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**Submission date:** 18-Jan-2024 01:13AM (UTC-0600)

**Submission ID:** 2273075155

**File name:** wati\_2021\_IOP\_Conf.\_Ser.\_Earth\_Environ.\_Sci.\_755\_012052-2-7.pdf (250.72K)

**Word count:** 2635

**Character count:** 12528

## The Effectiveness Of Cod Reduction In Tofu Waste Using Active Mud And Oxygenation Methods

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**Abstract.** Tofu waste is a byproduct of tofu processing that cannot be just thrown away as it can pollute the waters. In this study, a laboratory-scale test was carried out on tofu waste produced from tofu factories in the Cirebon area. In this tofu waste treatment, activated sludge was used where the waste water was put into an anaerobic reactor with various incubation times. The reduction of COD (Chemical Oxygen Demand) for tofu wastewater treatment was carried out using the  $K_2Cr_2O_7$  oxidizer and anaerobic reactor with an insulated reactor. Afterwards, the anaerobic effluent was collected into the aerobic reactor using broken bricks. Experiment variations were carried out in anaerobic reactors, namely: sludge variation (1/2 and 1/3) and residence time variations, namely: 2 days, 4 days and 6 days. Measurements were taken at 3 points, namely: influent, anaerobic effluent and aerobic effluent. Based on the research, the highest decrease in anaerobic efficiency was 68.8% in the condition of 1/2 sludge volume and 2 days residence time. As for the aerobic efficiency, it was 48.9% in the conditions of 1/3 sludge volume and 6 days residence time. Meanwhile, the highest decrease in COD levels was 79.4% in the swab condition as much as 1/3 in the 6-day incubation time.

### 1. Introduction

Tofu is one of the foods from soybean commonly consumed by Indonesians. Tofu is one of the people's choices in meeting the needs of vegetable protein needed by the body. According to Partoatmojo, S. (1991), 100 grams of tofu contain 7.8 grams of protein. With the large number of people consuming tofu, there is a growing number of tofu producers. The producers who have emerged produce tofu using simple methods and tools. As a result, in the process, there are still many who have not processed the waste from making tofu (Myrasandri et al, 2009). Based on Dhahiyat (1990), when we process 1 ton of soybeans into tofu, it will produce 30,000 to 40,000 liters of liquid waste. This amount is very large, especially if tofu production is carried out every day.

The liquid waste generated from the tofu processing which is just thrown into the water or to the ground would cause pollution to the environment. Moreover, they would create an unpleasant aroma because of the high organic matter content (Faisal, 2015) and the waste could also create foam (Chua et al. 2012). Tofu waste that is disposed of in the form of organic waste has high levels of COD (Chemical Oxygen Demand). The higher the COD value in water, the higher the level of water pollution (Helard, 2007). This would result in reduced oxygen dissolved in the water and would threaten the life of organisms in the water.

To overcome this problem, it is very important to treat the waste. Efforts are being made to build a proper sewage treatment plant so that the waste can meet the quality standards of wastewater before being discharged into the water. The wastewater treatment plant is made by constructing an anaerobic reactor and a place for the aeration process. The reactor was made considering that tofu



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waste is included in biological waste which takes incubation time to biodegrade the waste biologically (Droste, 1997). Thus, it is necessary to study how long is the effective time required for the incubation period to reduce COD maximally.

In addition to determining the incubation time, it is also necessary to pay attention to the amount of activated sludge used in this waste treatment. In this case, the main function of giving activated sludge during the incubation period is to be a medium for the development of microorganisms. This means that the amount of activated sludge needed for maximum results needs to be tested. Therefore, this study was entitled the effectiveness of reducing COD levels in tofu waste by using activated sludge and oxygenation methods.

## 2. Methodology

This This research is a performance test of tofu industrial wastewater treatment on a laboratory scale with variations in the ratio of activated sludge to waste water (1/2 and 1/3) in anaerobic reactors, and variations in residence time (2, 4, 6 days).

