IDENTIFICATION OF SLUDGE PRODUCTION IN WATER TREATMENT INSTALLATIONS OF URBAN DRINKING WATER COMPANIES

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Abstract

The by-product of sludge generated at the Water Treatment Plant can affect water quality degradation if disposed of directly without any prior treatment. As a company engaged in water management, the urban drinking water companies produce sludge in every production activity. This study aimed to identify the flow of sludge generation at the Water Treatment Plant, the quantity of sludge generated at the sedimentation unit, and the quality of the wastewater generated at the Sludge Treatment Plant. The identification results show that the flocculation, sedimentation, and filtration units produce sludge transported to the sludge treatment unit (SCP and SDB). The quantity of sludge generated in the sedimentation unit in March and April are 1,887m^3/day and 1,474m^3/day, respectively. The physical and chemical quality (pH, temperature, TDS) of wastewater produced by the sludge treatment unit are still below the quality standard based on PERMENLHK No. 5 of 2014, concerning Wastewater Quality Standards for Businesses or Activities That Do Not Have Wastewater Quality Standards.

Keywords: *drinking water treatment, sedimentation, sludge*

Introduction

Water Treatment Plant (IPA) in a Drinking Water Supply System (SPAM) is one part of human activities that can pollute the surrounding environment if they do not manage the waste generated. Every Water Treatment Plant must produce waste by-products in residues from various processing processes (Qasim, Motley, & Zhu, 2000). Residues from various treatment plants for drinking water treatment (IPA) are called sludges. Sludge produced as a by-product of water treatment can affect water quality degradation if disposed of directly without prior treatment (Julian, Lindum, & Winarni, 2015). These phenomena can potentially threaten aquatic life when the residue is channelled directly into water bodies with small discharges because it can cause sludge to accumulate at the disposal point (Adityosulindro, Hartono, & Pramusinto, 2013). This study aimed to identify the flow of sludge generation at the Water Treatment Plant, the quantity of sludge generated at the sedimentation unit, and the quality of the wastewater generated at the Sludge Treatment Plant.

Methodology

Research sites

The research was conducted at a local drinking water company located in Bandar Lampung, Indonesia.

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Tools and materials

The data collection method used was observation and interviews with the production and maintenance staff and practical work supervisors. The primary data related to the physical-chemical quality of the wastewater produced by the sludge treatment unit is done by sampling. Here are the tools and materials used:

1. Sample container bottle
2. Bucket
3. Thermometer
4. TDS Meter
5. Turbidity Meter
6. pH Meter
7. Glass Beaker 200 ml

Data processing

Processing of secondary data obtained for estimating the quantity of sludge generation using the following equation (Cornwell, Bishop, Gould, & Vandermeyden, 1987):

$$W = 8.34 \times Q \times (0.8Al + SS + A) \quad (1)$$

$$SS = b \times TU \quad (2)$$

Where W is sludge weight (lb/day), Q is installation discharge (mgd), Al is PAC dose (mg/l), SS is Suspended solid raw water (mg/L), b = ratio of suspended solids to turbidity, with a range 0.7-2.2 (Cornwell, Bishop, Gould, & Vandermeyden, 1987), in this calculation the value of 1.3 (Kawamura, 2000), TU is raw water turbidity (NTU), and A is other coagulant added (mg/L)

Furthermore, the calculation of the volume of mud with the following equation (Tchobanoglous, Burton, & Stensel, 2004):

$$Q_{sludge} = \frac{\boldsymbol{W}}{\boldsymbol{pw \times Ssl \times PS}} \quad (3)$$

Where Q is Total mud quantity (m3/day), Wis Sludge weight (tons/day), pwis 1000 kg/m3, specific gravity of water, Sslis 1.02, Specific gravity mud, Ps is Percentage of dry solids in decimal, 0.02 (Qasim, Motley, & Zhu, 2000).

Result and Discussion

Sludge Production Flow

Figure 1 shows the flow of both generated sludge and wastewater from the water treatment plant.

