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Cadmium (Cd) and Mercury (Hg)in the Soil, Leachate and Ground Water at the final Waste Disposal Pakusari Jember Distric Area

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Abstract

Open dumping and controlled landfill were method that used in almost the entire final waste disposal in Indonesia. It was potentially contaminate the soil, and grand water, especially heavy metal such as cadmium and Mercury. The objective of this research is to identifying cadmium and mercury in the soil, leachate and ground water at the final waste disposal Pakusari Jember District area. This research was an observational analytical study conducted cross sectionally. There were six kavlings, three leachate ponds and five ground water. Soil Samples were collected by diagonal method for every kavlings. There were 48 soil samples with composite samples, 3 leachete and 5 water samples. The result showed that mean total cadmium (TCd) and mercury (THg) were 1,46 ppm (kavling 3); 0,859 ppm (kavling4); 0,415 ppm (kavling 5a); 0,16 ppm (kavling 5b); 0,467 ppm (kavling 6);1,459ppm (kavling 9) and not detected for THg. TCd in the leachate ponds 1,2,3 were 0,029 ppm; 0,044 ppm; 0,045 ppm. THg in the leachate ponds 1,2,3 were 0; 0,013; 0,021.

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TCd in the wells 1,2,3,4,5 were 0,054 ppm;0,069 ppm;0,068 ppm;0,079 ppm;0,081 ppm, and THg in the monitoring wells 1,2,3,4,5 were not detected. Cadmium and mercury from the control landfill final waste disposal can be dangerous for environment and health because of their toxicity in the organism. Sanitary landfill should be applicated as soon as possible.

Keyword: Cadmium, Mercury, final waste disposal, controlled landfill.

1. Introduction

Waste is a global concern. The waste production are increase every year. Waste Volume in Indonesia was 490.000 ton/ day or 178.850.000 ton/ year**.** Population and their activity contribute the waste production. Final waste disposal are area that use throw the waste and to issolated waste to protected the environment from the pollution. The waste had the risk to contaminate the environment and effected to human health. Open dumping and controlled landfill were method that used in almost the entire final waste disposal in Indonesia. It was potentially contaminate the soil, and ground water, especially heavy metal such as cadmium and Mercury.

Pakusari final waste disposal are use the controlled lanfill method. The method is still not ideal for protected the environment from waste pollution. Controlled lanfill had potentially contaminate the soil and groundwater because it produce leachate. Leachate must be treatment. Leachate are very dangered for environment and health. Leachate together with runoff can going throw in the soil and ground water. Leachate can contain patogen and some heavy metal that very toxic such cadmium (Cd) and mercury (Hg). The main source of cadmium and mercury are anorganic waste, waste incinerator, sewage sludge, composeted municipal solid waste, corrosion of metal structures etc.

Cadmium and mercury from the final waste disposal can travel long distance into the soil, leachate, groundwater. They are toxic for organism by inhalation, ingestion and dermal contac. This research want to analysis the Cadmium (Cd) and Mercury (Hg) in the Soil, Leachate and Ground Water at the final Waste Disposal Pakusari Jember Distric Area which application controlled landfill method.

2. Material and Method

This research was an observational analytical study, with a cross sectional study design. The object in this research was soil, lecheate ponds and ground water on the Final Waste Disposal in Pakusari Jember. The soil samples were 6 kavlings that have been used. They were kavling 3 (1400m^2), kavling 4 (1540 m^2), kavling 5a (2501m^2), kavling 5b (1333m^2), kavling 6 (2046m^2), kavling 9 (4599 m^2). Soil Samples were taken by diagonal method for every kavlings. There were 48 soil samples which were taken in 8 points for every kavlings, within 0-25 cm depth, 40-60 cm depth, 90-110 cm depth which composite samples.

The leachate samples were taken one point center in every leachate ponds (pond 1,2,3). by diagonal method. The fifth sample of ground water (monitoring wells) were collected at 12 meter, 90 meter, 7 meter, 0 meter, 80 meter from the point source. Water samples were taken in 20 cm depth from the water surface and taken once. Soil Sample was taken at 31 December 2012 at 8 in the morning and leachate sample and ground water sample

was taken at 2 January 2013 at 8 in the morning and then analysis in the laboratory.

Cadmium and mercury in the soil, leachate and ground water was conducted by Atom Absorption Spectrophotometer (AAS) method.