Tofu wastewater samples were taken from the original liquid waste from the tofu industry in the Cirebon area. Activated sludge seeding was obtained from the Laboratory of the Faculty of Pharmacy and Science of UHAMKA. This research included laboratory tests of the effect of variations:

- Volume of activated sludge in anaerobic reactor (t) (1/2 and 1/3).
- The effect of residence time (t), 2 days, 4 days and 6 days on the efficiency of reducing the COD concentration of wastewater. The number of responses observed were 6 variations.

Responses observed were COD concentrations of tofu wastewater ranging from influent, anaerobic effluent and aerobic effluent, as shown below:

Table 1. Observed Data

Treatment (P)	Residence Time (Day)	Mud Height (cm)
P1	2	1/3
P2	4	1/3
P3	6	1/3
P4	2	1/2
P5	4	1/2
P6	6	1/2

Tofu wastewater as influent was flowed to the anaerobic reactor. Afterwards, the anaerobic effluent was flowed to the aerobic reactor. Samples were taken from 3 points; influent, anaerobic effluent and aerobic effluent. Observations were made in conditions that were considered steady state, which in this study the length of time was one residence time.

- P1: At 1/3 sludge volume; residence time of 2 days  
 P2: At 1/3 sludge volume; residence time of 4 days  
 P3: At 1/3 sludge volume; residence time of 6 days  
 P4: At 1/2 sludge volume; residence time of 2 days  
 P5: At 1/2 sludge volume; residence time of 4 days  
 P6: At 1/2 sludge volume; residence time of 6 days

Observations were made in a steady state condition. The observed data were taken from 3 points, namely influent; anaerobic influent and aerobic effluent. Data were taken 2 times in the morning at 06.00 and in the noon at 12.00.

In this study, the focus of research is COD (Chemical Oxygen Demand). The value of COD is very important to know because it is a measure of water pollution by organic substances which is

oxidized through microbiological processes and results in reduced dissolved oxygen in the water. The determination of the COD value is a reduction-oxidation reaction, making other reduced materials, such as sulfides, sulfites, and ferrous iron, oxidized and measured as COD.

COD testing was performed by carrying out the oxidation process by the  $K_2Cr_2O_7$  solution in a boiling acidic state. Afterwards, silver sulfate ( $Ag_2SO_4$ ) was added as a catalyst to speed up the reaction. Next, the analysis of dissolved COD was preceded by the preparation of COD reagent (standard solution of potassium dichromate, standard solution of FAS, ferroin indicator, sulfuric acid-silver sulfate solution), FAS standardization, blank solution. 5 ml of liquid waste was taken and then diluted to 50 ml in a measuring cup. 2 ml of sample and 2 ml of blanks in the COD tube were taken. 0.04 mg  $HgSO_4$ , 1 ml potassium dichromate and 3 ml sulfuric-silver sulfate acid solution were added. The solution was heated for 2 hours at 170 C and then cooled for 30 minutes. 8 ml of aquadest and 2 - 3 drops of ferroin indicator in erlenmeyer were added. Thereafter, the titration was carried out with Ferro Ammonium Sulfate (ferroin) until the green color was slowly turned brick red.

COD concentration was calculated by the equation:

$$COD \text{ (mg O}_2\text{/l)} = \frac{(a-b) \times c \times d \times p \times 1000}{\text{ml sample}} \quad (1)$$

Notes:

- a = volume of FAS used for blank titration (ml)
- b = volume of FAS used for sample titration (ml)
- c = normality of the FAS solution (ml)
- d = weight of oxygen equivalent (8)
- p = dilution

10

### 3. Result and Discussion

Based on the sample used, the following COD data were obtained from calculations:

The following is the calculation of the COD value based on equation 1 above:

**Table 2.** Titration Calculation Results Blank (B), Influent (1), Anaerobic Effluent (2), Aerobic Effluent (3)

TREATMENT	TITRATION	DILUTION	COD
P1	Blank: 2.88		
V= 1/3	1 : 1.24	10 x	6560
N=0,1	2 : 0.50	5 x	4760
2 days	3 : 1.33	5 x	3100
P2	Blank: 2.38		
V= 1/3	1 : 1.14	10 x	4960
N=0,1	2 : 1.26	5 x	2240
4 days	3 : 1.75	5 x	1260
P3	B : 2.80		
V= 1/3	1 : 0.32	10 x	9920
N=0,1	2 : 1.6	5 x	3840
6 days	3 : 1.78	5 x	2040
P4	B : 2.80		
V= 1/2	1 : 0.80	10 x	8000
N=0,1	2 : 1.55	5 x	2500
2 days	3 : 1.88	5 x	1840
P5	B : 3.42		
V= 1/2	1 : 2.34	10 x	4320
N=0,1	2 : 2.25	5 x	2340
4 days	3 : 2.76	5 x	1320
P6	B : 2.32		
V= 1/2	1 : 1.33	10 x	3960

N=0,1	2 : 1.12	5 x	2400
6 days	3 : 1.65	5 x	1340

The reduction of COD tofu wastewater was carried out using an anaerobic reactor with an insulated reactor. The anaerobic effluent was then collected into the aerobic reactor using broken bricks. Experiment variations were carried out in anaerobic reactors, namely: sludge variations (1/2 and 1/3) and residence time variations, namely: 2 days, 4 days and 6 days. Measurements were taken at 3 points, namely: influent, anaerobic effluent and aerobic effluent. The results of COD measurement for tofu liquid waste are presented in Table 3 as follows:

**Table 3.** Measurement Results of COD Level Reduction

Treatment (P)	Influent (mg/l)	Anaerobic Effluents (mg/l)	Efficiency (%)	Aerobic Effluent (mg/l)	Efficiency (%)	COD reduction (%)
P1	6560	4760	27,4	3100	34,9	52,7
P2	4960	2240	54,8	1260	43,8	74,6
P3	9920	3840	61,3	2040	48,9	79,4
P4	8000	2500	68,8	1840	26,4	77,0
P5	4320	2340	45,8	1320	43,6	69,4
P6	3960	2400	39,4	1340	44,2	66,2

Table 7 above shows that the lowest anaerobic efficiency reduction was in the number of 27.4% in treatment P1, namely treatment with a sludge volume of 1/3 and a residence time of 2 days, while the highest was in P4 with a decrease in value of 68.8% in conditions of 1/2 sludge volume and a residence time of 2 days. The combination of the use of active lash was very good for the tofu waste treatment process (Kim and Lee, 2010). Meanwhile, the lowest aerobic efficiency was 26.4% in the P4 treatment, namely the treatment with a sludge volume of 1/2 and a residence time of 2 days, while the highest was in P3 with a reduction value of 48.9% in conditions of 1/3 sludge volume and residence time of 6 days. With the presence of pollutant oxygen, it was converted into biomass by microorganisms (Said, 2005). Interestingly, the P4 treatment showed that the level of efficiency had the highest level of anaerobic COD efficiency and the total COD efficiency but for aerobic COD efficiency was actually the lowest.

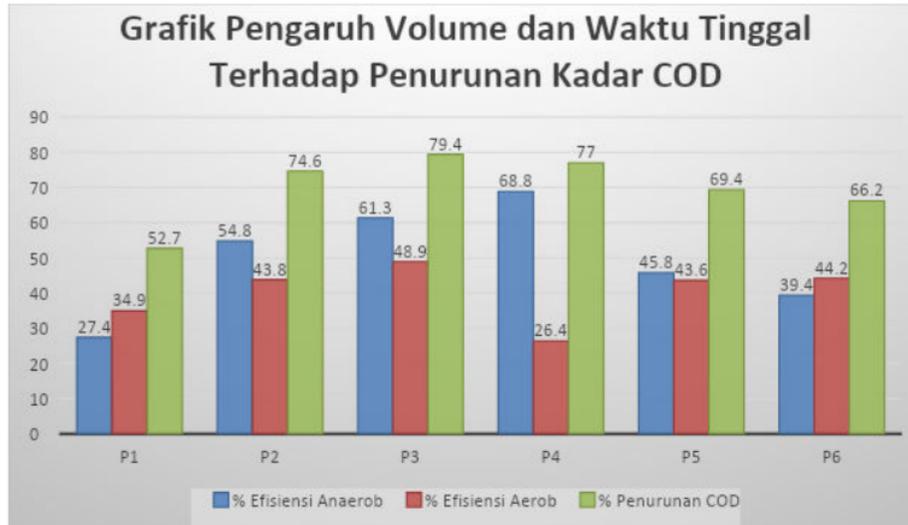
The effect of volume on reducing COD levels is shown in Table 4 below:

**Table 4.** Efficiency of Anaerobic and Aerobic COD Reduction Based on Volume and Residence Time

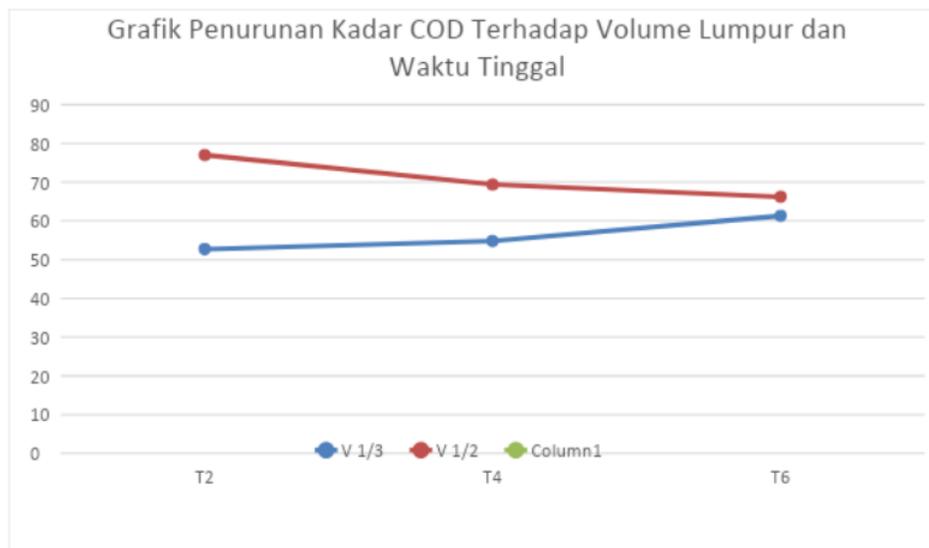
Mud Volume	Residence Time (Days)	% COD Reduction	
		Anaerobic	Aerobes
1/3	2	27,4	34,9
	4	54,8	43,8
	6	61,3	48,9
1/2	2	68,8	26,4
	4	45,8	43,6
	6	39,4	44,2

Based on the table above, the anaerobic and aerobic reactors worked optimally in each situation. For example, the anaerobic reactor worked optimally in the P4 state and the aerobic reactor worked optimally in the P3 state.

The following is the graph showing the effectiveness of reducing COD levels in anaerobic and aerobic reactors in various conditions.



**Graph 1.** The Effect of Volume and Residence Time on Decreasing COD levels



**Graph 2.** The Effect of Increasing COD levels on Sludge Volume and Residence Time

Based on the graphic above, the decrease in COD levels in the sludge volume was  $\frac{1}{2}$  better than that at  $\frac{1}{3}$  volume. Meanwhile, the best residence time was in T2 with a volume of  $\frac{1}{2}$  or T6 with a volume of  $\frac{1}{3}$ . This showed that activated sludge was able to absorb organic compounds (Delis et al, 2015) and can reduce COD (Dhas, 2008).

#### 4. Conclusion

1. The volume of sludge had an effect on the efficiency of the decreasing of the COD concentration of wastewater. The greater the sludge volume, the greater the efficiency of decreasing COD concentration; namely, the sludge volume  $\frac{1}{2}$  was greater than the  $\frac{1}{3}$  sludge volume.
2. Residence time had an effect on the efficiency of COD reduction, whereby the longer the residence time (6 days), the greater the efficiency of COD reduction at  $\frac{1}{3}$  volume. Meanwhile, the best  $\frac{1}{2}$  sludge volume was at 2 days residence time.

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