MODIFICATION OF TRIPIKON-S WITH BIOBALL ADDITION IN ARTIFICIAL BLACK WATER TREATMENT FOR SWAMP AND COASTAL AREAS

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Abstract*:*Tripikon-S can be used as a septic tank or pit latrine households to areas of shallow groundwater, tidal areas and swamps, or on small plots of land area. Construction Tripikon-S consists of three concentric pipes with the working principles of the treatment process is similar to a conventional septic tank. This study is intended to treat black water on batch and continuous systems with tripikon-S reactor volume of 18 liters. The reactor used in the research are original Tripikon-S reactor (Tripikon-S Control) and Tripikon-S with the bioball addition (Tripikon bioball). Black water used is black water artificial. Organic load variation is 1500 mg COD/ l and 2000 mgCOD / l. The parameters analyzed were pH, DO, temperature, COD, total nitrogen (NTK) and total phosphate. In a batch system average COD removal efficiency in the reactor Tripikon-S and Tripikon-S bioball is 44.31% and 49,81%. In the continuous system with a residence time of 48 hours and a variety of organic load in 2000 is able to provide the best results in COD, NTK and total phosphate. COD removal efficiency, NTK and total phosphate in the reactor Tripikon-S was 63.04%, 25.20% and 26.53%. While Tripikon-S reactor bio-ball COD removal efficiency, NTK and total phosphate was 75.93%, 25.02% and 35.39%.
Keywords : Blackwater, Tripikon-S, Bioball, Septic tank

INTRODUCTION

At this time the condition of sanitation in Indonesia is still bad, where public access to sanitation facilities are lacking especially in areas that are difficult area such as coastal areas and marshes. Sanitation infrastructure needed to separate the waste from the environment to prevent the onset of disease (Flores et al, 2008; Setiawati et al, 2013) Sanitation in Indonesia only increased from 46% to 55% during 1994-2004. These circumstances make sanitation ranked Indonesia is below average for the Southeast Asian region and the world (Fatoni et.al, 2010). Improving sanitation needs to be done to reduced productivity and environmental degradation (Genser et al., 2008; Rutsein, 2000; Victroia et al., 1998; Katukiza et al, 2012). Inadequate sanitation can also cause a variety of infectious diseases(Lemonick, 2011; Thye et al, 2013).Coastal and swamp areas are the most difficult areas to improve sanitation. Various attempts were made in the improvement of sanitation in coastal and swamp areas one of which is the development of the septic tank was named Tripikon-S. Construction Tripikon-S consists of three concentric pipes with the working principles similar to a conventional septic tank that was applied to the coastal areas, swamps, rivers and places with a high groundwater level(Saraswati et al., 2009; Wijaya et al., 2010; Nurmandi, 2012; Putri et al, 2013).

The research that has been conducted by saraswati et al, 2009 showed that the performance of Tripikon-S is only able to reduce effluent BOD_5 to 40% so that the necessary be done to improve the performance development Tripikon-S. This research will be modified with bioball addition. The addition of bioball is intended as a biofilter for embedding large amounts of bacteria with a very small risk of deadlock. Also called a biofilter for wastewater aeration contacts will come into contact with microorganisms attached to the surface of the media so as to improve the efficiency of decomposition of organic matter (Pohan, 2008). Thus allowing for wastewater treatment with a high concentration of load as well as the efficiency of processing large enough (Said, 2000). So, with a combination of the above techniques are expected to be applied to Tripkon-S in order to improve the performance Tripikon-S in black water treatment in coastal and swamp areas.

METHODOLOGY

This study focused on the performance Tripikon-S in treating black water. The stages of the research can be seen in **Figure 1**.

