Technical evaluation of leachate treatment plant at Klotok Landfill Kediri in 2017

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Abstract. Landfilling is a conventional waste treatment method that is widely used in Indonesia because of its technical feasibility, ease of operation, minimum supervision, and low operating costs. However, landfilling processing techniques lead to more leachate production than other processing methods. The Klotok Landfill in Kediri City has a leachate treatment plant that has been operating since 2016. The monitoring of leachate quality is important to be performed in order to evaluate the leachate treatment process. The leachate treatment plant consists of an anaerobic, a facultative, and a maturation ponds. The first year of monitoring was conducted in 2017 with two times of sampling, February and May. The results of the leachate quality monitoring in Klotok Landfill showed that quality were not yet optimal because some effluent parameters of leachate treatment plant were still above the quality standard as regulated in the Indonesian Minister of Environment and Forestry Regulation P.59/Menhk/Setjen/Kum.1/7/2016. The parameters that did not meet the quality standards were BOD₅, COD, TSS, and Total N. Therefore, it is necessary to improve the efficiency of processing at Klotok Landfill. The improvements that need to be made are measuring the daily parameters and monitoring the microorganisms growing in the treatment unit.

1. Introduction
The increase in waste production (municipal solid waste) in recent years is due to growth in industrial activity, population growth, and lifestyle changes [1]. Increased waste production affects waste treatment patterns. Conventionally, landfilling is the preferred method due to technical feasibility, ease of operation, minimum supervision, and low operating costs. However, this processing technique causes more leachate production than other processing mechanisms such as incinerators. Leachate is a type of fluid that arises due to the entry of external water into waste pile, which dissolves and rinses dissolved matter, including biological decomposition of organic matter [2]. Untreated leachate can contaminate ground and surface water.

The leachate produced from the degradation of solid waste has a composition that varies depending on the percolation of water, the biochemical processes in the waste cells, and the level of waste compaction [3] [4] [5]. Leachate from new landfills (1-2 years) has different characteristics than leachate from old landfills (> 10 years). The leachate characteristics of new landfills are high COD, TOC, and BOD₅ content and a BOD₅/ COD ratio of > 0.6. Meanwhile, leachate from old landfills contain lower COD (<4000 mg / L) and a BOD₅/ COD ratio of <0.1, which indicates low biodegradability.

Kediri City operates Klotok I landfill, which was built in 1992 with a controlled landfill system. Furthermore, in 2011 the city government built Klotok II Landfill, which is located not far from Klotok I Landfill. Both landfills are located on the slopes of Klotok Mountain. Different from Klotok I landfill, Klotok II Landfill is operated using the sanitary landfill system, so it is equipped with methane gas and leachate processing.
The waste generation in Kediri City in 2013 was 518 m³/day or equivalent to 6,216 m³/year. The composition of residents' waste consists of 56% of organic waste, 26% inorganic waste, and 18% hazardous and toxic materials. The waste generation that goes to Klotok II Landfill increases every month and it is feared that this Landfill will not operate according to plan.

2. Research Methods
Sampling was performed by the administrators of Klotok Landfill Kediri City two times in one year. The activity was conducted at four points: anaerobic pond, facultative pond, maturation pond, and wetland. The parameters analyzed were pH, BOD₅, COD, TSS, Total N, Cd, and Hg. The parameter analysis refers to the enacted standards in Indonesia. Further quality monitoring results were compared with the quality standards. The parameters that did not meet the quality standard were technically evaluated based on the processing process occurring at Klotok Landfill Kediri City.

3. Result and Discussion
The leachate treatment plant at TPA Klotok Kediri consists of Collecting Well, Anaerobic Pond, Facultative Pool, Maturation Pond and Wetland. The leachate water treatment plant plan can be seen in Figure 1. There is an equalizing unit at each end of the processing unit. An equalizing unit is equipped with a pipe that serves to channel excessive leachate during the rain seasons.

In 2017, monitoring of the leachate water treatment plant was completed with sampling in February and May 2017. The researchers took samples in each unit (Anaerobic Pond, Facultative and Maturation). The analysis results can be seen in Table 1. The results of the analysis in Wetland were subsequently compared with the applicable quality standards instruction, namely the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/Menlhk/Setjen/Kum.1/7/2016 on the Leachate Quality for Business and/or Activities of Landfill. Compliance with the quality standards can be seen in Table 2.

| Parameter | Anaerobic Pond | Facultative Pond | Maturation Pond | Wetland |
|-----------|----------------|------------------|-----------------|---------|
| pH        | 7.15           | 7.89             | 7.27            | 7.94    | 7.15 | 7.92 | 7.24 | 7.89 |
| BOD₅      | 107.2          | 364.3            | 33.26           | 609.3   | 29.66 | 227.3 | 37.84 | 258.8 |
| COD       | 1654           | 2137             | 798.1           | 1657    | 529.3 | 1435 | 245.1 | 1435 |
| TSS       | 145            | 285              | 516             | 353.3   | 68    | 259  | 54   | 136.7 |
| Total-N   | 21.17          | 112.2            | 27.39           | 93.56   | 18.43 | 78.91 | 9.38  | 73.49 |
| CD        | *              | *                | *               | *       | *     | *    | *    | *     |
| Hg        | *              | *                | *               | *       | *     | *    | *    | *     |

Description:
BOD₅, COD, TSS, N-total Parameters in mg/L.
• Undetected

The results of the sample measurement in May 2017 showed results that exceeded the quality standard, so it is necessary to evaluate the process occurring in the treatment unit.
3.1. Anaerobic Pond

The anaerobic pond at Klotok Landfill Kediri City consists of eight compartments with each compartment dimension being $5 \times 10 \times 3.5$ m ($L \times W \times D_{water}$). The anaerobic pond is used to treat waste with high concentrations of BOD. The high BOD load of each pool volume causes the oxygen consumption rate to be several times greater than the oxygen production rate. This causes the conditions in the pond to become anaerobic.

