Decreasing of COD, Phosphate (PO_4) and Detergent (LAS) Using Fixed Bedreactor with an Anaerobic Process

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Abstract

In the absence of adequate management, the majority of laundry wastes, such as detergent and clothes softener, are typically dumped directly and unceremoniously into the channel that leads to a body of water. A Fixed Bed Reactor containing media in an anaerobic Bioball is one method that can be utilized to process laundry waste. Other methods include the underlying qualities of waste clothing is COD: Detergents: 291 mg/l Total: 29.74 mg N/l total P: 172.58 mg/l 29.12 mg/l. This study used a variety of COD concentrations to waste the early (So) = 280 mg/l, 232.8 mg/l (80% * So), 174.6 mg/l (60%) and 116 mg/l (40%) and discharge 150, 130, 110, 80, and 60 ml/minute, respectively. The best COD concentrations were found to be 91.06 percent for COD at the COD variation of 58.2 mg/l and 60 ml/min discharge, and the concentrations of phosphate (PO4) were found to be 82.13 percent at 20 percent waste discharge 60 mg/minute Concentrations of detergent and 76.13 percent at 20 percent waste discharge 60 mg/min Concentrations of phosphate According to the 2002 decision of the Governor of East Java Number 45, the concentration of bioball media meets the standard quality of raw liquid waste at concentrations of COD, phosphate (PO4), and detergents that are processed on a fixed bed reactor.

Keyword: *COD, Phosphate, Detergent, Fixed Bed Reactor, Anaerobic, Process.*

A. INTRODUCTION

Most laundry businesses use PDAM water, but some use well water. The dominant laundry waste comes from fabric softeners and detergents, which are generally disposed of directly into canals leading to water bodies without proper management (Stollenwetk, 1996; Herlina et al., 2020). The active ingredients that are mostly found in fabric softeners and detergents are *quaternary ammonium chloride, LAS, sodium dodecyl benzene sulfonate, sodium carbonate, sodium phosphate, alkylbenzene sulfonate*. Ingredients It is an environmentally friendly and *biodegradable material*. But when its presence in water bodies is excessive, laundry waste has the potential to contaminate water bodies. Because apart from containing these active ingredients, laundry waste is also rich in phosphate which reaches 253.03 mg/L as P-total. Excessive amounts of phosphate will pose a danger of eutrophication and algae explosion in the sea (Puspitahati et al., 2012).

By looking at the reasons above, we need an application of wastewater treatment technology in order to properly address the problem of environmental pollution. Processing can be done in various ways, one of which is using an anaerobic biofilm process (Golzary et al., 2018). Biological processes with embedded cultures, namely waste treatment processes in which the microorganisms used are cultured on a medium so that the microorganisms are attached to the surface of the media. This process is also known as the microbiological film or biofilm process (Said, 2000).

B. LITERATURE REVIEW

Laundry waste contains the active compound methylene blue (surfactant) which is difficult to degrade and is hazardous to health and the environment. An effort to treat waste originating from laundry activities is needed to reduce environmental pollution (Anonymous, 2010; Akpor et al., 2008).

Anaerobic biological wastewater treatment aims to decompose organic matter in wastewater into simpler, harmless materials. Besides that, in the anaerobic biological treatment process, gases such as CH_4 and CO_2 gas will be produced (Sasolevandi et al., 2019; Dereszewska et al., 2015). This process can be applied to organic wastewater with a high organic matter load (COD) (Sumada, 2012).

Biofilm is a term used to describe a special living environment of a group of microorganisms attached to a solid surface (Jamilah 2003; Malekmohammadi et al., 2016). This is a unique microenvironment in which the microorganisms in the biofilm differ structurally *and* functionally from those that are free-living (planktonic). Biofilms consist of microorganism cells that are firmly attached to a surface so that they are in a sessile state, not easily separated or moved (*irreversible*). This attachment, like that of microbes, is accompanied by the accumulation of organic materials which are covered by the extracellular polymer matrix produced by these microbes (Safina, 2012; de Kreuk et al., 2005).