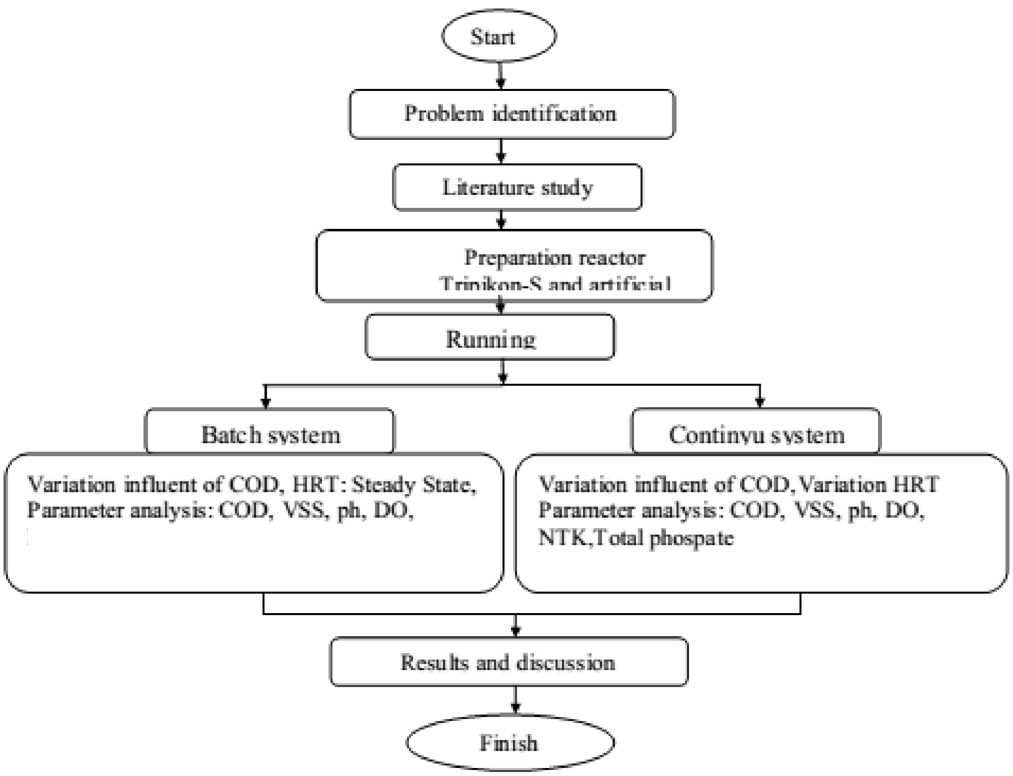


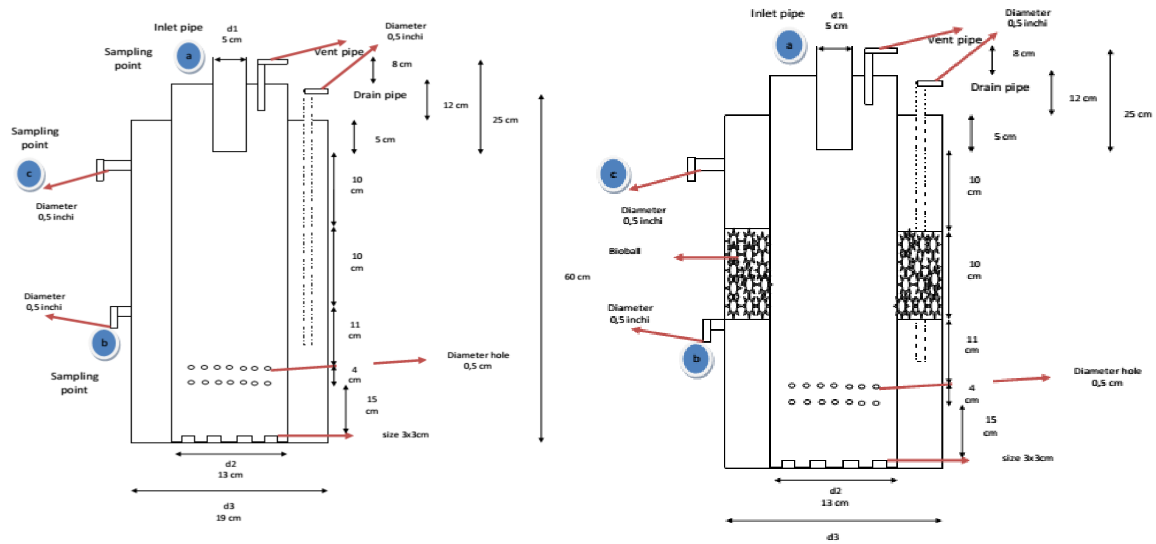
Figure 1. Flow diagram

Location and Time Research

Location research and preparation of artificial blackwater is done in Laboratory of Water Quality Environmental Engineering Institut Teknologi Bandung (ITB).

Research tools

This study uses two reactors Tripikon-S-shaped tube made of pipes made from PVC. Tripikon-S reactor without development (Tripikon-S Control) that is used has a medium volume of 18 liters. While the reactor with the addition bioball Tripikon- S (Tripikon bioball-S) has a volume of 14.6 liters media and cavity volume fraction of 3.6 liters. Schematic is shown in **Figure 2**.



(a) Tripikon-s control

(b) Tripikon-s bioball

Figure 2. Reactor scheme

Preparation Artificial Black Water

Black water artificially made using glucose, $(NH_2)_4SO_4$, $KH2PO_4$ and Kaolin

Preliminary Waste Characterization

Parameters measured include COD, total nitrogen (NTK), total phosphate, pH, temperature, and DO.

Laboratory analysis

Procedures performed sample collection and examinations based on the Indonesian National Standard (SNI). Methods of analysis parameters used are listed in **Table 1**.

Table 1. Method and frequency parameter analysis

No	Parameter	Method	Frequency
1.	COD	Refluks tertutup/COD Mikro	Everyday
2.	pH	pH meter	Everyday
3.	Temperatur	Termometer	Everyday
4.	Total Nitrogen (NTK)	Destruksi-Destilasi-Titrasi	Beginning and end
5.	Total Phospat	Spektrofotometri	Beginning and end
