Rainwater quality improvement using zeolite, activated carbon, limestone and preheated 400°C limestone

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Abstract. Resources of clean water have decreased significantly in recent years, one of the reasons is water pollution. Utilization of rainwater as clean water resource is among the best option, especially in big cities like Jakarta. Excessive rainwater during wet season can be saved and used as the source of clean water during dry seasons. However, rainwater contains some pollutants, thus suitable treatment method should be utilized to improve its quality as clean water for daily needs. This study compared the effectiveness of zeolite, limestone, activated carbon and preheated 400°C limestone as additive to improve the rainwater quality. Results show that both limestone and preheated 400°C limestone improve all the parameters observed, meanwhile both activated carbon and zeolite had shown to have detrimental effect on water conductivity.

1 Introduction

Although the earth surface is covered almost 70 % by water, but only approximately 3 % of water can be used [1]. People in Indonesia, mostly in large city like Jakarta, using ground water as one of the water resources to fulfill their daily needs [2]. The rainwater has not been an option yet for people in Jakarta while there are many advantages that can be obtained from rainwater [3].

Rainwater in Indonesia contains acid and the pH level is 5.6 [4]. It needs treatment so it can be used for daily needs.

Water conductivity, pH and TDS are the water characteristics to be observed. Water conductivity shows the ability of water to transmit electricity [5]. Water pH is indicator of level of acidity and basicity of water [6]. Water TDS is the total amount of ions, including minerals, salts or metals dissolved in the water [7].

2 Experimental details

The first stage of experiment was to determine the material used as filter. Zeolite, activated carbon, limestone [8,14-15] and preheated 400°C limestone were used to improve the rainwater quality.

Zeolite was used as an absorbent for reducing water hardness[9]. Activated carbon removed water odor and taste, absorbed water chlorine and purified water [10]. Limestone purified water and stabilized water pH. Limestone (CaCO3) was heated to produce Calcium Oxide (CaO) to reduce the water hardness [11].

Zeolite was soaked using 1 N NaCl for 24 hours.Activated carbon was soaked using 1 N NaOH for 24 hours. Then both were dried using an oven with a temperature of 115°C for 24 hours [12,13].

Limestone was heated gradually. The temperature was increased by 100°C every 15 minutes, starting from 200°C and ended at 400°C [14].

Each of materials were categorized into 3 different sizes: large size (materials passing sieve number 4 and retained by sieve number 8), medium size (materials passing sieve number 8 and retained by sieve number 10) and small size (materials passing sieve number 10 and retained by sieve number 16) [14,15].

Each variation of size divided to 10 weight of variation (0.5 g, 1 g, 3 g, 5 g, 7 g, 10 g, 15 g, 20 g, 25 g, 30 g). This experiment was conducted 3 times for each variation.

3 Results

3.1 Conductivity

Zeolite increased the water conductivity as shown in Fig.1. The results of water conductivity using zeolite varied from 0.01 to 0.25. Medium sized zeolite resulted the highest conductivity compared to the other sizes. Large sized zeolite and small sized zeolite resulted the similar effect on water conductivity. The addition of zeolite weight into the water increased the value of water conductivity.

As shown in Fig.2, the water conductivity increased significantly because of activated carbon. The results of water conductivity using activated carbon varied from 0.03 to 1.29. The results showed the size of activated carbon affected the water conductivity. Large sized

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activated carbon resulted the highest conductivity compared to the other sizes. Small sized activated carbon resulted the lowest conductivity compared to the other sizes. The addition weight of large sized activated carbon increased the value of water conductivity. When the weight of medium sized activated carbon were 0.5 g, 1 g, 3 g, 5 g, 7 g, 10 g, 15 g and 20 g, the value of water conductivity gradually increased. But when the weight of medium sized activated carbon was 25 g, the value of water conductivity decreased. The value of water conductivity increased again when the weight of medium sized activated carbon was 30 g. The water conductivity of small sized activated carbon kept increasing until the weight of 25 g, and it decreased when the weight was 30 g.