Anaerobic Filter (AF) or *Fixed Bed* or *biofilter* is the reactor contains media (stone, Raschig plastic ring, flexi ring, plastic ball, cross flow and tubular media, wood, bamboo or other) for the attachment of bacteria. Media is usually installed randomly or randomly with three operating modes *upflow*, *downflow* and *fluidized bed*. Of course, each comes with its advantages and disadvantages. The key to success of the reactor is being able to produce self-sustaining (restriction of cell movement in a space) biomass in the form of biofilms and/or biogranules (biograins) (Anonymous, 2006).

Bioball as this media is because it is lightweight, easy to re-wash, and has the largest specific surface area compared to other types of biofilter media, which is 200-240 m^2/m^3. While the type of bioball chosen is a spherical with a diameter of 3.5 cm because this type of bioball has the smallest diameter and with a spherical shape (random packing) can minimize *clogging*. This bioball functions as a place to live for bacteria-bacteria needed to maintain water quality (Prakoswo, 2012).

C. METHOD

The wastewater used is waste from the laundry industry, due to the high concentration of contaminants, with initial characteristics of laundry waste, namely COD: 291 mg/l, Detergent: 29.74 mg/l, N total: 172.58 mg/l, P total: 29 ,12 mg/l. Fixed Bed Reactor construction research equipment, as a waste water treatment made on a laboratory scale, consists of:

Tool Specifications: 1) Waste water holding tank; 2) Discharge regulator tub; and 3) Fixed bed reactor, with dimensions:

Length = 120 cm Divided by three chambers:

1. The length of chamber I = 40 cm
2. The length of chamber II = 40 cm
3. The length of chamber III = 40 cm

Wide = 55 cm and Tall = 40 cm, Media bioball, with a diameter = 3.5 cm, Effluent bath, and Pump.

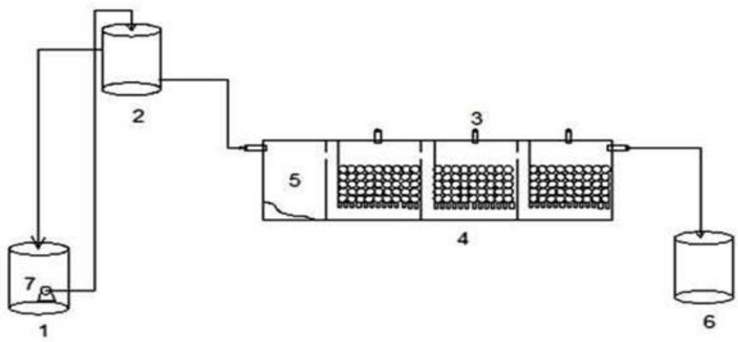

Figure 1. Reactor Equipment Details Fixed Bed

Information:

1. Waste holding tank
2. Discharge regulator tub
3. Vent pipe
4. Fixed bed reactor
5. Settling tub
6. Effluent bath
7. Pump

Fixed variable: 1) Bioball with diameter = 3.5 cm; 2) Reactor volume = 96 lt; and 3) Reactor dimensions = length: 120 cm, divided into 3 chambers, each chamber has a length of 40 cm. Height: 40 cm. Width: 55 cm.

Run variable: 1) Discharge (ml/minute) = 60, 80, 110, 130, 150; and 2) Laundry waste concentration (mg/lt) = 291 (100% laundry waste), 232.8 (80% laundry waste), 174.6 (60% laundry waste), 116 (40% laundry waste), 58.2 (20 % laundry waste).

This research was carried out in a *Continue* and carried out in three ways *process stages, namely* the conditioning, preparation (*seeding* and *acclimatization)* stages and the operation of the Fixed Bed Reactor.

