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## The Ability of Chunks of Building in the Recovery of Mercury (Hg) Pollution for Water Quality of Agriculture

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**Abstract.** Waste water is the most frequently found heavy which pose risks to human health and the environment. Various sources of heavy metals including soil erosion, natural weathering of the earth's crust, mining, industrial waste, waste disposal, insect or disease control agents applied to plants, and many others. Remediation on polluted water needs to be done as an effort to reduce the impact of heavy metals on the environment, plant and aquatic biota. This study aims to test the ability of chunks of building to reduce the pollution of mercury (Hg) until it reaches the limit of class-4 of water quality or water quality for agriculture. The treatment involved with three chunks of building as an agent of remediation such as former brick, former concrete and former ceramic. Each chunk of building was treated with three thicknesses of 5 cm, 7.5 cm and 10 cm. Levels of mercury (Hg) that will be tested to be lowered by remediation treatment with three chunks of building is 1 level of concentration and be repeated 3 times with depth of solution of 20 cm was 0.02 mg/L. The results showed that the three chunks of building that were used namely former brick, former concrete and former ceramic could reduce the concentration of mercury (Hg) in achieving the water quality standards for agriculture. Of the three treatments with all three thicknesses, it turns out that treatment with used former bricks with a thickness of 10 cm has the fastest ability to reduce the concentration of mercury (Hg). Based on the interpolation method, it turns out that treatment with used former brick only takes 6.25 weeks to reach below the water quality standard for agriculture. In terms of percentage reduction in mercury (Hg), former brick with a thickness of 10 cm is the best treatment, where in the eighth week reaching 85% or only 15% remaining in the solution. The treatment using used ceramics for all thickness treatments requires a longer time compared to the treatment of used former bricks and used former concrete to achieve the desired agricultural quality standards.

Keywords: Ability of Chunk, Recovery, Mercury, Water Quality, Agriculture

### 1. Introduction

Waste water is the most frequently found heavy metal including arsenic, cadmium, chromium, copper, lead, nickel and zinc, all of which pose risks to human health and the environment [1]. Various sources of heavy metals including soil erosion, natural weathering of the earth's crust, mining, industrial waste, urban runoff, waste disposal, insect or disease control agents applied to plants, and many others [2]. The nature of heavy metals that can endanger the environment and humans because heavy metal is difficult to degrade, so it tends to accumulate in the environment. In addition, heavy metals can accumulate in the body of organisms and concentrations can get higher, or can experience bioaccumulation and biomagnification [3].



Thus, generally all heavy metals can become poisons that poison the bodies of living things, only a portion of these heavy metals is still needed by living things in very little levels. The required metal is called the body's essential metals or minerals. Some names of essential heavy metals are copper (Cu), zinc (Zn), and nickel (Ni) [4]. Heavy metals in the waters will one day descend and settle to the bottom of the water, forming sedimentation with mud, this will cause organisms that feed on the bottom of the water will have a great chance of being exposed to heavy metals that have been bound to the bottom of the water and form sediments [5]. The previous research conducted in Dharmasraya District, in Batang Hari River, has discovered that the existence of heavy metal pollution by Mercury was as a result of gold mining, whereas the river is a source of irrigation [6].

Remediation on polluted water needs to be done as an effort to reduce the impact of heavy metals on the environment, plant and aquatic biota. Many techniques that can be done to recover (remediate) contaminated land, one of which is phytoremediation that uses aquatic plants as cleaning agent [7].

Besides that, it is also very possible to recover the polluted land which is also done by utilizing chunks of the building's former demolition as a medium for absorption of heavy metals mentioned above. Chunks of former buildings have never been used, except only for hoarding. Based on the problems mentioned above, the authors have conducted a study entitled "The Ability of chunks of building to reduce mercury (Hg) pollution".

## 2. Methods

This research was conducted on July – September 2018 about a mercury analysis which has been performed in Environmental Engineering Laboratory of Engineering Faculty, Andalas University. The tools that are used in the implementation of this study are; plastic buckets, 140 ml sample bottles, MVU (mercury vaporation unit). The materials are; water, Hg (NO<sub>3</sub>)<sub>2</sub> 1000 mg/l and former brick, former concrete and former ceramic, as well as tools and other materials that support during the study. This study aims to test the ability of chunks of building to reduce the pollution of mercury (Hg) until it reaches the limit of class-4 of water quality for agriculture which is 0.005 mg/L [8]. The treatment involved with three chunks of building as an agent of remediation such as former brick, former concrete and former ceramic. The selection of the three chunks of building is easily on findings in West Sumatra. This study used laboratory-scale experiments by using bath condition. Each chunks of buildings are treated with three thicknesses of 5 cm, 7.5 cm and 10 cm. Levels of mercury (Hg) that will be tested to be lowered by remediation treatment with three chunks of building is 1 level of concentration and be repeated 3 times with depth of solution of 20 cm was 0.02 mg/L.

