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CHEMICAL CONDITIONING OPTIMIZATION TO IMPROVE DEWATERING EFFICIENCY (CASE STUDY : SLUDGE IPLT BALAI PIALAM YOGYAKARTA)

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ABSTRACT:
Abstract. The disposal of laundry wastewater into the septic tank and the condition of the septic tank in the IPLT Balai PIALAM service area which does not meet the quality standards caused the fecal sludge product from the IPLT Balai PIALAM difficult to dry because of the high water content and it still emits pungent smell. IPLT Balai PIALAM has carried out the process of increasing the operating unit and dewatering process unit but has not yet obtained optimum dewatering results. Therefore, it is necessary to optimize the chemical conditioning process to increase dewatering efficiency. Chemical agent used in the process are alum, lime, and a combination of alum and lime. The purpose of this study is to analyze the effect of increasing the dose of chemical agent that can increase the efficiency of sludge dewatering in IPLT Balai PIALAM as well as assess the type and optimum dosage of chemical agent that used in the chemical conditioning process. The parameters used in this study are water content, TSS, TS, SRF, and CST in faecal sludge. The result of chemical conditioning optimization based on the study is the type of the most optimum chemical agent which is the combination of alum and lime ratio of 1:2 with an optimum dose of 14 g/L that can reduce the water content in the sludge from 90,14% to 64,68%, TSS from 73.000 to 6.915, TS from 102.950 to 13.620, CST from 90,29 to 22,4 seconds, and SRF value from 6,69 x 1010 to 1,23 x 1010 m/kg.

Keywords: chemical conditioning, alum, lime, water content, TSS, TS, SRF, CST, fecal sludge.

INTRODUCTION

Background

Domestic wastewater is wastewater produced from various forms of household activities (Sulistia & Septisya, 2019). The wastewater consists of black water, which is feces from toilet wastewater and non-toilet wastewater (grey water), which is wastewater used for laundry from kitchens and bathrooms. In handling latrine wastewater, most people in Indonesia still use a local treatment system (on site) in the form of septic tanks. A septic tank is a watertight building that functions to collect and treat household wastewater (Sulistia & Septisya, 2019). The wastewater in it will

undergo a process of deposition of solids and decomposition of organic materials by anaerobic microbes naturally into fecal sludge.

Fecal sludge is a source of pollution consisting of dissolved solids in water which mostly contain organic material and microorganisms including viruses, bacteria, and others (Naidoo & Olaniran, 2014). Fecal sludge has general characteristics with TSS 4,000-100,000 mg/l, COD 5,000-80,000 mg/l, BOD5 2,000-30,000 mg/l, and total coliforms 56-8.03 x 107 CFU/100 ml (Metcalf and Eddy, 2014). Therefore, in order not to pollute the environment, fecal sludge must first be treated at the Fecal Sludge Treatment Plant (IPLT).

IPLT Balai pialam Yogyakarta is a fecal sludge treatment plant that has been operating since 2016 with a fecal sludge treatment capacity of 60m3 / day. The service area of IPLT Balai PIALAM covers the urban area of Yogyakarta (Yogyakarta City, Sleman Urban District, and Bantul Urban District) (SAVIRA, 2022). Fecal sludge accumulated in septic tanks is transported to STP Balai PIALAM using the services of a fecal truck. The urban area of Yogyakarta (Yogyakarta City, Sleman Urban District, and Bantul Urban District) is one of the cities in Indonesia that still applies the local treatment system (on site) in the form of septic tanks. Every day fecal trucks that dispose of fecal sludge waste to the IPLT Balai PIALAM have an average capacity of 30 to 40 fecal trucks with a volume of 2500 to 3000 liters (Dilla et al., 2018).

The problem that occurs today is the behavior of people in service areas that not only collect toilet wastewater in their septic tanks (Hashemi & Boudaghpour, 2020). However, laundry wastewater containing chemicals from soap and detergent is also accommodated (Ahmad & Hisham, 2008). The chemicals in the used laundry water contain The main component is surfactant. The surfactant content can kill decomposing bacteria needed for the natural decomposition process of organic matter in septic tanks. In addition, the condition of the septic tank owned by the community has not met the standards including has not experienced complete degradation which should not form sludge in the decomposition chamber. This makes fecal sludge products from the Balai PIALAM STP difficult to dry because of the high water content and still smells pungent.