D. RESULT AND DISCUSSION

1. Effect of Debit (Q) and COD Concentration on COD Reduction

From the results of the research on removal of COD concentrations with the Fixed Bed Reactor, results were obtained based on the Decree of the Governor of East Java No.45 of 2002, the quality standard for liquid waste from the soap or detergent industry was COD 180 mg/l. From the research data, it can be seen in Table 1 where microorganisms that grow or attach to Bioball media are able to reduce COD concentrations with the *Continue process* and meet the quality standards for liquid waste from the soap or detergent industry in laundry waste business activities. The results that meet the liquid quality standards are in the COD concentration, which is 291 mg/l (100% waste) at a discharge (Q) of 150 ml/minute.

Table 1. Effect of Debit and Concentration of Laundry Waste on % COD Removal

No	Discharge (ml/min)	% COD Allowance				
		291 mg/l (100%)	232.8 mg/l (80%)	1746 mh/l (60%)	116 (mg/l (40%)	52.2 mg/l (20%)
1	150	51%	69%	72%	80%	84%
2	130	54%	69%	76%	81%	87%
3	110	64%	76%	79%	85%	90%
4	80	60%	68%	80%	83%	87%
5	60	70%	79%	85%	88%	91%

Source: Data Proceed

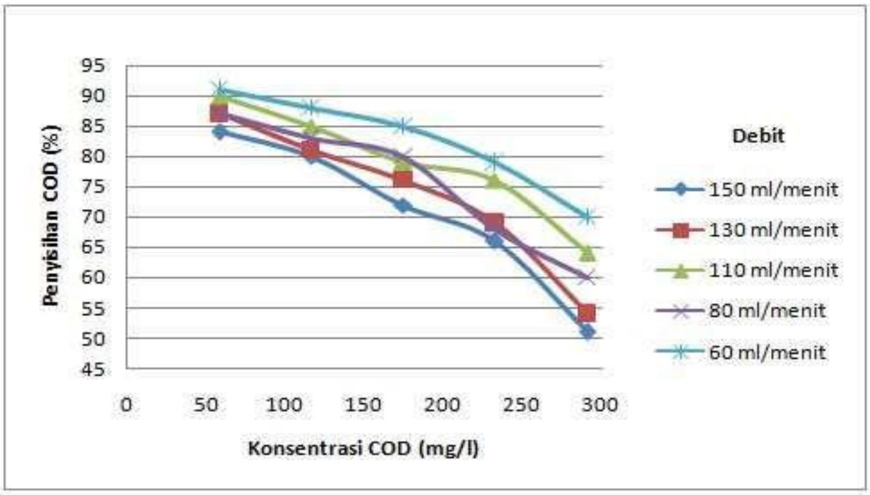

Figure 2. Relationship between COD Concentration and % COD Removal at Various Discharges

From these data it can be explained that the best removal efficiency occurs at a flow rate of 60 ml/minute with a COD concentration of 58.2 mg/l (20% waste) with a removal percentage of 91% and if the discharge is increased to 80 ml/minute (20% waste), then the percentage of COD removal becomes smaller, namely 87%. This shows that the smaller the wastewater flow rate means the longer the residence time of wastewater in the reactor increases and this can increase the efficiency of the removal that occurs. Because the longer the contact time between the wastewater and the suspended microorganisms in the Fixed Bed Reactor, a degradation process occurs in the organic pollutant parameters which makes the COD removal greater or increases, as research has conducted by (Ningrum, 2012) that the lower the speed in the reactor causes the residence time of wastewater in the reactor to be longer, so that the contact time between anaerobic bacteria and wastewater becomes longer which causes better processing results.

The decrease in *removal efficiency* is due to the working mechanism of anaerobic bacteria in reducing organic content and will be more perfect if the residence time is longer. Methanogenic bacteria require a long time in the growth process so that the conversion into the *methane form* becomes more perfect with a longer residence time and *glanular stability. sludge* does not guarantee the process degradation can take place well if the residence time is too short (Lutviah, 2007). This is due to insufficient contact time between microorganisms and waste.