The next step to insert the solution of heavy metals (0,02 mg/L) into a plastic box measuring in 80 × 54 × 50 cm and accordance with the desired of water level at 20 cm. The observations are done every week until mercury (Hg) concentrations in the water have reached the quality standard for agriculture. When the water sampling will be conducted, the high level of water in the bucket cultivated as the initial state which is 20 cm.

To investigate the decrease of heavy metal concentration, analysis was conducted from water samples in the laboratory by using inductively coupled plasma mass spectrometry (ICP-MS). The results of the analysis will be compared to the quality standards for agriculture water. Observations on the study at each treatment is conducted every week to determine the reduction tendency of concentration mercury (Hg). The observation will be completed if the reduction in the concentration of mercury (Hg) has been in the raw water for agriculture. Data which is obtained as a result of decreasing in water pollution by the former brick, former concrete and former ceramic would be compared to a quality standard for agriculture. Remediation index calculation (IFR) is done based on data from the treatment. The collected data are calculated to find the declined rate of mercury concentration during the activity. The declined rate of mercury concentrations known as remediation index (IFR) was obtained with formula [9]:

$$\eta = \frac{C_{in} - C_{out}}{C_{in}} \times 100\% \tag{1}$$

where  $\eta$  is removal efficiency (%),  $C_m$  is Hg concentration in the initial solution (mg/L), and  $C_{out}$  is Hg concentrations in solution at equilibrium (mg/L).

### 3. Results and Discussion

#### 3.1. Former Brick

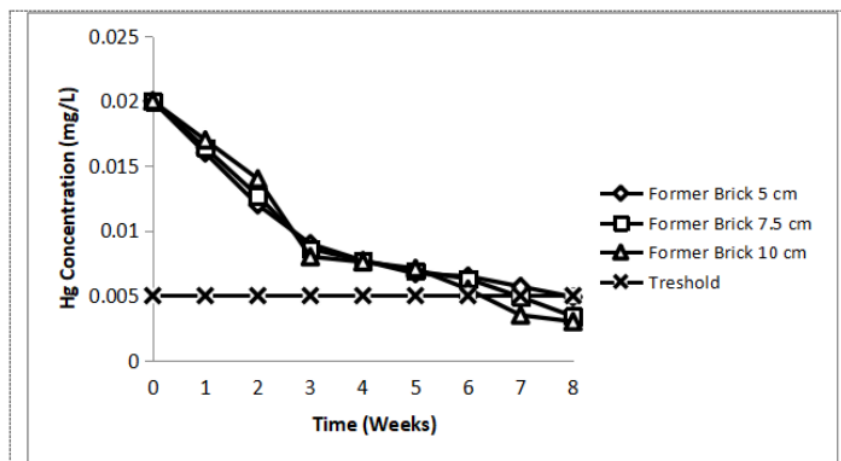
The average concentrations (levels) of mercury (Hg) in the solution (research vessel) with an initial concentration of 0.02 mg/L during the observation can be seen in Table 1.

**Table 1.** Levels of mercury (Hg) with initial concentration of solution 0.02 mg/L at former brick

No.	Week	Former brick 5 cm	Former brick 7.5 cm	Former brick 10 cm
1.	0	0.0200	0.0200	0.0200
2.	1	0.0160	0.0164	0.0170
3.	2	0.0120	0.0127	0.0140
4.	3	0.0090	0.0086	0.0080
5.	4	0.0077	0.0077	0.0076
6.	5	0.0067	0.0069	0.0071
7.	6	0.0065	0.0063	0.0055
8.	7	0.0057	0.0049	0.0035
9.	8	0.0049	0.0034	0.0030

Table 1 shows the average concentration of mercury (Hg) exists in research containers, with an initial concentration mercury (Hg) 0.02 mg/L. For treatment using used former brick with a thickness of 10 cm and 7.5 cm in the 7th week the concentration of mercury (Hg) has been below the desired quality standard for agriculture of 0.004 mg / L and 0.0049 mg / L. Meanwhile, for 5 cm thickness, the mercury (Hg) concentration was below the desired quality standard only reached in the 8th week, which was 0.0049 mg / L. Thus, the thickness of the used brick layer affects the absorption of mercury (Hg). The thicker the used brick is treated, the faster the allowance for the reduction in mercury (Hg) is obtained

The reduction trend in mercury (Hg) during the observation of the initial concentration of 0.02 mg/L at former brick can be seen in Figure 1.