In making efforts to improve the quality of fecal sludge, IPLT Balai PIALAM carried out an improvement process of the operation unit and dewatering process unit which is still under test of the application of the Andrich Tech System method which can be used as an effective method to reduce sludge volume (Duggan et al., 2013). However, optimal dewatering results have not been obtained. So there needs to be a study to improve the efficiency of dewatering in IPLT, namely by chemical conditioning process (Septiariva et al., 2022).

RESEARCH METHODS

Before conducting research, it is necessary to prepare the tools and materials to be used so that the research can run well. The place of research and parameter checking is carried out at the Water Treatment Technology Laboratory of Institut Teknologi Sepuluh Nopember. The tools used in the study consisted of a jar test, a Buchner Funnels vacuum filter that can be used for > 10 mL capacity, and a Capillay Suction Time tool. The materials used are fecal sludge samples from IPLT

Balai PIALAM Yogyakarta and chemicals in the form of lime and alum used in the conditioning process as chemical agents

Preliminary Research

Before conducting research on a laboratory scale, primary data measurements were first carried out on fecal sludge samples so that the characteristics of fecal sludge were known. The primary data measured at the beginning are water content data, Specific Resistance to Filtration (SRF), Capillary Suction Time (CST), Total Suspended Solids (TSS) and Total Solids (TS) which are control variables and will be measured during the study. SRF and CST tests can estimate the dewaterability value of sludge quite empirically (Sawalha et al., 2010). Initial analysis of fecal sludge is carried out after sampling to avoid the aging process due to prolonged sample storage (Hosnani et al., 2010). Fecal sludge samples were taken as much as 500 ml for each research variable then examined the initial condition of the sludge. Each parameter was tested three times to obtain more representative research data.

Primary Research

The main research was conducted by testing variations in types and doses that have been determined to determine its ability to reduce water content parameters, SRF, CST, TSS, and TS. A total of 500 ml of fecal sludge samples were given chemical agents, namely alum, chalk, and a combination of alum and lime according to variations in type and dose.

RESULTS AND DISCUSSION

Proses Chemical Conditioning

The fecal sludge samples taken were located in the equalization pond at the IPLT Balai PIALAM Yogyakarta. Physically, the fecal sludge samples of STP Balai PIALAM used in the study were black and diluted.

Fecal sludge samples are then carried out a process of testing the initial moisture content parameters, SRF, CST, TS and TSS which are used as initial characteristics to determine the parameter values before the chemical conditioning process is carried out. The characteristics of fecal sludge can be seen in Table 3.1.

Characteristics of fecal sludge	Value	Unit
Up to air	90,14	%
SRF	6,69 x 1010	m/kg
CST	90,29	second
Total solid	102.950	mg/L
Total Suspended solid	73.000	mg/L

When testing solid levels, researchers used references from the 21st edition of "Standard Methods for the Examination of Water and Waste Water" (2005), to calculate TSS levels from fecal sludge samples to see the addition of sludge generation due to the use of additional chemicals. In addition to testing TSS to get more representative results in measuring the presence of additional mud generation, it will be more representative if you look at the weight

fraction that can be tested against TS. Thus, the heavy fraction of mud that represents mud generation will be seen more clearly and significantly. Total solid (TS) sludge testing was carried out by heating a sludge sample of 10 ml without dilution in the oven at 105oC for 24 hours. At that temperature for 24 hours all the water contained in the sludge has evaporated, so that the heavy fraction of the sludge can be identified and quantified.

After testing the initial parameters as the initial characteristics of the fecal sludge sample before chemical conditioning is carried out, the sludge sample is carried out preservation and packaging because the fecal sludge sample will be brought from the IPLT Balai PIALAM Yogyakarta to the Water Treatment Technology Laboratory of Institut Teknologi Sepuluh Nopember by taking 4 hours. Preservation is carried out by lowering the pH of fecal sludge samples from 6 to 1 in accordance with SNI 6989.59.2008. This acidification is done by adding as much as 2 ml of H2SO4 solution. When the sample arrives and will be researched, it is carried out to increase the pH of the sample to pH 7 by giving as much as 3 ml of NaOH. The pH setting is adjusted to the optimal pH for each type of chemical conditioning used. If not done at the optimal pH range, the coagulation process cannot form floc (Wardani et al., 2009) Alum has an optimal pH of 5-7.5 (Rahardjo, 2010). As for the optimal pH of lime is 9-11 (Risdianto, 2007). According to (Liao et al., 2010), around neutral pH, suspended sludge particles become more easily aggregated and the portion of free water in sludge can increase, which means it is easier to dry.