6.	TS		Everyday
7.	VSS		Everyday

Batch

Batch phase is the phase of the reactor start-up and acclimatization. Organic load variations are 1500 and 2000 mg COD / l. The parameters measured were pH, temperature, DO, COD, and VSS. At the end of the study the kinetics of the allowance is calculated using the model of Monod's kinetic.

Continuous

At this stage that is varied HRT (Hydraulic Retention Time). The parameters tested were COD, VSS, DO, pH, temperature, total nitrogen (NTK) and total phosphate.

RESULTS AND DISCUSSION

Initial characterization

Prior to the initial characterization, artificial black water was made. Options concentrations and characteristics of artificial black water is used as a reference based on the study of literature native black water effluent concentration. It is intended that the artficialblack water represent the characteristics of the original black water. Referenced waste characteristics are shown in **Table 3**.

Table 3. Composition of black water
(Palmquist and Haneus, 2005)

Parameters	unit	Average (Deviation standar)	Range
Q	$m^3 h^{-1}$	0.17 (0.01)	0.16 – 0.18
Total phospat	mg L^{-1}	42.7 (19)	21 - 58
Total Nitrogen	mg L^{-1}	150 (26)	130 - 180
BOD_5	mg L^{-1}	1037 (545)	410 - 1400
COD_{Cr}	mg L^{-1}	2260 (1268)	806 - 3138
Total solid	mg L^{-1}	3180 (2000)	920 - 4320
VS	mg L^{-1}	2560 (1900)	420 - 3660
pH	-	8.94 (0.1)	8.87 – 9.08

Results of characterization black water artificial can be shown in **Tabel 4**.