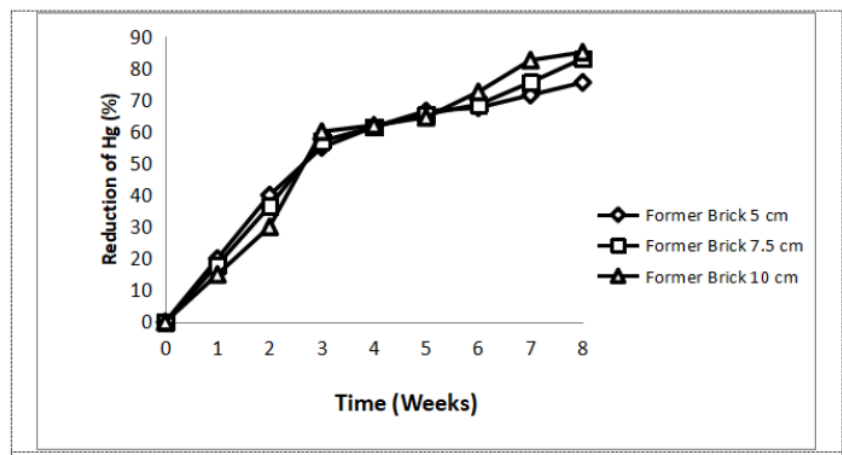


**Figure 1.** Concentration reduction of mercury (Hg) with initial concentration 0.02 mg/L at former brick.

Based on Figure 1, it can be seen how long it takes for used former brick to reduce the concentration of mercury (Hg) to the quality standard for agriculture with an initial concentration of 0.02 mg / L. In containers with a thickness of 10 cm requires the shortest time among the three treatments, where time is less than 7 weeks the standard quality of mercury concentration (Hg) for agriculture which is 0.005 mg / L has been obtained. Based on the interpolation method, it turns out that treatment with used former brick only takes 6.25 weeks to reach below the water quality standard for agriculture. Meanwhile, the treatment with a thickness of 5 cm requires the longest time to reach the water quality standard for agriculture, which is at the 7.88<sup>th</sup> week.

Treatment with used bricks with a thickness of 10 cm is fast enough to reduce the concentration of mercury (Hg), but when compared with water hyacinth, in the treatment with the same initial concentration, the treatment with the former brick is still slower. Water hyacinth plants only take 11.67 days to reach below the water quality standard for agriculture [9].

The reduction level of mercury concentrations then is known as remediation index (IFR) obtained from the reduction of the initial concentration to the last concentration and it is divided by the initial concentration multiplied by one hundred percent. Remediation index calculation (IFR) is based on data from the treatment. The collected data is calculated to reduce the level of mercury (Hg) concentration during the activity. The percentage of reduction level of mercury (Hg) concentration with initial concentration 0.02 mg / L can be seen in Figure 2.



**Figure 2.** Reduction level percentage of mercury (Hg) concentrations with initial concentration 0.02 mg /L at former brick

The percentage decrease in mercury (Hg) metal concentration with an initial concentration of 0.02 mg / L solution, in a used former brick container with a thickness of 10 cm at the 8th week reaching 85% or only 15% remaining in the solution. This is the treatment with the highest ability in the removal of mercury (Hg). While the container with a thickness of 5 cm has the lowest percentage in the reduction of mercury (Hg), where at the 8th week the percentage decrease in the concentration of mercury (Hg) has only reached 76% or 24% is left in the solution. It can be seen in the Figure 2.

In terms of percentage reduction in mercury (Hg) concentration, treatment with former brick is still slower when compared to water hyacinth plants. Water hyacinth plants, it has the higher reduction percentage in mercury (Hg), where on the 15th day, the percentage of mercury (Hg) concentrations reaches 96% or it is only 4% left in the solution[9].

