ANALYSIS OF PHOSPHATE IN LIQUID WASTE HOSPITAL

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Abstract

Liquid waste generated by various activities in the hospital environment has the potential to pollute the environment if the parameters contained in it exceeds the specified quality standards. Parameters that most often exceeded the quality standard is phosphate (PO_4^{3-}). Phosphate which exceeds the limit of 2 mg/L may affect the balance of aquatic ecosystems. One way to lower phosphate levels is using the coagulation flocculation process. This study aims to uncover the root cause of high levels of phosphate and recommendations for decline it and propose to install coagulation flocculation units.

Research methodology starts from search and identification of phosphate levels of various source of phosphate in the hospital environment, from sump pit Dapur (Kitchen), sump pit Poli (Polyclinic), sump pit Lucas, sump pit Biara (Monastery), sump pit Genset and sump pit Carolus. Then doing the jar test in coagulation flocculation process using coagulant that is alum and lime with rapid stirring for 60 seconds and slow stirring for 15 minutes. Jar test was used to determine the optimal dose of coagulant for alum dose range between 50-150 (mg/L) and lime between 75-125 (mg/L). Coagulation flocculation units will be built on the largest phosphate producer with sampling as much as 6 times to determine the fluctuations of phosphate. Lab test of phosphate levels were performed using the spectrophotometric of $SnCl_2$ method.

The study data include phosphate levels from source of phosphate and phosphate fluctuations in the greatest source. Based on the results the largest source from pond Elisabeth. Jar test process is done by sampling as much as a liter of waste water taken from pond Elisabeth with total discharge of 26,640 L/day. Showed that the initial Phosphate of maximum from 7,1 mg/L decreased to 1,73 mg/L (75,63%) if given the alum dose of 50 mg/L and lime 125 mg/L which generates as much as 7,049 kg of sludge per day. Phosphate of average from 4,58 mg/L decreased to 0,73 mg/L (84,06%) with alum as much as 50 mg/L and lime as much as 75 mg/L which produces sludge as much as 5,378 kg/day. Phosphate of minimum from 2,23 mg/L decreased to 0,14 mg/L (93,72%) if given the alum dose of 50 mg/L and lime 75 mg/L with sludge as much as 4,931 kg/day.

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1. Introduction

Hospital is a health care institutions that conducting professional health care. Medical service activities in Panti Rapih Hospital located at Cik Di Tiro Street Yogyakarta ranging from emergency services and outpatient clinic services, medical check-up services, inpatient services, Intensive Care Units (ICU) services, pharmacy services, laboratory services, radiology services, operating room services, haemodialisa services, nutrition services, physiotherapy services, also baby massage services and other supporting activities (Primary Data of Panti Rapih Hospital, 2013).

In accordance with its activities, waste water from all activities in Panti Rapih Hospital containing of organic materials, inorganic materials/chemicals toxic and infectious material. Liquid waste generated by activities in the Hospital such as laundry waste (washing), kitchen waste, bathroom waste, laboratory waste such as reagents and blood also medical waste (scar) such as rinse water at operating room that discharged into bathroom.

Based on test results of WWTP outlet Panti Rapih Hospital, phosphate is most often exceeded the quality standard that is above 2 mg/L. Therefore it is necessary to analyze the causes so can be made the solution to decrease often pollute the environment. One way to decrease phosphate levels is by means of chemical precipitation using coagulant such as alum and lime (Eckfendeler and Wesley, 2000).

This study aims to identify the root cause of high levels of phosphate contained in hospital wastewater and provide suggestions/recommendations decreased levels of phosphate. Recommendations will built at the largest phosphate source with coagulants used were alum and lime.

2. Research Methodology

Hospital sewage wastes consisting of laundry water (washing), waste kitchen, bathroom wastes and other liquid wastes are discharged to the wastewater channel as well as chemicals used in the hospital activity. Chemicals for testing and decreased levels of phosphate are fenolphtalein (PP), H2SO4, aquades, solution of ammonium molybdate, solution of SnCl2, solution of lime (10 g/L), solution of alum (10 g/L). The tools used in this study are:

1. Bailer sample
2. Sample bottle
3. Volumetric flask
4. Beaker
5. Pipette
6. Motor stirrer
7. pH meter
8. UV-VIS spectrophotometer
9. Analytical balance
10. Stop Watchs

Recommendations made for decreasing levels of phosphate with coagulation flocculation process using coagulant such as alum and lime. The study begins with Jar Test to test the coagulation flocculation process. The Jar Test is conducted as follows:

1. Setting up the original wastewater sample then examined the levels of phosphate.
2. Creating solution of alum 10 g/L and solution of lime 10 mg/L.
3. Fill the 5 beaker with 1000 mL of water waste.
4. Adding a solution of lime in each glass beaker of 7,5 mL. Adding alum as much as 5 mL, 7,5 mL, 10 mL, 12,5 mL, and 15 mL of each glass beaker.
5. Turning stirrer at 100 rpm and perform rapid stirring for 1 minute. Then do a slow stirring at 20 rpm for 15 minutes.

