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COMBINATION OF PHOTOCATALIST TiO_2 *(Titanium Dioxide)* AND H_2O_2 *(Hydrogen Peroxide)* IN LAUNDRY WASTEWATER TREATMENT

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ABSTRACT

Any laundry operation will discharge the waste water directly to the water surface, which can lead to pollution in the water. One method that can be used to treat laundry wastewater is a photocatalytic method with TiO_2 (Titanium Dioxide) as an UV-assisted catalyst that is combined with a strong H_2O_2 oxidizer to produce OH (hydroxyl radical) to oxidize pollutants. The study aims to determine the differences in pH, TSS, BOD, COD, and Phosphate separation values with combination of TiO2 and H2O2 doses with variations in UV exposure time for 30, 60, and 90 minutes. A good quality TSS level obtained in the 60th minute with a dose of 1 g TiO_2 and in combination with 10 ml H_2O_2 can reduce TSS levels by 20 mg/l from the initial TSS with a residual weight of 180 mg/L. A decrease in the quality COD level at a 90 minute clearance time with a dosage of 1 gr TiO_2, in a combination of 10 ml H_2O_2, can reduce the COD levels by 32.5 mg/ l from the original COD value of 89.1 mg/l. A reduction in the phosphate level achieved at the cleaning time of 30 minutes at a combined dose of 4 gr TiO_2 in a 40 ml combination, can lower the phosphatic level by 0.05 mg /l from the starting value of 5.61 mg/l and already meet the quality standard of laundry waste water.

Keywords : Washing, Wastewater, UV Light, Titanium Dioxide, Hydrogen Peroxide

ABSTRAK

Setiap usaha laundry akan membuang air limbahnya langsung ke permukaan air, yang mana dapat menyebabkan terjadinya pencemaran di perairan. Salah satu metode yang dilakukan untuk mengolah air limbah laundry adalah dengan prinsip kerja fotokatalis yang menggunakan TiO_2 (Titanium Dioksida) sebagai katalis yang dibantu sinar UV, dan dikombinasikan dengan Oksidator kuat H_2O_2 (Hidrogen Peroksida) untuk menghasilkan OH (radikal hidroksil) guna mengoksidasi polutan. Penelitian ini bertujuan untuk mengetahui adanya perbedaan nilai penyisihan pH, TSS, BOD, COD, dan Fosfat dengan kombinasi dosis TiO_2 dan H_2O_2 dengan variasi waktu pemaparan lampu UV selama 30, 60, dan 90 menit. Parameter pH masih memenuhi standar baku mutu air limbah laundry yaitu 6-9. Kadar TSS dengan kualitas baik didapatkan pada menit ke 60 dengan dosis 1 gr TiO_2 dan di kombinasikan dengan 10 ml H_2O_2 dapat menurunkan kadar TSS sebanyak 20 mg/l dari kadar TSS awal dengan berat residu 180 mg/l. Penurunan kadar COD berkualitas baik berada pada waktu penyinaran 90 menit dengan dosis sebanyak 1 gr TiO_2 di kombinasi 10 ml H_2O_2 dapat menurunkan kadar COD 32,5 mg/l dari nilai COD awal 89,1 mg/L. Penurunan kadar fosfat di peroleh pada waktu penyinaran 30 menit pada dosis TiO_2 4 gr di

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kombinasikan H_2O_2 40 ml dapat menurunkan kadar fosfat sebanyak 0,05 mg/L dari nilai awal 5,61 mg/L dan sudah memenuhi baku mutu air limbah laundry.

Kata kunci : *Air Limbah Laundry, Lampu UV, Titanium Dioksida, Hidrogren Peroksida*

Introduction

Laundry waste treatment can be done physically, biologically and chemically. In this study, using chemical processing with the principle of photocatalytic is used with TiO2 (Titanium Dioxide) as a catalyst assisted by UV rays, and combined with a strong oxidizer H2O2(Hydrogen peroxide), to produce OH (hydroxyl radical) that is useful to oxidize pollutants (Hermawan A. 2019).

Photocatalysts are a combination of photochemical and catalytic reactions. Photocalysts involve light, ultraviolet rays capable of working well with titanium dioxide (TiO2). A catalyst is a substance or chemical that can affect the speed of a reaction without changing chemically. The study uses a combination of TiO2 and H2O2 photocatalysts, where the combination is a mixture of a solution to obtain optimal results. Titanium dioxide acts as a catalyst in this photocatalytic process by absorbing the light energy emitted by UV rays. In the process of degradation, TiO2 performs electron transfer to lower its pollution value. The oxidizer H2O2 is a compound that has the ability to oxidize other compounds or commonly known as electron receptors (Nugroho, R.T, 2017).

Dina Laundry is one of the laundry located in 20 N T. Nyak Arief Street, Lamnyong, Syiah Kuala, Banda Aceh City. According to the field observations at Dina Laundry, discharging the waste water directly into the well that causes pollution in the surrounding environment, it could threaten the existence of the water biota. So far, no one has tested the wastewater from Dina laundry. Then it needs to be tested on the washing waste water to see if the waste water can just be thrown into the stream without going through the process of treatment. In this study will be performed a combination of photocatalytic TiO2 (Titium Dioxide) and H2 O2 (Hydrogen Peroxide) in lowering the parameters of COD, BOD, pH, TSS, and phosphate on the wastewater laundry in Dina Laundry Lamnyong, Syiah Kuala, Banda Aceh.