Table4. Data of charateristic black water artificial

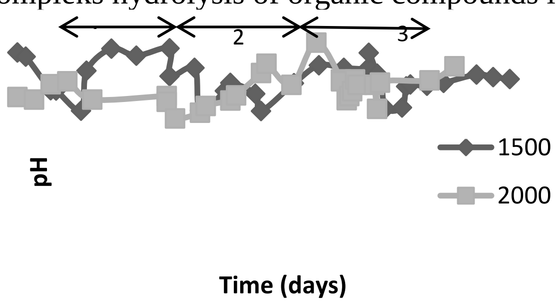
Parameters	Concentration (mg/l)
COD	2470
BOD	2120
TN	147
TP	43
pH	6.25

From the data of characterization shown that the waste contains high levels of organic compounds. This is indicated by the value of COD and BOD. Biological treatment is recommended as a viable treatment alternative treatment. BOD loadings exceeding 1000 mg / l to make decent use of anaerobic processes (Davis and Cornell, 1991 in Happy, 2010).

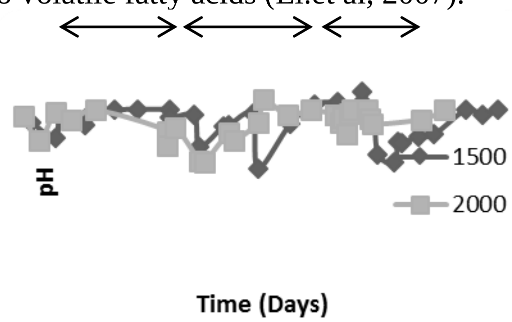
Batch System

pH

In **Fig3.** it can be seen that the measured pH values for both reactors are not much different. In Tripikon-S control for variations in organic load 1500 mg COD / l measured pH values were in the range 4.83 to 6.59. As for the variation of the organic load of 2000 mg COD / l measured pH values were in the range 4.6 to 6.89. Decrease in pH at the beginning of the batch process indicates rapid growth of bacteria that contribute acidogenesis elaborate monomer compleks hydrolysis of organic compounds into volatile fatty acids (Li.et al, 2007).



(a) Tripikon-s control

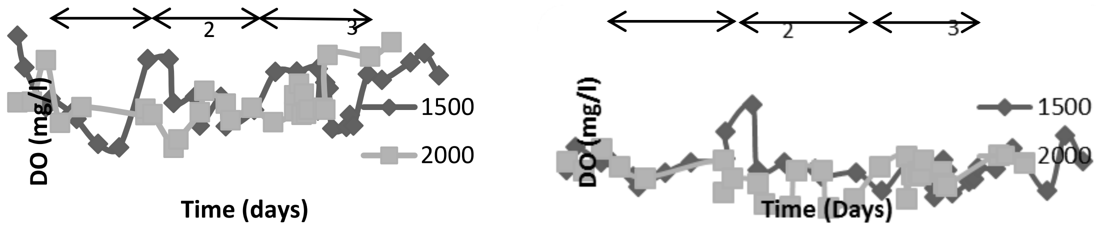


(b) Tripikon-s bioball

Figure 3.pH in the reactor

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is the amount of oxygen dissolved in the water. DO values measured in **Figure 4.** for Tripikon-S controlfor organic load 1500 and 2000 mg COD / l were in the range 1.15 to 6.91. In Tripikon-S Bio-ball measured DO values were in the range 1.2 to 6.02. Average DO values for organic load variations 1500 mg COD / l is almost always higher than the value of DO for organic load variations COD 2000 mg / l. Rise and fall of the measured DO values indicate the activity of microorganisms. Microorganism activity would increase if the DO decreased. According to Gomez et al, 2002; Tait et al, 2013 Increasing DO concentration showed a decrease in the growth of biofilm and bacterial density in biofilm.