2. Concentration of Phosphate (PO_4) in Fixed Bed Reactor.

Laundry waste *effluent* based on the quality standard of liquid waste on Phosphate (PO_4), which is 10 mg/l. To find out whether the Fixed Bed Reactor is able to reduce the concentration of Phosphate (PO_4), it can be seen from the results of analysis data on the reduction of laundry waste in the Fixed Bed Reactor.

Table 2. Effect of Laundry Waste Discharge and Concentration on % of PO_4 Phosphate Removal

No	Discharge (ml/min)	% PO_4 Phosphate Removal				
		291 mg/l (100%)	232.8 mg/l (80%)	1746 mh/l (60%)	116 (mg/l (40%)	52.2 mg/l (20%)
1	150	53%	62%	69%	73%	75%
2	130	56%	68%	74%	76%	79%
3	110	64%	72%	75%	78%	80%
4	80	61%	69%	83%	75%	81%
5	60	63%	68%	85%	78%	82%

Source: Data Proceed

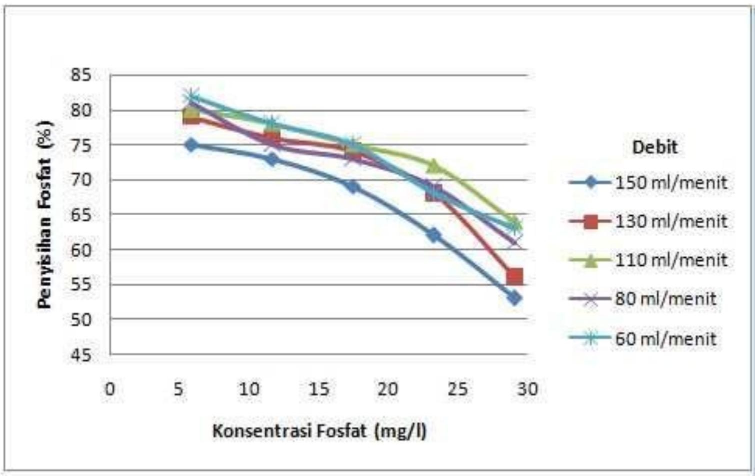

Figure 3. Relationship between Phosphate Concentration (PO_4) % Phosphate Removal PO_4 at Various Discharges

It can be seen that the largest percentage of removal is at a discharge of 60 ml/minute with a PO_4 concentration of 5.82 mg/l (20% waste) of 82%, while the lowest is at a discharge of 150 ml/minute with a phosphate concentration of 29.12 mg/l (100% waste) that is 53%. From the results of this study it can be explained that the smaller the wastewater flow rate, the longer the residence time of wastewater in the reactor and this can increase the efficiency of the removal that occurs. Because there is a long contact between the wastewater and the microorganisms in the reactor, it means that with a small discharge and the longer the residence time, the more opportunities for microorganisms to biodegrade the organic matter in the wastewater, with a long residence time it will also reduce the velocity of upward so as to provide an opportunity for discrete particles to precipitate (Lutviah, 2007). And according to (Syafrudin, 2012) that the longer the process lasts, the more optimal the results obtained, even though in reality it only shows a very small difference in the decline rate.

3. Detergent Concentration (LAS) in Fixed Bed Reactor

From the results of the research on the removal of detergent concentrations using the Fixed Bed Reactor, the quality standard for liquid waste from the soap or detergent industry is 30 mg/l detergent. From the research data it can be seen in Table 3 where microorganisms growing or attached to the Bioball media are able to reduce detergent concentrations by the *Continue process* and meet the quality standards for liquid waste from the soap or detergent industry in laundry waste business activities. The results that meet the liquid quality standards are in the concentration of detergent, which is 29.74 mg/l (100% waste) at a discharge (Q) of 150 ml/minute.