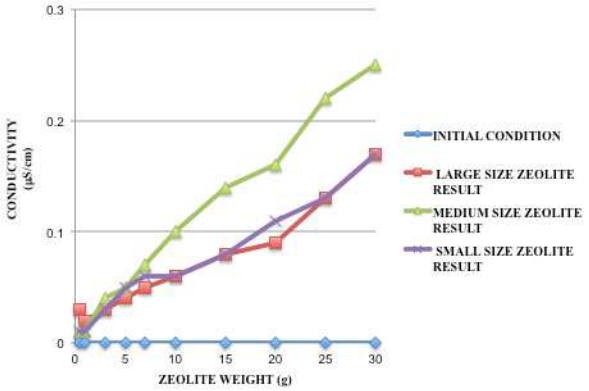

Fig. 1. Water conductivity using zeolite

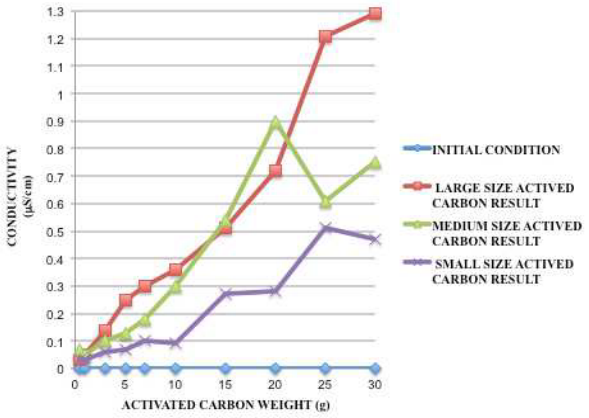

Fig. 2. Water conductivity using activated carbon

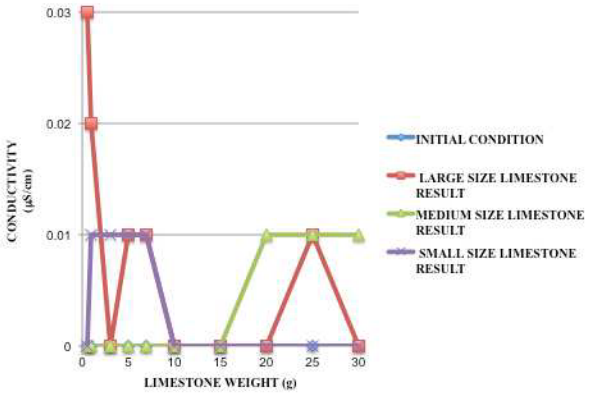

Fig. 3. Water conductivity using limestone

Both preheated 400°C limestone and limestone, didn't affect much on the water conductivity. It can be seen at Fig.3 and Fig.4. As shown in Fig.3., the results of water conductivity using limestone varied from 0.00 to 0.03. The large sized limestone with weight less than 3 grams resulted the highest conductivity compared to the other sizes and weights.

As shown in Fig. 4, the results of water conductivity using preheated 400°C limestone varied from 0.00 to 0.02. The small sized preheated 400°C limestone with weight less than 3 grams resulted the highest conductivity compared to the other sizes and weights.

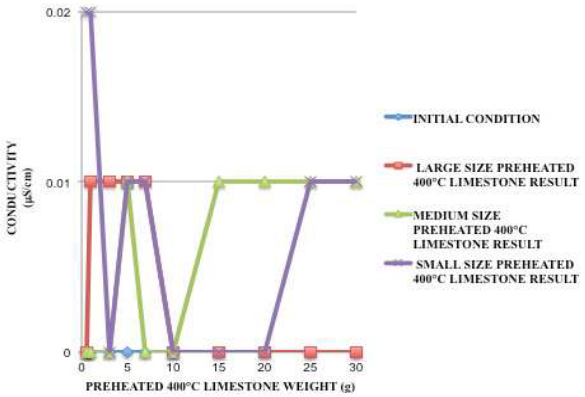

Fig. 4. Water conductivity using preheated 400°C limestone

3.2 Water pH

The increasing results of water pH using zeolite varied between 0.37 and 2.31 point higher from the initial condition. Large sized zeolite and medium sized zeolite resulted the similar effect on water pH but the large sized zeolite resulted the highest water pH compared to the other sizes, as shown in Fig.5. The addition weight of large and medium sized zeolite increased the value of water pH.

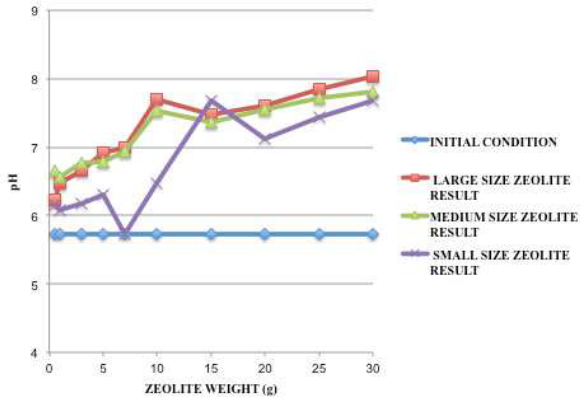

Fig. 5. Water pH using zeolite

The increasing results of water pH using activated carbon varied between 0.58 and 2.32 point higher from the initial condition. The large sized activated carbon resulted the highest water pH compared to the other sizes, as shown in Fig.6.