**3.2. Former concrete**

The average concentration (content) of mercury (Hg) in the solution (research container) with an initial concentration of 0.02 mg / L with the treatment of used former concrete, during the observation can be seen in Table 2.

**Table 2.** Levels of mercury (Hg) with initial concentration of solution 0.02 mg/L at former concrete

No.	Week	Former Concrete 5 cm	Former Concrete 7.5 cm	Former Concrete 10 cm
1.	0	0.0200	0.0200	0.0200
2.	1	0.0150	0.0161	0.0166
3.	2	0.0100	0.0122	0.0131
4.	3	0.0085	0.0079	0.0072
5.	4	0.0075	0.0070	0.0067
6.	5	0.0070	0.0060	0.0062
7.	6	0.0065	0.0055	0.0053
8.	7	0.0057	0.0050	0.0043
9.	8	0.0050	0.0041	0.0033

Table 2 shows the average concentration of mercury (Hg) in the study container, with an initial mercury (Hg) concentration of 0.02 mg / L. For treatment using used bricks with a thickness of 10 cm

at the 7th week the concentration of mercury (Hg) has been below the desired quality standard of 0.0043 mg / L. The concentration of mercury (Hg) is precisely at the desired quality standard of 0.005 mg / L at the seventh week in treatment with a thickness of 7.5 cm. Meanwhile, in a treatment with a thickness of 5 cm, the right mercury (Hg) concentration was at the desired quality standard that is equal to 0.005 mg / L and was only reached in the 8th week. Thus, the thickness of the used former concrete layer like used brick also affects the absorption of mercury (Hg).

Trends in the reduction of mercury (Hg) by the treatment of used concrete during observation for an initial concentration of 0.02 mg / L can be seen in Figure 3.

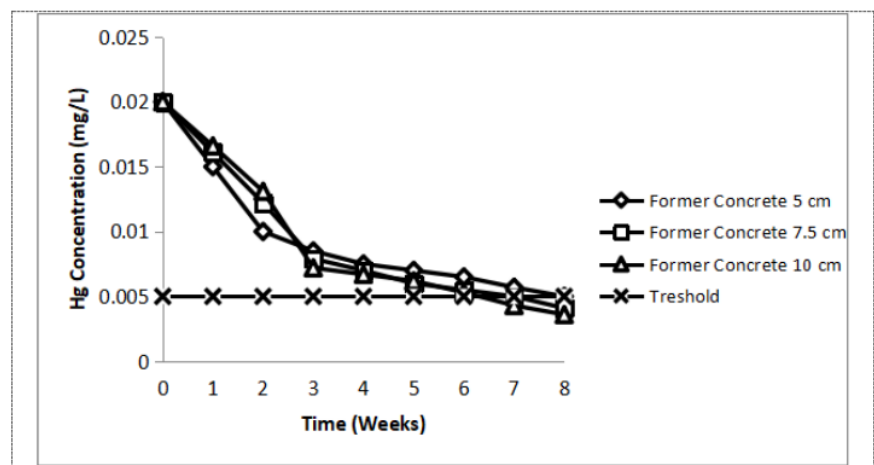


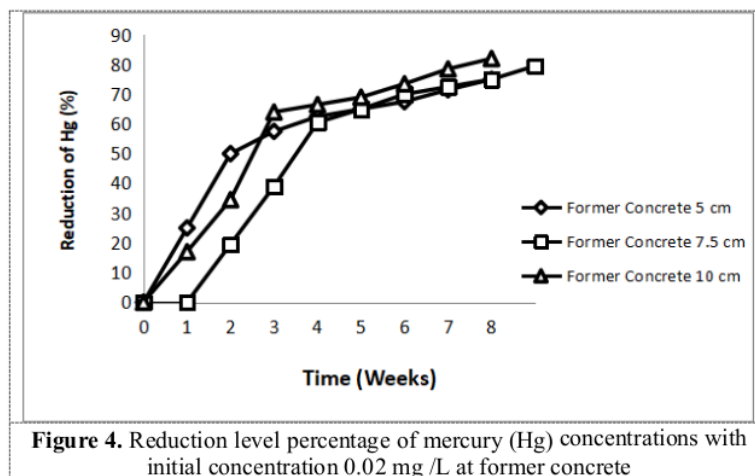
Figure 3. Concentration reduction of mercury (Hg) with initial concentration 0.02 mg/L at former concrete.