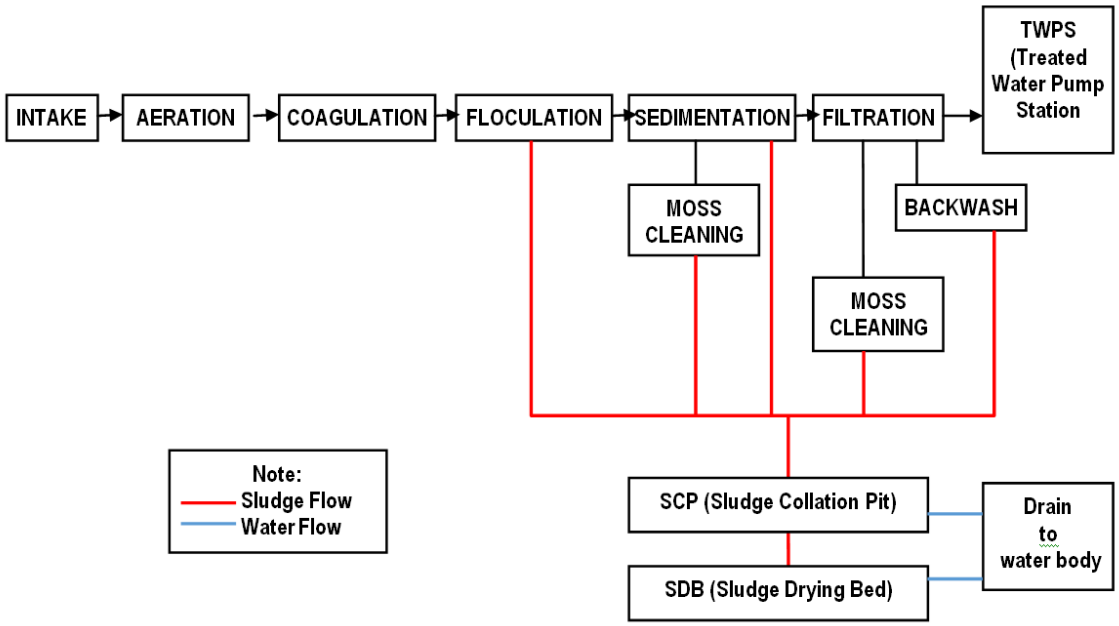

Figure 1. Sludge Production Flow Diagram

Potential Slide in Flocculation, Sedimentation, Filtration, Sludge Collection Pit (SCP), Sludge Drying Bed Units

Sludge in the flocculation unit will be followed by a drain pump with a manual pump to the collection tank. In practice, the drainage of sludge with a drain pump in the flocculation unit is only carried out if the sludge has started interfering with the water production process (Pintor et al., 2016). So, there is no definite schedule in the draining process.

The types of sludge produced in the sedimentation unit are mud containing colloids, suspended solids, sand, organic and inorganic substances, as well as metal hydroxides derived from the coagulant itself, such as alum sludges iron sludges (Manual/AWWA, 1996). The drain pump in the sedimentation unit will be turned on every time water is produced and after cleaning the moss. During water production, the drain pump will be turned on for one hour so that, on average, the drain pump in the sedimentation unit will be turned on for two hours a day.

In the filtration unit, the type of mud produced is mud in the form of flocs with an acceptable size, and this mud is mud that escapes the sedimentation unit, then is trapped in the filtration filter media and carried away when the backwash process is carried out.

Sludge Collection Pit (SCP) is a unit that is used to accommodate all the sludge that flows from the flocculation, sedimentation, and filtration units. The processing process at SCP is Thickening or concentrating sludge to reduce the volume of sludge before it is processed in the next unit. The process of concentration in this SCP unit occurs by gravity. Furthermore, the mud that has undergone a concentration process or has settled in the SCP is circulated to the Sludge Drying Bed (SDB) pool. The water at the top, which is estimated to be clear enough, will be drained using a pump. The disposal of the water contained at the top of the SCP pool is carried out to avoid excess capacity so that sometimes the water discharged is still in a state that has a reasonably high density when seen with the naked eye. The water at the top, which is estimated to be clear enough, will be disposed of using a pump through the drainage leading to the water body.

Sludge Drying Bed (SDB) is the last sludge treatment unit at urban drinking water companies. The mud circulated from the SCP will be treated by concentrating the mud in the open air so that it is exposed to sunlight to form a cake, or it can also be called the Dewatering and Drying process. The number of SDB units in urban drinking water companies is four. The filter media used in the SDB unit at urban drinking water companies is stone ash with a height of 1 meter. The pipe used to drain seepage water that passes through the filtrate media is covered with a geotextile layer.

Sludge Generation Quantity

a. Sludge Weight

Table 1. Sludge Weight

	Month	Average (pound/day)	Average (kg/day)
1	March	38.508	17.467
2	April	30.080	13.644

b. Sludge Volume

Table 2. Sludge Volume

No	Month	Average (m^3/day)
1	March	1.887
2	April	1.474

Factors that affect the difference in the value of the quantity of sludge produced are the high turbidity value (Kobya et al., 2006) in March compared to April. This increase in turbidity is caused by weather conditions in March, which have high rainfall.

The highest pH value of wastewater was found in the SCP unit, with an average value of 7.37. Furthermore, the highest temperature values

tend to have the same number of variations for each unit, where each unit has a value range between 25 - 28^{o}C. Then, for the Total Dissolved Solids (TDS) value, it was shown that the highest value was obtained in the SDB 2 unit, with an average value of 222.18 mg/l. Overall, the results of testing pH, TDS, and temperature at the three sampling locations still meet the quality standards required by Ministry of Environment Decree of No. 5 year 2014 concerning Wastewater Quality Standards for classes I and II.

Conclusion

The flow of sludge generated at the Water Treatment Plant at urban drinking water companies is found in the flocculation, sedimentation, and filtration units. The sludge produced in the three units is channeled to a sludge treatment unit consisting of one unit of Sludge Collection Pit and four units of Sludge Drying Bed. Based on the calculation results, the quantity of mud produced in the sedimentation unit is 38,508 pounds/day in March and 30,080 tons/day in April. The quantity of mud volume produced in the sedimentation unit is 1,887m^3/day in March and 1,474m^3/day in April. The physical-chemical characteristics were tested based on Ministry of Environment Decree No. 5 of 2014 concerning Wastewater Quality Standards. Parameter of pH, temperature, and TDS of wastewater from the SCP unit and SDB unit still meet the quality standards.

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