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Chitosan on Reducing Chemical Oxygen Demands in Laundry Waste Water

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Abstract

Laundry liquid waste contains several chemical substances in detergent raw materials such as phosphate, surfactants, ammonia, and total suspended solids. The existence of detergent in high concentrations and exceeds the quality standards that have been estabilished in a body of water can lead to cases of enviromental pollution in the form of increased turbidity an Chemical Oxygen Demands (COD) levels. Therefore in order to maintain and to ensure the availabillity of water in terms of quality, it requires coagulation-flocculation process to laundry liquid waste before discharging into water bodies. This study aims to determine the decrease of COD levels and turbidity level in laundry liquid waste using chitosan coagulant in "X" laundry, Tembalang District, Semarang. The research is a quasi experimental study with pretest-posttest with control group research design with 6 times replication. The total samples are 60 in wich 24 tested for the levels of turbidity and 6 controls. The test results of Kruskal-Wallis with significance p-value < 0,05 indicates that dosage variation (p=0,000) gives different levels of COD and dosage variation (p=0,000) provide 755,97 mg/l and the advantage levels of turbidity before treatment was 516,20 NTU. The optimum dosage of chitosan coagulant is on the dose of 200 mg/l with the effectiveness decrease of COD levels and turbidity levels on 72,67% an 98,67% respectively.

***Keywords*:** coagulation; waste water treatment; laundry.

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1. Introduction

Laundry liquid wastes have characteristics which contain phosphates, surfactants, ammonia and nitrogen as well as levels of dissolved solids, turbidity, BOD (Biologycal Oxygen Demands) and COD (Chemical Oxygen Demands) [1]. The characteristics caused by the use of detergents, detergent presence in high concentrations in water bodies can cause environmental pollution cases. In developing countries, including Indonesia, domestic waste into the main pollutant (85%) who entered the water bodies so that the process of self purification is not in balance [2]. When this happens constantly be increased levels of COD and turbidity in rivers. The increase in COD and turbidity caused by high levels of phosphate sourced from laundry waste. As happened in the city, an increase in the amount of laundry business led to high levels of eutrophication in rivers.

Phosphates in detergents is a macronutrient for plants, excess phosphate in water bodies and stimulate the growth of aquatic plants commonly called eutrophication. It causes dissolved oxygen that should be shared by all animals / plants water is reduced. Besides caused by eutrophication, weeds and water plants will die due to the high turbidity in the water body thus affecting the penetration of sunlight can therefore limit the impact on the process of photosynthesis and aquatic primary productivity decline [3].

Chemical Oxygen Demands (COD) is the amount of oxygen required to oxidize organic substances are chemicals in wastewater by utilizing an oxidant potassium dichromate as the source of oxygen. The higher the COD value, meaning the higher the organic matter in the wastewater and vice versa [4]. COD levels in the receiving water bodies required in the Central Java Regional Regulation No. 5 of 2012 on Wastewater Quality Standard should not exceed 100 mg/l [5] . Observations and preliminary surveys on laundry liquid waste in the "X" Laundry, Tembalang subdistrict, Semarang, of COD reached 715.30 mg / l and the turbidity level reached 616.68 NTU. This figure exceeded the quality standard of waste required, therefore, to maintain and ensure the availability of water in terms of quality (quality) is required laundry wastewater treatment before discharge into water bodies [6].

Mechanical treatment of wastewater containing detergents, one of which is a chemical treatment with coagulation-flocculation to remove particles that are not easy to settle (colloidal), by affixing coagulant into raw water followed by rapid stirring (coagulation) and slow stirring (flocculation) so resulting clots colloidal particles are then largely be separated in the sedimentation process [7]. Coagulation-flocculation method generally managed to reduce the content of COD as much as 40-70% [8].

Coagulant in the coagulation-flocculation process serves to accelerate the formation of larger floc, sturdy and stable, in this study using chitosan coagulant. Rodrigues (2008) in Rachmi (2014) suggest that chitosan can increase the speed of sedimentation, turbidity decrease and increase the density of sludge generated in wastewater treatment [9]. In line with Manurung (argued that the coagulant coagulation chitin / chitosan is superior in reducing turbidity alum [10]. Research Izaki concerning the use of chitosan as an adsorbent material in the wastewater of batik through coagulation-flocculation method able to reduce COD 73.75%. [11]. Research on Chitosan others, namely by [12] regarding the use of chitosan from shrimp shells in lowering levels of TSS in wastewater Industrial plywood that can reduce COD of 279 mg / l to 217 mg /l [12]. Preliminary trials

conducted on liquid waste "X" Laundry, showed chitosan coagulant able to reduce the content of COD and turbidity levels, respectively for 68.38% and 74.60%.