6. Turning off the mixer and observe floc formed and allowed to stand for 15 minutes until a precipitate is formed.
7. Separate the filtrate from the precipitate and inspect the filtrate in each beaker for pH and phosphate parameters after the flocculation coagulation process.
8. Repeat the procedure 2 until 7 with variations of solution lime successively 7,5 mL, 12,5 mL, and 17,5 mL.

The flowchart of this research described in the following figure:

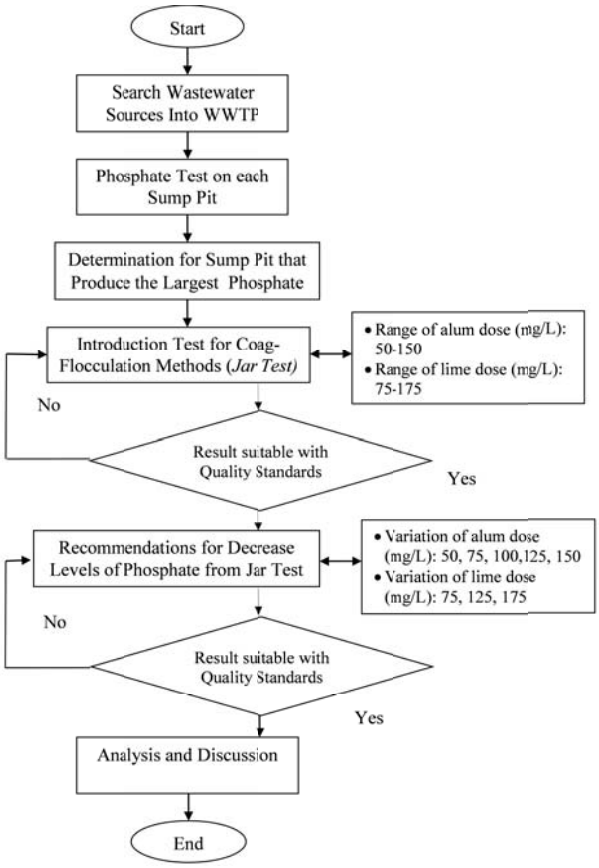

Figure 1. Flowchart of Research

3. Results of Research

Based on the identification is done, it was found that the onset of phosphate levels in the Panti Rapih Hospital as a result of the use of chemicals containing phosphate and derived from natural sources, namely:

a. The use of detergents in the activities of the hospital linen
b. The use of bath soap, shampoo, toothpaste in clean themselves activities
c. The use of cutlery soap and cookware
d. The use of liquid floor cleaner
e. The use of hand soap and laundry soap medical instrument
f. Discharge of human waste (urine and feces)
g. Natural processes within the water itself (background source) is the natural phosphate content in water

Here are the results of laboratory tests phosphate levels in each WWTP and sump pit with maximum quality standard of 2 mg/L, namely:

Table 1. Results of laboratory tests for phosphate levels in each unit WWTP and sump pit

No	Source	Level of PO_4^{3-} (mg/L)
1	Equalization Tank	6,65322
2	Clarifier Tank	6,37728
3	FBK Tank	3,047604
4	Polishing Tank	2,741004
5	Holding Tank	2,97402
6	Sand Filter (Outlet)	2,121672
7	Sump Pit Kitchen	45,92868
8	Sump Pit Polyclinic	2,11554
9	Sump Pit Lucas	5,94804
10	Sump Pit Abbey	4,96692
11	Sump Pit Genset	6,46926
12	Sump Pit Carolus	0,472164
13	Laundry	0,410844

Source: Test Results Health Laboratory Yogyakarta, 2013

Having in mind that the highest is in the sump pit kitchen, then test for highest source the of phosphate in the kitchen sump pit. The following are the test results of pond wastewater in ward Elisabeth, kitchen and laundry before going into the kitchen sump pit, namely:

Table 2. Results of laboratory tests on the source of phosphate levels in the sump pit kitchen

