non-cohesion soils, while fine grained soils are often called cohesion soils. Table 1 shows the main soil classes based on grain size limits.

Particle Size

U.S. Departement of Agriculture (USDA) making a soil classification system based on soil texture. Soil texture is the state of the soil smoothness that occurs because the different composition of gravel fraction content, sand, dust, and clay contained in the soil. Soil texture is composed of grains of soil with various sizes. The fraction of soil particle has the largest diameter size that is more than 2 mm, sand with size 0,05 - 2 mm, dust with size 0,002 - 0,05 mm and clay with size less than 0,002 mm.

To describe the soil based on its particle size, some organizations develop the size limit of the soil type classes. The organization consists of Massachussetts Institute of Technology (MIT), U.S. Departement of Agriculture (USDA), American Association of State Highway and Transportation Officials (AASHTO) and by U.S. Army Corps of Engineers and U.S. Bureau of Reclamation which then generate Unified Soil Classification System (USCS). The particle size can be classified into gravel, sand, silt, and clay (Table 2).

Table 1. The main soil class with grain size limits

Course grained soil				Fine grained soil	
gravel	Pasir			silt	clay
	course	medium	fine		
60	2	0,6	0,2	0,06	0,002

RESULT AND DISCUSSION

In this study, the soil classification system uses soil texture based on U.S. Departement of Agriculture (USDA). USDA distinguishes the soil texture based on the limits of particle soil. Table 3 shows the results of particle size determination by the weight of each sieve diameter.

The results of the laboratory analysis are then applied to the Soil Texture Triangle Diagram. The soil texture triangle is a diagram to determine the soil texture classes and is divided into 12 textures. Twelve different textures are based on the percentage of sand, dust and clay fractions (Table 4).

Laboratory results indicate that the percentage of Madura soils for the fraction of sand, dust and clay are respectively 16%, 31%, and 53%. Based on the soil texture triangle diagram, Madura land into the soil textured clay class (Table 5). The clay can be shaped like a ball and made easily, if it is held heavy and smooth and very sticky. The clay soil feels a bit

Tabel 2. Particle size

Organization	Particle size (mm)			
	Gravel	Sand	Silt	Clay
Massachussetts Institute of Technology (MIT)	>2	2- 0,06	0,06 – 0,002	<0,002
U.S. Departement of Agriculture (USDA)	>2	2 – 0,05	0,05 – 0,002	<0,002
American Association of State Highway dan Transportation Officials (AASHTO)	76,2 - 2	2 – 0,075	0,0075 – 0,002	<0,002
U.S. Army Corps of Engineers dan U.S. Bureau of Reclamation	76,2- 4,75	4,75 – 0,075	fine (silt and clay) <0,0075	

Table 3. Particle size determination by the weight of each sieve diameter

Sieve diameter		Weight (gram)					
Number of sieves	Sieve	Mojokerto	Lumajang	Madura	Gresik	Sidoarjo	Surabaya
4	4,75	0,561	0,7	0	34,792	13,292	0,121
10	2	0,453	0,19	0,132	14,459	6,201	1,116
20	0,85	3,824	2,963	0,175	12,467	5,713	0,991
40	0,425	6,706	12,732	0,966	17,455	9,991	1,412
100	0,149	11,692	17,722	10,979	25,739	16,938	9,104
200	0,075	9,832	11,091	11,564	7,182	9,635	10,272

Source: research result, 2016

Table 4. Percentage of particle size distribution

No	Soil samples	Sand (%)	Silt (%)	Clay (%)
1	Lumajang	55,0	10,0	35,0
2	Mojokerto	60,0	5,0	30,0
3	Madura	16,2	30,5	53,3
4	Sidoarjo	70,0	15,0	15,0
5	Gresik	16,0	30,0	53,0
6	Surabaya	55,0	45,0	0,0

Source : research result, 2016

slippery, a little easy to attach and if rolled up a little easily crumbled. While the clay soil if formed into rolls, the surface will shine, can be formed a bit firm and does not feel rough and slippery.