2. Materials and Methods

This type of research is quasi-experimental research (quasi-experimental) research design is Pretest-Posttest with Control Group.

The independent variables in this study are chitosan at a dose of 100 mg / l, 150 mg / l, 200 mg / l and 250 mg / as coagulant l. The dependent variable is the decrease in the concentration of COD and turbidity in wastewater "X" laundry.
The population in this study is all laundry liquid waste in the "X" Laundry, Tembalang subdistrict, Semarang with a total sample of 30 samples taken on the same day.

Replication of the experiments carried out to better provide accurate data of COD before and after treatment. The number of replication in the experiment was calculated using the formula:

$(T-1)(r-1) \geq 15$

$(4-1)(r-1) \geq 15$

$(3)(r-1) \geq 15$

$3r - 3 \geq 15$

$3r \geq 15 + 3$

$r \geq 6$

t: treatment

r: the number of replication

The statistical test used is normality test data. In this study, the data obtained are not normally distributed, then performed the Kruskal-Wallis test. The level of confidence in this test is 95% or with a significance level $\alpha = 0.05$, and making decisions based on the probability value (p-value); when p-value <0.05, significant difference. When p-value> 0.05 means there is no significant difference.

3. Results and Discussion

"X" in one day laundry wash services capable of serving up to 100 kg of water required ranges from 750 liters of water per day. The liquid waste generated from the washing process streamed directly from a pipe connected to the washing machine and then discharged through the sewer to the water without processing it first. The

frequency of liquid waste disposal in accordance with the frequency of washing that is performed 23 times. If clothes washing load is high, the frequency of liquid waste disposal and laundry washing frequency performed 32 times. characteristics of Waste The results of initial testing of wastewater characteristics "X" Laundry presented in Table 1.

Table 1: Characteristics of the Liquid Waste "X" Laundry

Parameter of waste	Unit	Results
COD	mg/l	755,97
Kekeruhan	NTU	516,20

The level of turbidity in the effluent was negatively correlated with the amount of dissolved oxygen, thereby increasing turbidity, the amount of dissolved oxygen decreases. In addition, bodies of water need dissolved oxygen to support aquatic primary activity. When the availability of dissolved oxygen decline, but on the other hand the amount of oxygen required to degrade pollutants in the water increases, also increases the content of COD in the effluent and the receiving water bodies. So it can be concluded that the decline in the level of turbidity is directly proportional to the decrease of COD. But the figure of removal efficiency of turbidity and COD content does not give the same results. This is because in the laundry waste water is not only organic compounds are deposited, so that the COD removal efficiency is not as great as efficiency level of turbidity.

Characteristics coagulant Chitosan

Chitosan is used as a coagulant has the characteristics in Table 2. The results of the COD measurement and before and after coagulation and flocculation process using chitosan can be seen in Table 3.

The average content of COD highest in chitosan coagulant dose of 250 mg / l ie 461.50 mg / l, while the average COD content was lowest for the chitosan coagulant dose of 200 mg / l in the amount of 206.62 mg / l. The principle of coagulation-flocculation using chitosan coagulant is the force of attraction between the colloid in the laundry liquid wastes are negatively charged with chitosan coagulant properties of cationic polyelectrolyte so that a positively charged cations contained in the ends of the carbon chain of chitosan coagulant reactive binding negative charge on colloids.

Dosing coagulant chitosan in the dose range of 100 mg / l, 150 mg / l and 200 mg / l helps bind the colloids in the liquid waste, laundry and then make colloidal cause turbidity which initially are stable to unstable cargo, then there is the force of attraction be deposited floc. Thus colloidal deposition processes in wastewater "X" lasted laundry, and led to a reduction of COD and turbidity in wastewater "X" laundry successively reached 72.67% and 98.67%. The result of COD removal efficiency in line with research conducted by Izaki in 2014 regarding the use of chitosan as an adsorbent material in the wastewater of batik through coagulation-flocculation method can lower 73.75% .11 The result of COD removal efficiency of turbidity levels in line with research conducted Darnianti [13] on decreased levels of color wash jeans industry wastewater with chitosan

and weathered white mushrooms can lower turbidity or cloudiness 95.80% [13].