3. Results

3.1 Final Waste Disposal

Pakusari are the bigest final waste disposal in jember distric area, east java Indonesia. The waste management method that had been use were contolled landfill. Controlled lanfill is method to procesing waste with throwing waste without sorting on the soil 60-100 cm depth and then burying with the land cover ± 40 cm depth. Controled lanfill method produced leachate. There are 3 leachate ponds. Leachate had the potential to contaminate the soil and groundwater. The volume of waste that throw on the final waste disposal are increase every year accordance the population. The waste on the final waste disposal are organic and anorganic waste. The characteristik of organic waste were 61,7% and anorganic waste were 38,3%.

3.2 Cadmium and Mercury in the Soil

The soil are solid compartement of the environment. Soil or sediments may binds the pollutant. The soil received the polutant from the atmospheric deposition and sewage sludge disposal. Wet and dry deposition of cadmium from atmosphere may also contribute of cadmium to soil in (Figure 1). The soil are essential for the human being becaue of they were producing the nutrition for the plantations. Otherwise, the pollution in the soil distrubing the organism life cycle. The soil pollution often contributes the other pollution too, such of water surface and groundwater.

The mean cadmium in the soil were 1,46 ppm (kavling 3); 0,16 ppm (kavling 5b); 1,459 ppm (kavling 9). Kavling 3, kavling 5b and kavling 9 were had the higest cadmium on the top soil (0-25cm depth). Cadmium in the kavling 3 was decrease accordande with the depth. Cadmium in kavling 3 were 1,655 ppm (0-25cm depth); 1,511 ppm (40-60 cm dpth); 1, 222 ppm (90-110 cm depth). Kavling 3 was not receive waste anymore. This kavling was closed since 1994.

Kavling 5b and kavling 9 were had the higest cadmium on the top soil, and decrease in the sub soil (40-60 cm depth) and then increase in the 90-110 cm depth. The cadmium in the kavling 5b were 0,261 ppm (0-25cm depth); 0,104ppm (40-60 cm depth); and 0,18 ppm (90-110 cm depth). The cadmium in the kavling 9 were 0,652ppm (0-25cm depth); 0,319ppm (40-60 cm depth); and 0,488ppm (90-110 cm depth). Kavling 5b was not received waste since 1995. Kavling 9 dvide into the north and south. The north still active receive waste, and the south was not received waste anymore since 1997. The soil sample was taken in the south.

Cadmium ussually had in the top soil. Cadmium mobility in soil depends on humic acid and availability of organic matter. Pollution can transfer and transport by wet deposition and dry deposition. The dry deposition can occur by fresh water that still throwed in the north part of kavling 9 and incenerators. Cadmium strongly

adsorbs to organic matter in soil. Cadmium bind with organic component that much founded in the top [1]. In the north, the decomposition of waste were still in process. There are much waste in the top soil which organic waste and anorganic waste. The waste were throw away without sortir. It can be the source of heavy metal cadmium in the top soil. The organic waste are some foods, kitchen waste, hausehold waste, old threes, animal carcas etc. an organic waste are plastic, cans, batteries, the ruins of buidings, pipe instalation etc. The pores of top soil were the bigest than other [2], so it probably make the cadmium in the kavling 3, 5b and 9 higer in the top soil. Cadmium distribution had correlation with soil depth, actually cadmium were higher in the top soil [1].

The highest cadmium in the top soil in the kavling 5b probably because of dry and wet deposite from the other kavling such kavling 7,8,9 and 12 which still active received waste. Some of anorganic waste were still in process of decomposition in the top soil may carry off in soil samples. Some times run off could not carried the heavy metal to enter the deeper lyer of soil because of soil pores. Cadmium in the 90-110 cm depth were higher than in the sub soil because of waste were mostly stay there.

The mean cadmium in the kavling 4,5a,6 were 0,859 ppm; 0,415ppm; 0,467 ppm. Samples soil in the kavling 4,5a and 6 showed cadmium were increase accordance with the soil depth. The highest cadmium was in the 90-110cm depth. Cadmium in the kavling 4 were 0,527 ppm (0-25 cm depth); 0,979 ppm (40-60 cm depth) ; 1,071 ppm (90-110 cm depth). Kavling 4 was not receive waste since 1994. The people around the final waste disposal use kavling 4 to planting chilli and cassava.

Kavling 5a and kavling 6 have been used and closed at 1996. Cadmium in the kavling 5b were 0,261 ppm (0-25 cm depth); 0,389 ppm (40-60 cm depth); 0,597 ppm (90-110 cm depth). they increase accordance with the soil depth. cadmium in the kavling 6 were 0,396 ppm (0-25 cm depth); 0,467 ppm (40-60 cm depth); 0,54 ppm (90-110 cm depth).