The depth of the pond has already met the design criteria of the anaerobic pond. Anaerobic ponds are also suitable in areas with warm temperatures because temperature is an important factor in biomass reproduction and substrate conversion rate. Anaerobic pond is able to remove BOD by 50-70%. The anaerobic pond at the Klotok Landfill Kediri has a froth layer on its surface as shown in Figure 2.

![Figure 1. Leachate Treatment Plant](image)

The froth layer that appears in the anaerobic pond is a natural occurrence. This layer is able to maintain anaerobic conditions, control the temperature, and avoid the release of odors. This layer appears due to the presence of froth, oil, and plastic. Meanwhile, the odor that appears in the
The processing unit can be due to overload and low detention time. The efficiency of the anaerobic pool cannot be calculated because there is no parameter measurement in the collector tub. Leachate also does not flow during the survey due to the onset of dry season, resulting in low leachate production. The anaerobic pond and other units should always be flowed with leachate (continuous water flow) to keep the food supply for microorganisms in the anaerobic, facultative, and maturation ponds.

### 3.2. Facultative Pond

Effluent anaerobic pools generally still contain a high amount of organic material, so advanced treatment is needed. The most widely used advanced treatment is the facultative pond. The facultative pond at Klotok Landfill Kediri City consists of nine compartments with the dimension of each compartment being $5 \times 10 \times 2 \text{ m (W x L x D}_{\text{water}}$). The facultative pond water depth at Klotok Landfill Kediri City is in accordance to the design criteria of $1.5-2 \text{ m (von Sperling, 2007)}$. There are three zones in the facultative pond, namely aerobic zone, facultative zone, and anaerobic zone. The aerobic zone is formed in the upper layer of the pond, where the oxidation of organic compounds occurs through aerobic respiration process. The anaerobic pond forms at the bottom of the pond. Organic compounds in particulate form are collected and form mud. This mud is decomposed by anaerobic microorganisms. The facultative zone is between the aerobic and anaerobic zones. Therefore, it is necessary to monitor the dissolved oxygen values in each pond.

### 3.3. Maturation Pond

Maturation pond serves to eliminate pathogenic organisms and does not eliminate BOD. Maturation pond can achieve a high coliform removal efficiency (99.99%), so the outflowing effluent can meet the quality standard. The coliform parameter analysis was performed in February 2017 with the result of coliform analysis in maturation pool being $430,000 \text{ MPN/100 mL}$. This shows that the maturation pond did not have a good performance.

The maturation pond at Klotok Landfill Kediri City consists of nine compartments with the dimensions of each compartment being $5 \times 10 \times 1 \text{ m (P x L x H}_{\text{water}}$). The shallow depth of the pond has benefits: (i) high solar radiation penetration, (ii) high pH, and (iii) high DO concentration. Two things that can be done to improve coliform removal efficiency are (i) two or three pools should be arranged in series or (ii) a single pool with a partition should be used instead.

### 4. Conclusion

The findings of the leachate quality monitoring in Klotok Landfill show that the results are not yet optimal because some effluent parameters of leachate water treatment plant are still above the quality standard as regulated in the Indonesian Minister of Environment and Forestry Regulation Number P.59/Menlhk/Setjen/Kum.1/7/2016 on the Leachate Quality for Business and/or Activities of Landfill. The improvements that can be done are (i) adjusting water flow into the processing unit by adding pumps in the equalization units; (ii) monitoring microorganisms that grow and act in processing units; (iii) measuring daily parameters such as water flow, air temperature, water temperature, pH, solid residue, and dissolved oxygen; and (iv) altering monitoring points at leachate treatment plants.

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### References

[1] Ahmed, F.N. and Lan, C.Q. 2012. Treatment of landfill leachate using membrane bioreactors: a review. Desalination. 287:41-54.

[2] Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia. 2016. Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.59/Menlhk/Setjen/Kum.1/7/2016 Mutu Lindi Bagi Usaha dan/atau Kegiatan Tempat Pemrosesan Akhir Sampah.
[3] Abbas, A. A., Jingsong, G., Ping, L.Z., Pan, Y.Y., and Al-Rekabi, W. S. 2009. Review on landfill leachate treatments. *J Appl Sci Res.* 5:534-545.

[4] Li, W., Hua, T., Zhou, Q., Zhang, S., and Li, F. 2010. Treatment of stabilized landfill leachate by the combined process of coagulation/flocculation and powder activated carbon adsorption. *Desalination.* 264:56-62.

[5] Xu, Z.Y., Zeng, G.M., Yang, Z.H., Xiao, Y., Cao, M., Sun, H.S., Ji, L.L., and Chen, Y. 2010. Biological treatment of landfill leachate with the integration of partial nitrification, anaerobic ammonium oxidation and heterotrophic denitrification. *Bioresour Technol.* 101:79-86.

[6] Dinas Kebersihan dan Pertamanan Kota Kediri. 2017. *Detail Engineering Design (DED) Tempat Pemrosesan Akhir (TPA) Kota Kediri: Review Perencanaan Teknis Instalasi Pengolahan Lindi TPA Sanitary Landfill Kota Kediri.* Surabaya: Citra Bangun Persada.