Table 2: Characteristics of *Chitosan coagulan*

Parameter	*Chitosan*
Raw materials	Cangkang Udang
Particle size	Particle (20-30 mesh)
Humidity (%)	< 10 %
Dust level	< 0,5%
Liquidity in acetate acid 1%	> 99%
Deasetilasi degree	> 80%
Total Mikroba	< 103 cfu/gram
Coliform	Negative
S.aureus	Negative
Salmonella	Negative
V. cholera	Negative

Table 3: Results of COD analysis before and after treatment

Replication	Control	COD Before treatment (mg/l)	COD after treatment (mg/l)			
			D1	D2	D3	D4
I	752,71	755,97	401,30	326,46	196,31	469,63
II	752,71	755,97	414,32	232,31	209,33	453,36
III	752,71	755,97	417,57	316,70	202,82	476,14
IV	752,71	755,97	420,82	310,20	225,60	456,62
V	752,71	755,97	404,56	323,97	199,57	463,12
VI	752,71	755,97	407,81	300,43	206,07	450,11
Average	752,71	755,97	411,06	301,08	206,62	461,50

The average effectiveness of COD biggest decline on chitosan coagulant dose of 200 mg / l is equal to 72.67%, while the average effectiveness of COD smallest decline in chitosan coagulant dose of 250 mg / l is equal to 43.57%. The effective dose of the study was 200 mg / l with an efficiency of 72.67%. Normality test data with the Shapiro-Wilk namely COD content data obtained before and after treatment p-value = 0.001 (<0.05), then Ho is rejected and Ha accepted. So the data difference COD content distribution is not normal. COD test different content data in a variety of dosage by Kruskal-Wallis namely that the reduction of COD obtained p-value = 0.000 (<0.05), then Ho is rejected and Ha is received, or in other words there is a difference of COD in liquid waste of laundry in a range of doses of chitosan as a coagulant.

According to Huda (2009) in 2014 stated that the turbidity Wardhani intimately linked to the levels of suspended substances as turbidity in the water due to suspended substances contained in the water [14]. Turbidity is caused by the presence of suspended substances in the water, but because of suspended substances

contained in the water is composed of various substances in the form and density vary the turbidity is not always proportional to the levels of suspended substances.

Suspended substances contained in the water consists of a variety of substances, such as fine sand, clay and mud are natural materials may also be inorganic or organic materials floating in the water. Organic ingredients which are suspended substances consist of various types of compounds such as cellulose, fat, protein floating in the water or can also be microorganisms such as bacteria, algae, and so on [15]. These organic materials other than derived from natural sources also coming from the waste of human activities such as industrial activities, agriculture, mining or household activities. The level of turbidity in the water is one of the important factors to control primary productivity, with the presence of suspended solids turbidity will reduce light penetration into the water thus affecting the regeneration of O2 through photosynthesis.

Table 3: the efficient of COD concentration decrease after treatment

Replication -	Treatment affectivity (%)			
	D1	D2	D3	D4
I	46,92	60,08	74,03	42,57
II	45,19	71,59	72,31	44,56
III	44,76	61,27	73,17	41,78
IV	44,33	62,07	70,16	44,16
V	46,48	60,38	73,60	43,37
VI	46,05	63,26	72,74	44,96
Average	45,62	63,11	72,67	43,57

Goldman and Hornein Suherman [16] states that the content of dissolved oxygen in water comes from photosynthesis and diffusion from the air. Oxygen is consumed continuously by plant in respiration activity. In this study surfactants in detergents serve to weaken dirt so that the dirt on the clothes apart to form a colloidal dispersed in the laundry liquid wastes. Colloids originating from laundry wastewater will increase the level of turbidity in receiving water bodies, with increasing levels of turbidity, the process of photosynthesis in the water are not optimal dissolved oxygen so that the production cannot meet the needs of living things in the water. In addition to the detergent builder that works to prevent sedimentation dirt or stains on clothes are washed, when phosphates into the water body will cause nutrient enrichment in the water. This is because phosphate is a micronutrient required by plants in this case is algae growing in the water as well as other plants that float on the water surface. Plants that float on the water can thrive as a result of the content of phosphate dissolved in the water, it is able to limit the supply derived from diffusion of oxygen between air and water, because the plants that float in the water picks up oxygen in the water through the roots [17,18].

Naturally, the pollutants that enter in the body of water can be degraded by microorganisms in the water. This degradation process requires oxygen. The availability of dissolved oxygen will support the activities of microorganisms to degrade the content of organic and inorganic materials in the waste. Chemical Oxygen Demands (COD) is the amount of oxygen are required for oxidize organic substances [19].

4. Conclusion

1. Efficiency of Chitosan as a coagulant in the chemical processing of 72.67%

2. The effective dose of chitosan as a coagulant in wastewater treatment room is 200 mg / l.

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