There are many factors contribute with cadmium and mercury in the soil. There are the characteristic of waste, volume, season, temperature, rain fall, soil pores, conductivity, the current of ground water, topography, and time to take samples. The land cover of final waste disposal that burying the waste are silt with pores and high permiabillity [3]. Particel diameter of silt are 0.002 to 0.05 millimeters. Silt had good infiltration and percolation that can transport the pollution with soil water movement faster than clay. Type of soil can be difference in every depth because of the characteristic waste that throw a way on the final waste disposal. Metal pollution in the soil can make metal organic complex reaction which more soluble at pH normal and then infiltrate with run off into the deeper soil layer [4].

Chilli and cassava were planting on the kavling 4. Kavling 4 had the highest cadmium in the 90-110 depth. Cadmium persistent in the environment and accumulated with organism by food chain. The toxicity of heavy metal such cadmium and mercury are higher in the next consumens [5]. Cadmium can taken up and retained into the cassava and chilli together with other mineral from their roots. it can be concentrated in the liver and kidney of consument. Mercury were not detected in every kavlings.

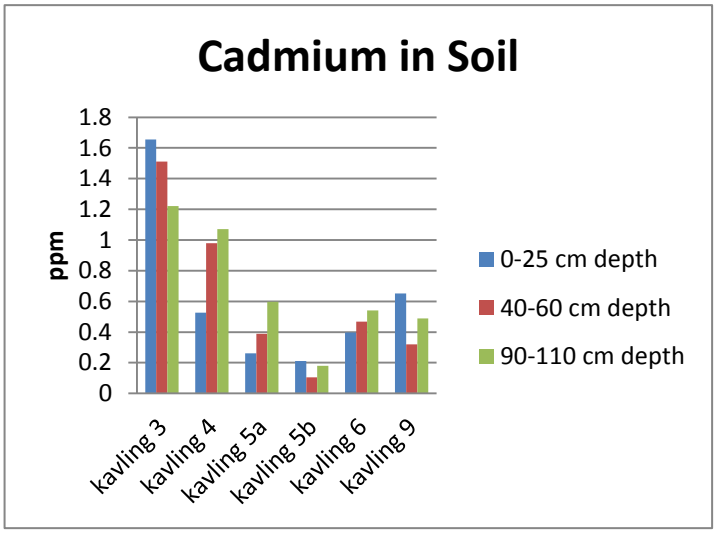

Figure 1: Cadmium in The Soil

3.3 Cadmium and Mercury in the Leachate

Leachate is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed. The source of leachate are from waste decomposition, runoff, drainage and ground water. Waste decomposition process produce leachate.

Cadmium was found in every leachate ponds, but mercury had founded only in pond 2 and pond 3. The cadmium was 0,029 ppm in the pond 1; 0,044 ppm in the pond 2 and 0,045 in the pond 3. The mercury was not detected in pond 1, 0,013 ppm in the pond 2; 0,021 ppm in the pond 3. (Figure. 2)

The contruction of three leachate ponds of pakusari final waste disposal are very simple. There are no cement concrete to retaining leachate from final waste disposal. The quality and quantity leachate are depend on the waste decompotition process. Decompotition of fresh waste produced leachate greater quantities [6] and had thicker.

The location of leachate pond 2 was in direction of kavling 7 without border. Kavling 7 still active to receive fresh waste. When waste still throw a way in that kavling, the volume of waste were decrease, and the leachate too. The location of leachate pond 3 was in direction of kavling 12. There are embankment border among each other. But the construction of the pond was not permeable, so the leachate emptied into all direction of environment. The cadmium in the leachate pond 1 was the lowest and the mercury was not detected. Leachate pond 1 was received the leachate from kavling 3,4 and 5a. Kavling 3 and 4 were not received waste anymore since 1994, and kavling 5a since 1996. The waste decomposition occure a long time a go. Cadmium and mercury was predicted emptied into other environment compartement.

Leachate in the pakusari final waste disposal flow with ground water by gravitation. It flow from high place to

low. There were no treatment for the leachete before throw to the environmnet. There are rain tract and sewage from kavling 3,4, and 5a to the leachate pond 1, but they ware founded leak and broke.

Leachate contain toxic and a harmfull substances that may then enter the environment. It can potentially also impact the ground water,ecosystems of rivers [7] streams, and oceans. Leachate can contain the patogen, heavy metal etc [8]. The leachate quality depent on waste characteristic, season, age of waste, and time to sampling [9].