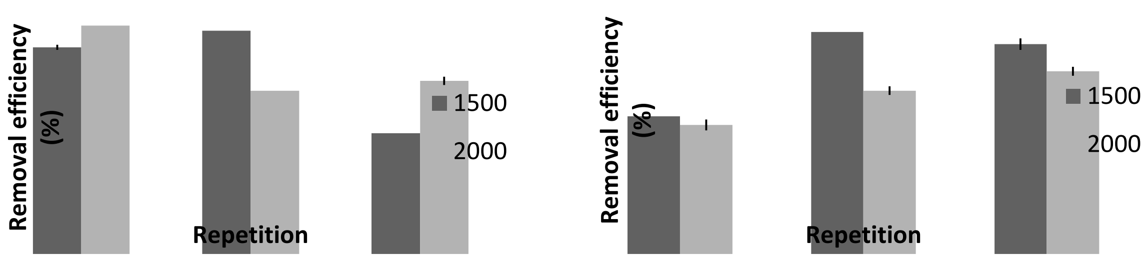


(a) Tripikon-s control (b) Tripikon-s bioball

Figure 4. Dissloved oxygen in the reactor

Removal of COD

In **Figure 5.** for Tripikon-S control when repetition 1st, removal efficiency reached 80% and 90% for load variations 1500 and 2000 mg COD / l. Then, during the 2nd repetition removal efficiency reached 90% and 62%. In the 3rd repetition removal efficiency decreased to 44% and 68% for load variations 1500 and 2000 mg COD / l. As for the Tripikon-S bioball when repetition 1st, removal efficiency reached 52% and 49% for load variations 1500 and 2000 mg COD / l. Then, during the 2nd repetition removal efficiency reached 83% and 62%. In the 3rd repetition removal efficiency decreased to 80% and 70% for load variations 1500 and 2000 mg COD / l. The increase in removal efficiency that occurs in the reactor Tripikon-S bioball showed that microorganisms present in the reactor and the media have been used to adapt the bioball incoming susbstrat.

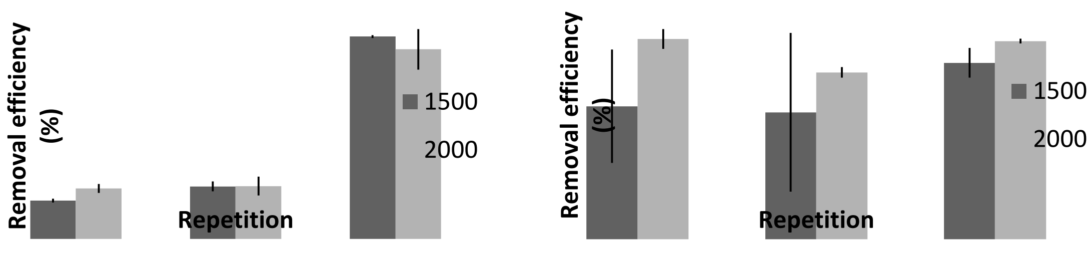


(a) Tripikon-s control (b) Tripikon-s bioball

Figure 5. Removal COD in the reactor

Removal of Nitrogen Total Kjehdal (NTK)

In Tripikon-S control (**Figure 6.)** on the organic load variations 1500 and 2000 mg COD / l NTK able to set aside up to 44.78% and 41.96% to 3th repetition. In Tripikon-S bioball (**Figure 6**) for the organic load variations 1500 and 2000 mg COD / l NTK capable of removing up to 35.62% and 39.66%