Based on Figure 3, it can be seen the amount of time needed by used concrete to reduce the concentration of mercury (Hg) to the quality standard for agriculture with an initial concentration of 0.02 mg / L. In containers with a thickness of 10 cm, as in the case of used former brick, treatment with used concrete also requires the fastest time among the three treatments, in which less than 7 weeks of the standard quality of mercury concentration (Hg) for agriculture is 0.005 mg / L can be achieved. Based on the interpolation method, it turns out that treatment with used former brick only takes 6.3 weeks to reach below the water quality standard for agriculture. Meanwhile, the treatment with a thickness of 5 cm also requires the longest time to reach the water quality standard for agriculture at the 8th week.

Judging from the time needed to achieve the standard quality of mercury concentration (Hg) for agriculture, it turns out that the ability of former concrete is not much different from the ability of former brick. This also means that the ability of former concrete is also still far lower than the ability of the water hyacinth plant[9].

The percentage of decreased levels of mercury concentration (Hg) with an initial concentration of 0.02 mg / L in treatment with used concrete can be seen in Figure 4.





**Figure 4.** Reduction level percentage of mercury (Hg) concentrations with initial concentration 0.02 mg /L at former concrete

The percentage decrease in the concentration of mercury (Hg) with an initial concentration of 0.02 mg / L solution, in a used concrete container with a thickness of 10 cm at the 8th week reaching 82% or only 18% remaining in the solution. This is the treatment with the highest ability in the removal of mercury (Hg) in used concrete. Whereas containers with a thickness of 5 cm have the lowest percentage in the reduction of mercury (Hg), where at the 8th week the percentage decrease in the concentration of mercury (Hg) has only reached 75% or 25% is left in the solution (Figure 4). For all thicknesses, treatment with former concrete approaches the ability of former brick.

### 3.3. Former ceramic

The average concentration (levels) of mercury (Hg) in the solution (research container) with an initial concentration of 0.02 mg / L with used former ceramic treatment, during the observation can be seen in Table 3.

**Table 3.** Levels of mercury (Hg) with initial concentration of solution 0.02 mg/L at former ceramic

No.	Week	Former Ceramic 5 cm	Former Ceramic 7.5 cm	Former Ceramic 10 cm
1.	0	0.0200	0.0200	0.0200
2.	1	0.0170	0.0171	0.0174
3.	2	0.0140	0.0143	0.0147
4.	3	0.0100	0.0098	0.0090
5.	4	0.0091	0.0088	0.0085
6.	5	0.0079	0.0083	0.0080
7.	6	0.0082	0.0079	0.0075
8.	7	0.0075	0.0077	0.0065
9.	8	0.0070	0.0067	0.0057
10.	9	0.0059	0.0058	0.0048
11.	10	0.0050	0.0049	0.0037

From Table 3 we can see the average concentration of mercury (Hg) in the study container, with an initial concentration of 0.02 mg / L mercury (Hg) in used ceramics. The treatment using used ceramics for all thickness treatments requires a longer time compared to the treatment of used former bricks and

used former concrete to achieve the desired agricultural quality standards. In the treatment with a thickness of 10 cm, the water quality is below the desired quality standard only achieved after the 8th week. Meanwhile, for 5 cm thick mercury (Hg) concentration, the desired quality standard was only reached in the 10th week.

The reduction trend of mercury (Hg) by the treatment of used former ceramic during observation for an initial concentration of 0.02 mg / L can be seen in Figure 5.