Table 5. Type of soil

No	Soil samples	Soil Charateristic
1	Lumajang	sand loamy
2	Mojokerto	Sand loamy
3	Madura	clay
4	Sidoarjo	sand loamy
5	Gresik	clay
6	Surabaya	sand loamy

Souce: analysis results

In this study, the simulation of the ability of each soil of each region in reducing TDS. TDS is chosen because it is a mineral parameter whose diameter can be smaller than TSS. This is as a test of the ability of the pores of the soil in the filter, because according to (Kusuma *et al.*, 2016), that pore size affects filtering. It has been shown that the soil is capable of reducing pollutants (Valdes *et al*., 2014) (Fig. 1). Other things that affect the decrease in TDS concentration are hydraulic conductivity, bilogical processes, and chemical processes (Hasenmueller *et al*., 2015; Jurel. E.R.S *et al*., 2013; Nham *et al*., 2015; Shwetha and Varija. Kb. 2015; Yoon and El Mohtar, 2015).

Figure 2 shows a decrease in the quantity of water, this is due to mechanical fouling and bilogical fouling (Touil *et al.*, 2014. Mentges *et al.*, 2016 says that high humidity affects the flow of water. The incoming water flow can erode the soil by 1.4 to 26.3% (20), then there is possibility of high turbidity. Capacity of water treated by soil is 50% -70%, Water losses in soil caused evaporation by 10% and percolation by 10% (Bhattacharya. A.K 2010).

CONCLUSION

Soil type for infiltration gallery media is better to use

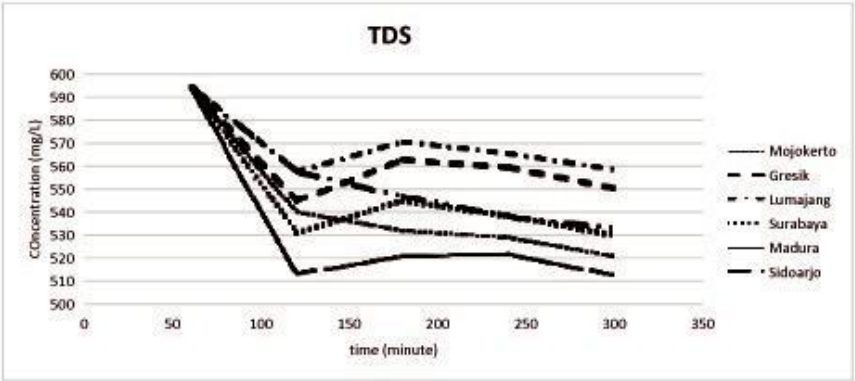

Fig. 1. TDS concentration reduction

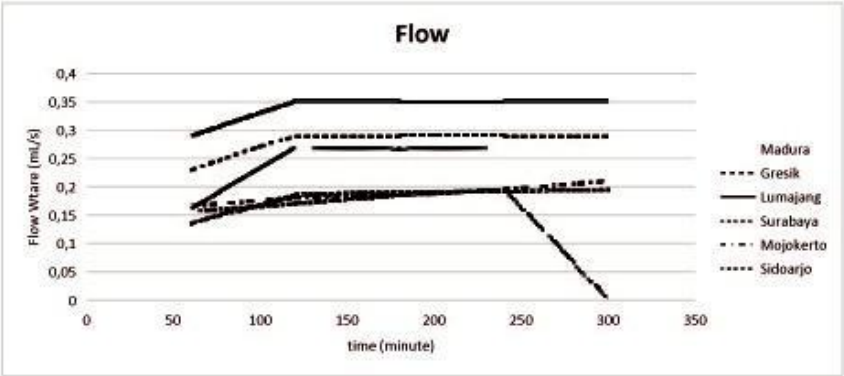

Fig. 2. Decrease in flows

sandy loamy because the level of permebilitas is better than clay class although clay is better for the quality. Thus the soil samples used for subsequent research used soil samples from lumajang, Mojokero, Sidoarjo, and Surabaya.

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