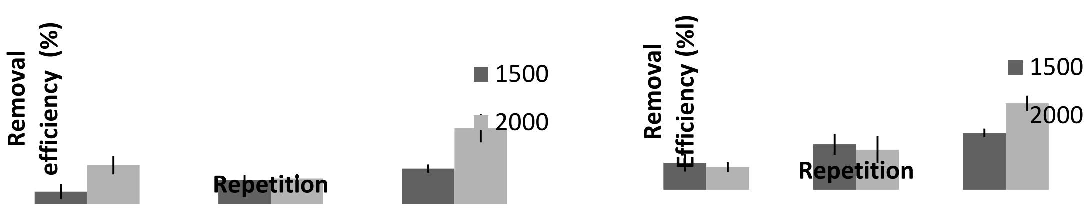


(a) Tripikon-s control (b) Tripikon-s bioball

Figure 6. Removal of nirogen total kjehdal in the reactor

Removal of Total Phospate

In the reactor Tripikon-S control removal efficiency for total phosphate with organic load variations 1500 and 2000 mg / l was 8.3% and 17.93% for 3th repetition. While the Tripikon-S bioball atotal phosphate removal efficiency for organic load variations 1500 and 2000 mg / l was 14.44% and 21.95%.



(a) Tripikon-s control (b) Tripikon-s bioball

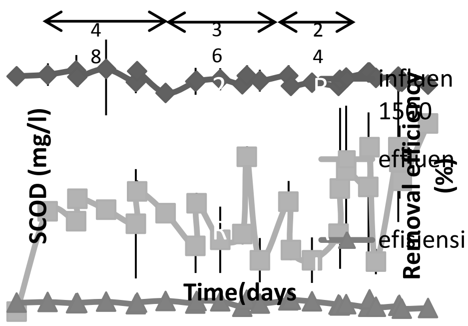
Figure 7. Removal of total phospate in the reactor

Continuous Systems

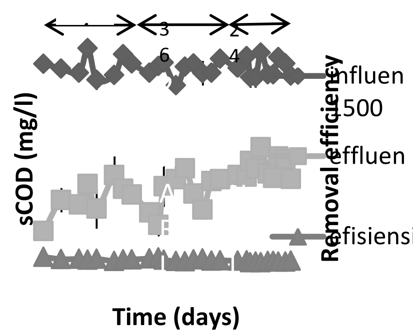
Removal of COD

In Tripikon-S control removal efficiency that occurs when the organic load variation 1500 mgCOD / l with a residence time of 48, 36 and 24 hours was 52.94%, 45.45% and 21.95%. As for the variation of the organic load of 2000 mg COD / l removal efficiency happens to a 24-hour stay was 48.36 and 63.04%, 42.62% and 17.24%. While the Tripikon-S bioball removal efficiency that occurs when the organic load variation 1500 mgCOD / l with a residence time of

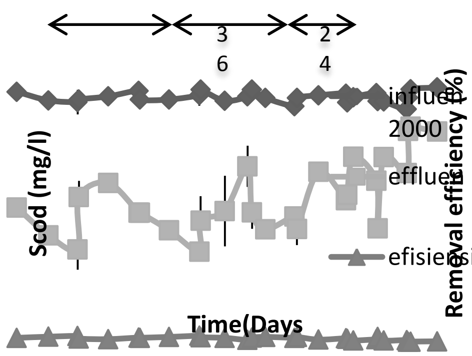
48, 36 and 24 hours was 71.36%, 53.46% and 53.69%. As for the variation of the organic load of 2000 mg / l removal efficiency happens to a 24-hour stay was 48.36 and 75.93%, 56.03% and 42.96%. From the above it can be seen that the best removal efficiency for Tripikon-S control is the residence time of 48 hours with a variety of organic load up to 2000 mg / l with a percentage of 63.04% allowance. For Tripikon-S bioball best removal efficiency given current residence time of 48 hours with a load variation to 2000 mg / l with a percentage allowance of 75.93% (**Figure 9**). This is consistent with reports Jing et al, 2002; Sakadevan and Bavor, 1999; Paulo et al, 2013 that with the longer residence time (HRT), the COD removal efficiency will be higher.