The season and rain fall contribute the volume of leachate ponds. Jember distric area Indonesia was tropical, with temperatur 23C- 31 C. Dry season at Mei till Agustus and rainy season at September till January. Rainy season make the decompotition faster and produce the leachate too [7]. The rain fall in jember was high, it is 1,969 mm till 3,394 mm.Rainy season can carry the heavy metal cadmium and mercury by runoff in wet deposition. It can make the volume highter. The volume can efect the pollution concentration in the leachate because of dilution [10] and distribution.

3.4 Cadmium and Mercury in the Groundwater

There are five ground water that used to monitoring the pollution in the pakusari final waste disposal. sample was taken on 2 januari 2013 at 9 in the morning. Cadmium were contaminate in the all of ground water, But mercury were not detected. The highest cadmium were in ground water 5, it was 0,081 ppm. The cadmium probably entered into the ground water from leachate pond 3. (Figure 3)

The contruction of leachate pond 3 was very simple without cement concrete which restrain the leachate in the pond. it means that leachate probably flow throw in the environment such us ground water. The seepage of leachate can from the kavling 12 and 8. Kavling 12 and 8 are the kavling which still active receive the waste. The waste without sortir can contain the souce of cadmium such of batteries, can, paint, pesticide can, electricity cable etc. The decomposition of fresh waste from kavling 12 dan 8 probably make the cadmium in the ground water 5 higest than other. The seepage of leachate tent to the west and nort west [11]. Kavling 8 and 9 had 166 meter high, and ground water 5 had 164 meter high, so cadmium seepage going flow by gravitation in to the ground water 5.

The type of soil are important to carrying the pollutan into the water [12] and the rainfall contribute to carrying the pollutan from the soil into the ground water. The ground water around the final waste disposal still used the community for their daily activities such as drinking, bathing, washing etc. Cadmium are toxic for human. The route of exposure of cadmium are ingestion from food, inhalation etc.

4. Discussion

Waste management system is very important for public health. Good waste management system can protec the environment from pollution and controlled disease. Controlled lanfill method still produce contamination in the environment. Controlled lanfill produce leachate that still contain the heavy metal. Heavy metal from final waste disposal can polluted the soil, and groundwater. The heavy metal are very toxic. They can taken up by plant and

intake in the organism by inhalation, ingestion and skin contact. Sanitary Waste management system must applied in Indonesia. Sanitary landfill shoud have applied in every final waste disposal in Indonesia

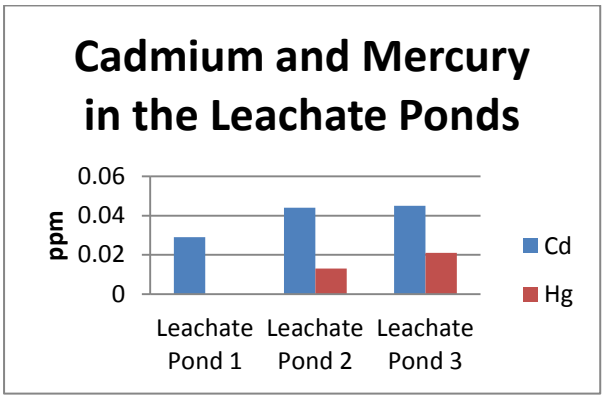

Figure 2: Cadmium and Mercury in the leachate ponds

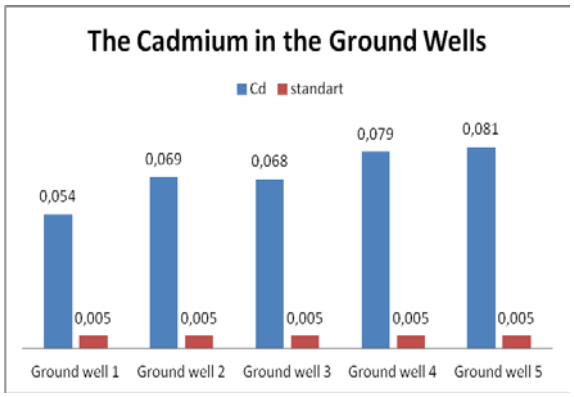

Figure 3: Cadmium and Mercury in the Ground wells

5. Conclusion

Heavy metal cadmium and mercury were produce by Control landfill method. Heavy metal cadmium and mercury had found in the soil, leachate and ground well.

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