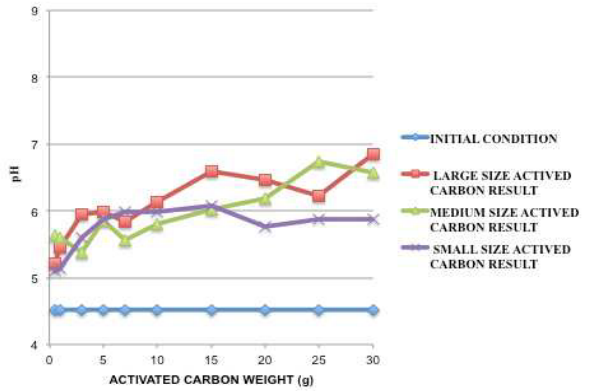

Fig. 6. Water pH using activated carbon

The increasing results of water pH using limestone varied between 1.01 and 2.18 point higher from the initial condition. The small sized limestone resulted the lowest water pH and the large sized limestone resulted the highest water pH compared to the other sizes, as shown in Fig.7.

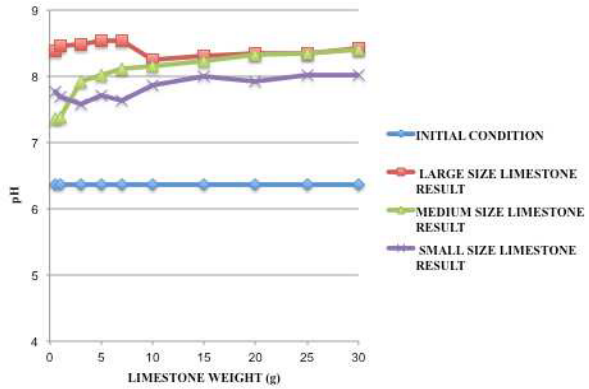

Fig. 7. Water pH using limestone

The increasing results of water pH using preheated 400°C limestone varied between 1.06 and 2.64 point higher from the initial condition. The large sized preheated 400°C limestone resulted the lowest water pH and the small sized preheated 400°C limestone resulted the highest water pH compared to the other sizes, as shown in Fig.8.

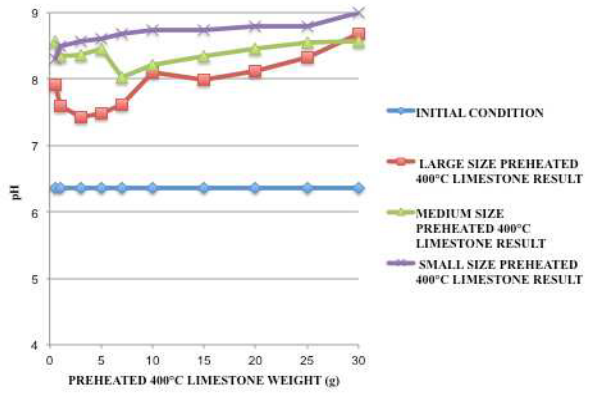

Fig. 8. Water pH using preheated 400°C limestone

3.3 Water TDS

As shown in Fig.9, the results of water TDS using zeolite varied between 0.00 and 0.12. Medium sized zeolite resulted the highest TDS compared to the other sizes. Large and small sized zeolite resulted the similar effect on water TDS.

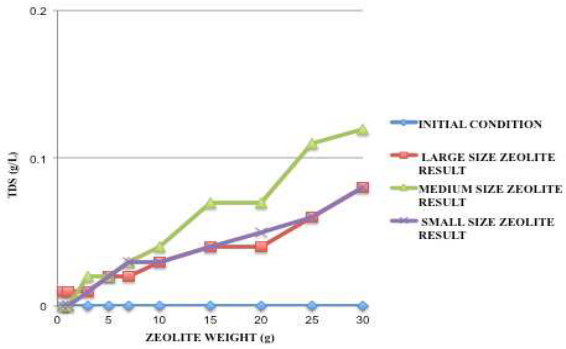

Fig. 9. Water TDS using zeolite

As shown in Fig.10, the water TDS increased because of activated carbon. The results of water TDS using activated carbon varied from 0.01 to 0.64. The large sized activated carbon resulted the highest water TDS compared to the other sizes. The small sized activated carbon resulted the lowest water TDS compared to the other sizes.