No	Source	Level of PO_4^{3-} (mg/L)
1	Elisabeth Pond	**6,16266**
2	Kitchen Pond	5,58012
3	Dish Washer in Kitchen	1,59432
4	Laundry Pond	0,754236
5	Dish Washer Laundry	2,7594
6	Clean Water	0,101178

Source: Test Results Health Laboratory Yogyakarta, 2013

Based on the test results showed that the phosphate levels in the Elisabeth pond produce the highest phosphate equal to 6,16266 mg/L. The high content of phosphate in the pond because liquid waste derived from Elisabeth ward and east office units. Elisabeth ward is a combination of the four wards that have capacity as much as 164 beds, while the east office units include inpatient pharmacy unit, logistic unit, Environment and Health unit, household unit, personnel unit, purchase unit, engineering unit, meeting rooms, and other units.

4. Discussion

Elisabeth ward is one of the largest source of liquid waste at the Panti Rapih Hospital with an average flow of 26,640 L/day. Based on the available data of facilities, the number of bathrooms as many as 72 pieces, enabling these wards produce a lot of waste water containing phosphate and high. This is because the number of guest around 2-3 people can produce phosphate contained in the feces or human waste. The liquid waste is also generated from self-

cleaning or bathing activities that require about 30 liters of clean water.

Based on the results of preliminary experiments were chosen dosage range of coagulant for lime between 75 mg/L and 275 mg/L and for alum between 50 mg/L and 150 mg/L. Here are the test results of phosphate levels on Elisabeth ward before downturn by coagulation flocculation process at maximum levels of phosphate, average levels and minimum level:

Table 3. Results of laboratory tests for phosphate levels in Elisabeth pond before decline recommendation

No	Parameter	Results of Test Lab for Phosphate (mg/L)
1	Maximum of phosphate	7,10
2	Average of phosphate	4,58
3	Minimum of phosphate	2,23

Source: Test Results Health Laboratory Yogyakarta, 2013

Based on the results of the above measurements, all of parameters phosphate exceeds quality standards are specified above 2 mg/L. Then, wastewater taken from Elisabeth pond performed treatment by means of coagulation and flocculation.

Showed that phosphate levels decreased after coagulation flocculation process with variety of doses. Low doses have been able to reduce phosphate levels to well below the standards on wastewater at maximum phosphate concentration, from 7,1 mg/L to 1,73 at a dose of alum 50 mg/L and lime 125 mg/L. Phosphate at average level and minimum level also has been able to drop below the quality standard with alum dose of 50 mg/L and lime 75 mg/L.

Here is a scheme of recommendation installation for decreasing phosphate levels with coagulation flocculation process that can be applied at Panti Rapih Hospital based on the data and the conditions in the field, namely:

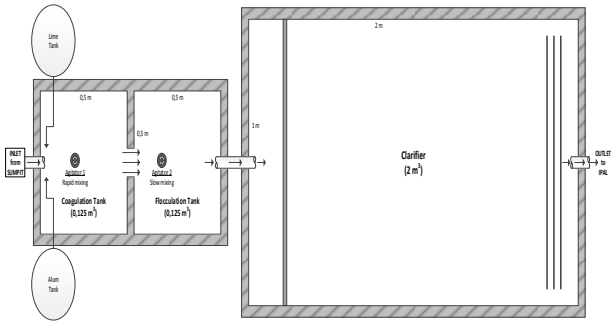

Figure 2. Schematic top view installation for coagulation flocculation process

5. Conclusion

1. Cause of the high levels of phosphate in wastewater contained in the sump pit Elisabeth as the largest producer of phosphate is the use of chemicals in everyday activities such as liquid soap for cleaning floors, detergents, soap for cooking utensils, soap for tableware cleaning, soap for medical instruments and from human waste.
2. Decreased levels of phosphate in wastewater hospital can be done by coagulation flocculation process with alum and lime as coagulant. Optimal dose for lowering maximal phosphate levels from 7.1 mg/L to 1,73 mg/L (75,63%) with the addition of alum is 50 mg/L and lime 125 mg/L. Average of phosphate from 4,58 mg/L decreased to 0,73 mg/L (84,06%) with alum 50 mg/L and lime 75 mg/L. As for the phosphate content of at least 2.23 mg/L decreased to 0,14 mg/L (93,72%) with the addition of alum 50 mg/L and lime 75 mg/L.
3. Further research is needed to reduce the volume of sludge generated in the processing of the coagulation flocculation. There needs to be other alternative to decreased levels of phosphate with other methods such as the use of microbes as a phosphate-lowering agents, the use of aquatic plants or modified of bentonite.

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