Testing of chemical conditioning begins by affixing the chemical agent to the raw fecal sludge based on predetermined variations. The concentration of the solution made for each chemical agent varies according to previous studies. The chemical conditioning testing process is carried out repeatedly 3 times for each variation until significant data on the reduction in sludge moisture content is obtained. For each chemical agent, the dosage variations tested are different from each other because the effect of the chemical agent on reducing sludge water content also varies.

In the first week of the study, the author made variations in the parent solution with doses determined based on Rahardja's (2013) research of 6 mg / L, 8 mg / L, 10 mg / L, 12 mg / L, 14 mg / L, and 16 mg / L. While for variations in the dose of Alum (alum) and Lime (CaCo) affixed to the sample, namely 0.3 mg / L; 0.4 mg/L; 0.5 mg / L; 0.6 mg/L; 0.7 mg / L; 0.8 mg / L. Then for the combination of Alum and Lime for each dose using a ratio of 1: 1, 1: 2, 2: 1, 1: 3, 3: 1. In the chemical conditioning experiment in the first week the decrease in water content reached 58% to 76%. According to (Yin et al., 2004), chemical conditioning can reduce water content from 90-99% to 65-85%, this is necessary in research. Therefore, in the following week the dosage range of the chemical agent is not added.

Fecal sludge samples that have been spiked with chemical agents based on their variations are then carried out in the chemical conditioning process according to the plan, namely by stirring using a jar test tool and a vacuum process using a vacuum filter buchner funnels. The stirring process uses a jar test tool with a high speed of 150 rpm for 3 minutes and continued with a low speed of 50 rpm for 5 minutes and sedimentation is carried out for 15 minutes. Then each sample of sludge that has been sedimented is taken mud that settles and then a vacuum process is carried out until the liquid in the sample runs out. In addition, moisture content, SRF, CST, TSS, and TS were also tested.

Chemical Conditioning Research Results

Based on the chemical conditioning process carried out on a laboratory scale, data results vary based on each chemical agent. Chemical conditioning experiments using alum, it was found that using a dose variation of 6 mg / L to 16 mg / L can reduce the initial TSS value by 73,000 mg / L to 10,540 mg / L, the initial TS value of 102,950 mg / L to 14,476 mg / L, the initial water content of 95.14% to 70.97, and the initial SRF value of 6.69 x 1010 to 1.84 x 1010.

CONCLUSION

From the results of data processing and analysis in this study, several things can be concluded, namely as follows:

Based on the 3 types of chemical agents used, namely alum, lime, and a combination of alum and lime, the influence of the type and dose of chemical agents is as follows:

- Alum with a dose of 10 mg/L can reduce the moisture content in mud from 90.14% to 70.97%, initial CST by 90.29 seconds to 24.40 seconds and initial SRF by 6.69 x 1010 m/kg to 1.92 x 1010 m/kg, initial TSS by 73,000 mg/L to 22,278 mg/L, initial TS by 102,950 to 57,313 mg/L.

- Lime at a dose of 8 mg/L can reduce the moisture content in the mud from 90.14% to 70.29%, the initial CST value of 90.29 seconds to 37.9 seconds and the initial SRF value of 6.69 x 1010 m/kg to 4.70 x 1010 m/kg, the initial TSS of 73,000 mg/L to 18,306 mg/L, the initial TS of 102,950 to 42,493 mg/L.

- The combination of alum and lime at a ratio of 1:2 dose of 14 mg/L can reduce the moisture content in mud from 90.14% to 64.68%, initial CST value of 90.29 seconds to 22.4 seconds and initial SRF value of 6.69 x 1010 m/kg to 1.23 x 1010 m/kg, initial TSS of 73,000 mg/L to 6,915 mg/L, The initial TS was 102,950 to 13,620 mg/L.

Broadly speaking, the more the use of chemical agent doses up to a certain dose, the mud water content will decrease until it reaches a saturation point at a certain dose.

2 . The most optimal type of chemical agent to be used in the chemical conditioning process of biological sludge IPLT Balai PIALAM Yogyakarta is a combination of alum and lime ratio of 1: 2 with an optimum dose of 14 mg / L.

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