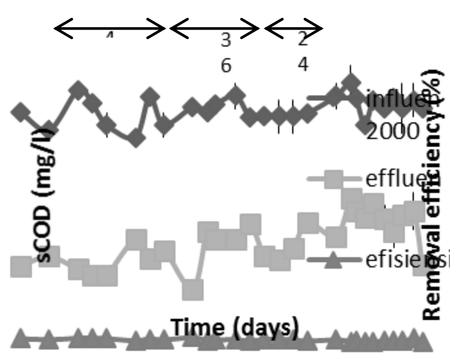
(a) Tripikon-s control



(b) Tripikon-s bioball



(a) Tripikon-s control

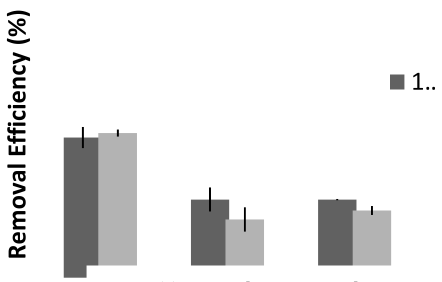


(b) Tripikon-s bioball

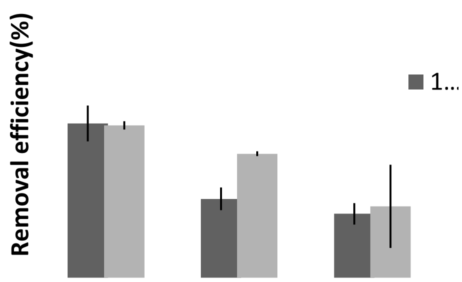
Figure 9. Removal of COD in the reactor

Removal of Nitrogen Total Kjehdal

The best removal (**Figure 9.)** efficiency for reactor control Tripikon-S is the residence time of 48 hours with a variety of organic load up to 2000 mg / l with a percentage of 25.20% allowance. For Tripikon-S bioball best removal efficiency given current residence time of 48 hours with a load variation to 2000 mg / l with a percentage allowance of 26.53%.



(a) Tripikon-s control

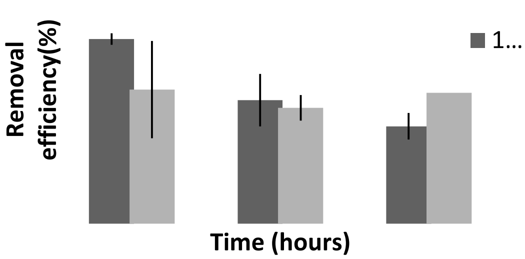


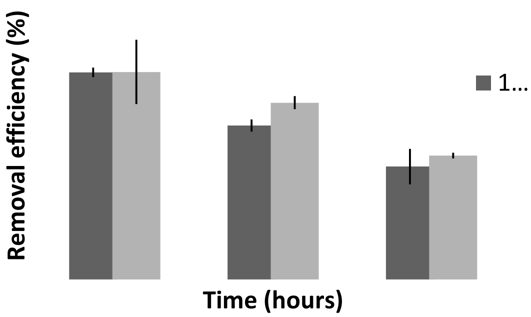
(b) Tripikon-s bioball

Figure 9. Removal of nirogen total kjehdal in the reactor

Removal of Total Phosphate

The best removal efficiency of total phospat shown in **Figure 10**. for reactor control Tripikon-S is the residence time of 48 hours with an organic load variations 1500 mg / l with a percentage of 34.31% allowance. For Tripikon-S bioball best removal efficiency given current residence time of 48 hours with a load variation to 2000 mg / l with a percentage allowance of 35.99%





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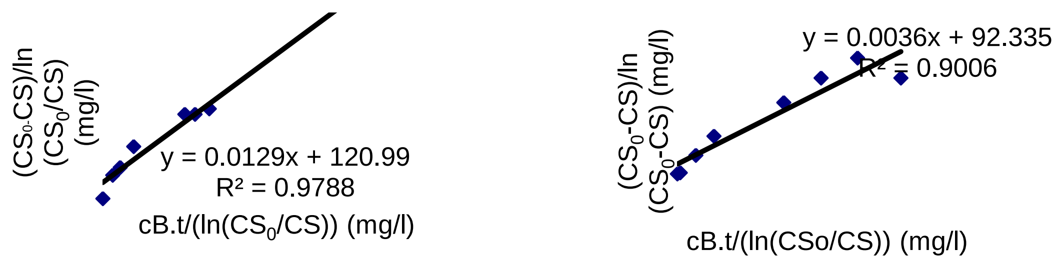
(a) Tripikon-s control