The results showed the size and the weight of activated carbon affected the water TDS. The addition weight of large sized activated carbon increased the value of water TDS. When the weight of medium sized activated carbon were 0.5 g, 1 g, 3 g, 5 g, 7 g, 10 g, 15 g and 20 g, the value of water TDS gradually increased. But when the weight of medium sized activated carbon was 25 g, the value of water TDS decreased. The value of water TDS increased again when the weight of medium sized activated carbon was 30 g. The water TDS of small sized activated carbon kept increasing until the weight of 25 g, and it decreased when the weight was 30 g.

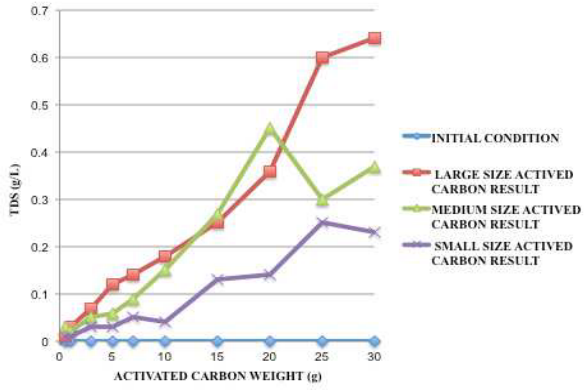

Fig. 10. Water TDS using activated carbon

As shown in Fig. 11 and Fig. 12, both preheated 400°C limestone and limestone, didn't affect much to the water TDS. The results of water TDS using limestone and preheated 400°C limestone varied from 0.00 to 0.01. The

large sized preheated limestone with weight less than 3 grams resulted the highest TDS compared to the other sizes and weights. The medium and small sized limestone had shown no effect on the water TDS, as shown in Fig. 11.

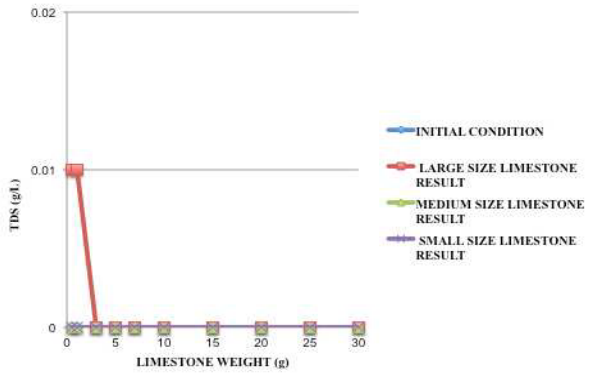

Fig. 11. Water TDS using limestone

The small and large sized preheated 400°C limestone had shown the similar effect on the water TDS. The small and large sized preheated 400°C limestone with weight less than 3 grams resulted the highest water TDS compared to the other sizes and weights. The medium sized preheated 400°C limestone had shown no effect on the water TDS, as shown in Fig. 12.

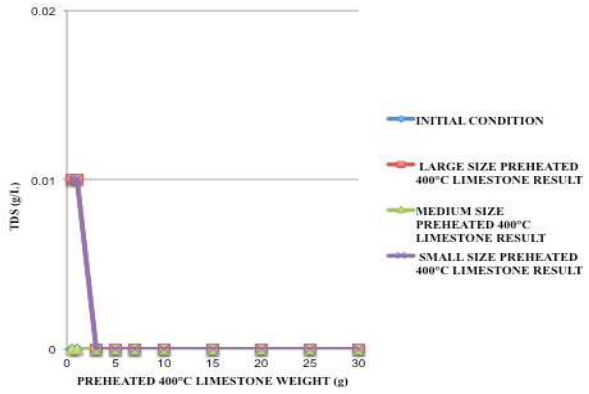

Fig. 12. Water TDS using preheated 400°C limestone

4 Conclusion

From the results, it concluded that both limestone and preheated 400°C Limestone were found to improve all parameters observed.

The small sized preheated 400°C Limestone was found to be the best material to obtain low water conductivity, higher pH and lower water TDS values.

Both activated carbon and zeolite had shown to have detrimental effect on water conductivity.

Activated carbon had shown similar effect on water conductivity and TDS.

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