Table 3. Effect of Laundry Waste Discharge and Concentration on % Detergent Allowance (LAS)

No	Discharge (ml/min)	% Detergent Allowance (LAS)				
		291 mg/l (100%)	232.8 mg/l (80%)	1746 mh/l (60%)	116 (mg/l (40%)	52.2 mg/l (20%)
1	150	43%	51%	53%	60%	62%
2	130	52%	55%	62%	65%	67%
3	110	54%	58%	64%	67%	71%
4	80	58%	63%	67%	69%	73%
5	60	63%	79%	70%	72%	76%

Source: Data Proceed

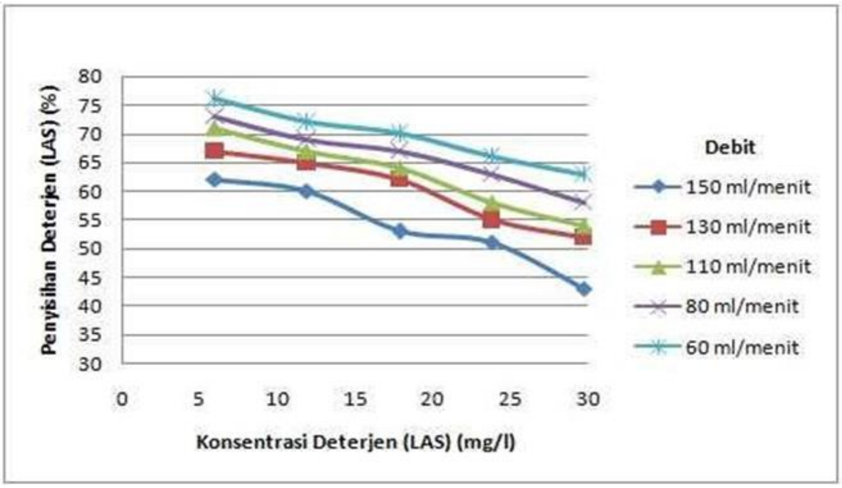

Figure 4. Relationship between Detergent Concentration (LAS) and % Detergent Allowance (LAS) at Various Discharges

From these data it can be explained that the best removal efficiency occurs at a flow rate of 60 ml/minute with a detergent concentration of 5.95 mg/l (20% waste) with a removal percentage of 76.13% and if the discharge is increased to 80 ml/minute (20% waste). %), then the percentage of detergent removal becomes smaller, namely 73.10%, this also applies to debits of 110 ml/minute, 130 ml/minute, 150 ml/minute, the percentage of detergent removal becomes even smaller, namely 70%, 66.05 % and 63.02%. This shows that the smaller the wastewater flow rate means the longer the residence time of wastewater in the reactor and this can increase the removal efficiency that occurs. Due to the longer contact time between wastewater and suspended microorganisms in the Fixed Bed Reactor, a degradation process occurs in the organic pollutant parameters which makes Detergent removal greater or increases, as research has been conducted by Ningrum (2012) that the lower the velocity in the reactor causes the residence time of wastewater in the reactor to be longer, so that the contact time between anaerobic bacteria and wastewater becomes longer which causes better processing results.

The decrease in removal efficiency is due to the working mechanism of anaerobic bacteria in reducing organic content and will be more perfect if the residence time is longer. Methanogenic bacteria require a long time in the growth process so that the conversion into the methane form becomes more perfect with a long residence time and the stability of the granular sludge does not guarantee that the degradation process can take place properly if the residence time is too short (Lutviah, 2007). This is due to insufficient contact time between microorganisms and waste.

E. CONCLUSIONS

From research on fixed bed reactors with bioball media in a *Continued manner* it can be concluded: 1) Using an anaerobic fixed bed reactor with bioball media was able to reduce COD, Phosphate (PO_4) and Detergent parameters; 2) At a COD concentration of 58.2 mg/l and a discharge of 60 ml/minute, it can reduce the COD concentration with a removal percentage of 91.06%; 3) At a concentration of Phosphate (PO_4) 5.82 mg/l and a discharge of 60 ml/minute it can reduce the concentration of Phosphate with a removal percentage of 82.13%; and 4) At a Detergent concentration of 5.95 mg/l and a debit of 60 ml/minute, it can reduce the Detergent concentration with a removal percentage of 76.13%.

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