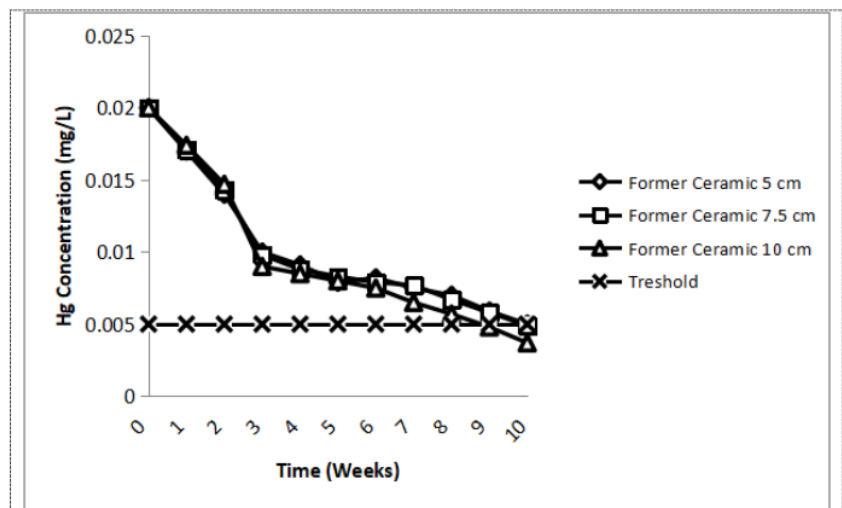
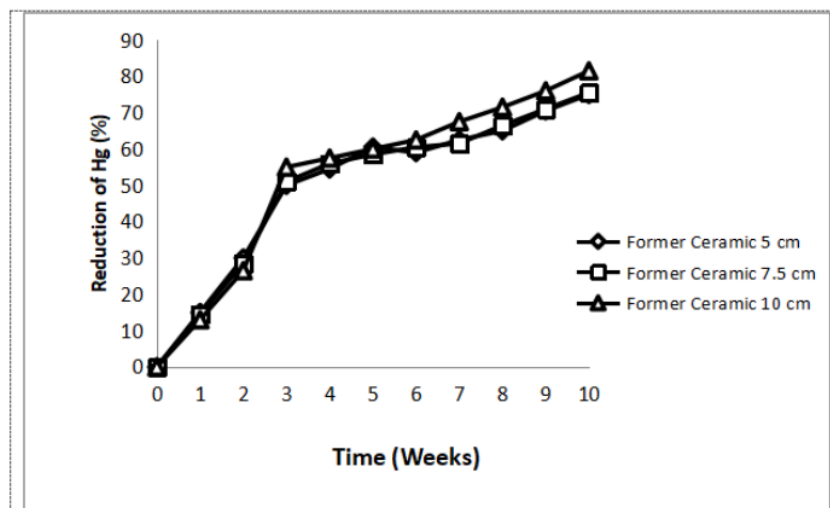


Figure 5. Concentration reduction of mercury (Hg) with initial concentration 0.02 mg/L at Former Ceramic.

Based on Figure 5, it can be seen how long it takes for used former ceramic to reduce the concentration of mercury (Hg) to the quality standard for agriculture with an initial concentration of 0.02 mg / L. In containers with a thickness of 10 cm as in the case of used former brick and used former concrete, treatment with used former ceramics also requires the fastest time among the three treatments. Where the time is less than 9 weeks the mercury concentration (Hg) is below the mercury (Hg) quality standard for agriculture. Based on the interpolation method, it turns out that treatment with used former ceramic takes 8.78 weeks to reach below the water quality standard for agriculture. Meanwhile, the treatment with a thickness of 5 cm requires the longest time to reach the water quality standard for agriculture at the 10th week.

The percentage of decreased levels of mercury (Hg) metal concentrations with an initial concentration of 0.02 mg / L in the used former ceramic treatment can be seen in Figure 6.



**Figure 6.** Reduction level percentage of mercury (Hg) concentrations with initial concentration 0.02 mg /L at former ceramic

From Figure 6 it can be seen the percentage decrease in mercury (Hg) concentration with an initial concentration of 0.02 mg / L solution, in used ceramic containers with a thickness of 10 cm at the 8th week reaching 72% or only 28% remaining in the solution. This is the treatment with the highest ability in the removal of mercury (Hg). While the container with a thickness of 5 cm has the lowest percentage in the reduction of mercury (Hg), where at the 8th week the percentage reduction in the concentration of mercury (Hg) metal has only reached 65% or 35% is left in the solution.

#### 4. Conclusion

The three chunks of building that were used namely former brick, former concrete and former ceramic could reduce the concentration of mercury (Hg) in achieving the water quality standards for agriculture. Of the three treatments with all three thicknesses, it turns out that treatment with used former bricks with a thickness of 10 cm has the fastest ability to reduce the concentration of mercury (Hg). Based on the interpolation method, it turns out that treatment with used former brick only takes 6.25 weeks to reach below the water quality standard for agriculture. In terms of percentage reduction in mercury (Hg), former brick with a thickness of 10 cm is the best treatment, where in the eighth week reaching 85% or only 15% remaining in the solution. The treatment using used ceramics for all thickness treatments requires a longer time compared to the treatment of used former bricks and used former concrete to achieve the desired agricultural quality standards.

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