(b) Tripikon-s bioball

Figure 10. Removal of total phospat in the reactor

Kinetics at Bacth System

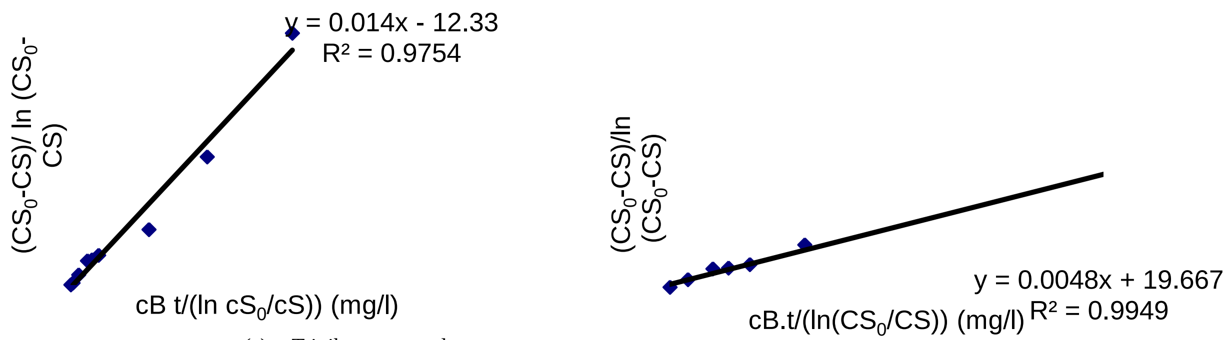
Kinetics were calculated on a batch system is the maximum bacterial growth kinetics. The kinetic model used to follow the Monod equation. In **Figure 11.**for Tripikon-S reactor load control with 1500 mg COD / l was obtained µmax and ks was 0.0129 and 120.99. While the on Tripikon-S bioball to load 1500 mg COD / l was obtained µmax and ks was 0.0036 and 92.335**.**



(a) Tripikon-s control (b) Tripikon-s bioball

Figure 11. Kinetics of bacterial growth maximum on the reactor

In **Figure 12**. it appears that the value of μmax and ks for Tripikon-S reactor control with load variation COD 2000 mg / l was 0.014 and 12.33. While the reactor Tripikon-S bioball with the same load obtained μmax and ks was 0.0048 and 19.667.



(a) Tripikon-s control (b) Tripikon-s bioball

Figure 12. Kinetics of bacterial growth maximum on the reactor

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CONCLUSION

In the batch reactor system Tripikon-S-S Control and Tripikon bioball capable of removing COD by 44% and 80% for load variation 1500 and 2000 As for the load variation of COD removal efficiency for the reactor Tripikon-S-S Control and Tripikon bioball is 68% and 70%.

For a continuous system best removal efficiency is given by the residence time of 48 hours with a load variation 2000 mg COD / l. COD removal efficiency in the reactor Tripikon-S-S Control and Tripikon bioball is 63.04% and 75.93%. While the allowance for reactor Tripikon NTK-S-S Control and Tripikon bioball is 25.20% and 26.53%. Furthermore, the total elimination of phosphate efficiency in the reactor Tripikon-S-S Control and Tripikon bioball is 25.02% and 35.39%.

Based on the results of this study concluded that the reactor Tripikon-S bioball gives better results than the Tripikon-S Control on COD, NTK and total phosphate. Therefore, Tripikon-S bioball should be considered as an alternative to treat wastewater in the black water in coastal and swamp areas.

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