Methods

The tools used in this study are Beaker glass 1000 ml and 100 ml, UV light, Aluminum Voil, triple, Analytical Stamping, Spatula, Name Label, pH Meter, Jerigen, Hot Plate, Magnetic stirrer, thermometer. The materials used in this study include the discharge of Laundry derived from 17 liters of Dina laundry, H2O2 and TiO2. The variables used in this study are the fixed, independent and dependent variables. The fixed variable is 10 watt UV lights, independent variables cover the TiO2 coagulation doses of 0 grams/L, 1 gram/ L, 2 grams / L, 3 grams, 4 grams of L, and H2O2 doses of 0 ml, 10 ml, 20 ml, 30 ml, 40 ml, as well as variations in the duration of 30 minutes, 60 minutes, and 90 minutes. The dependent variables are pH, Phosphate, COD, BOD, and TSS.

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Table 1. Variabel Penelitian

Fixed Variable	Independent Variable	Dependent Variable
10 watt UV lamp	The TiO2 dosage is 0.1 gr, 2 gr, 3 gr, 4 gr and the H2O2 doses of 0.10 ml, 20 ml, 30 ml and 40 ml.	pH, Phospate, COD, BOD, and TSS.
	Time variations of 30 minutes, 60 minutes, and 90 minutes	

The research phase starts with sampling of washing waste water, conducting preliminary analysis, preparing UV light reactors, TiO2 and H2O2 combination processes, as well as parameter measurement. The flow diagram is shown in Figure 1.

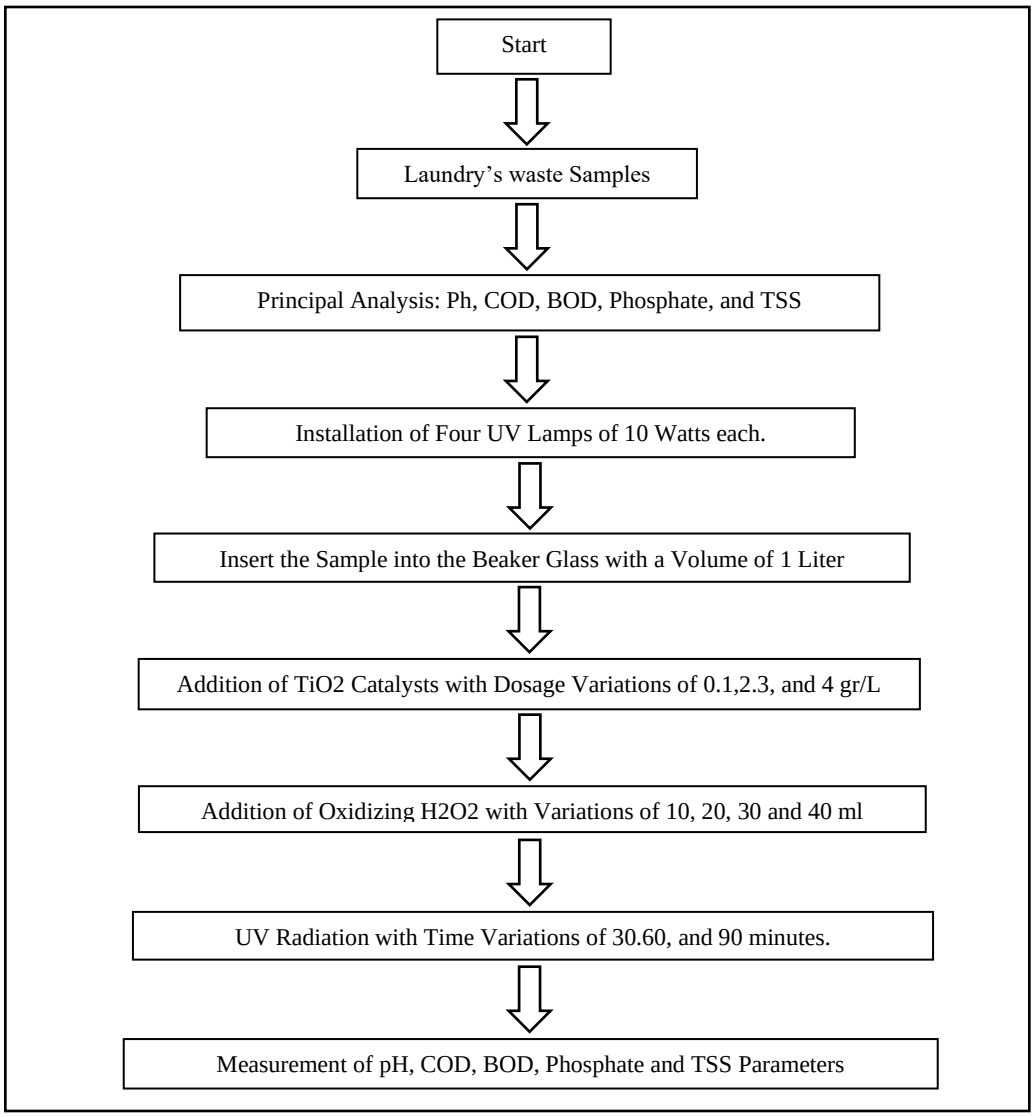

Figure 1. Research Flow Diagram

DOI : 10.22373/ijes.v1i2.4149
ISSN 3046-885X

Results and Discussion

The result of the sample testing of Dina Laundry Wastewater with BOD, COD, TSS, pH, and phosphate parameters before treatment can be seen in Table 2 and the results of testing after treatment are shown in Table 3.

Table 2. Results of test parameters of laundry sewage before treatment

Parameter	Early Test Results	Quality Standard	Description*
pH	8,6	6,0-9,0	Eligible
TSS	180	60	Not eligible
BOD	12,66	75	Eligible
COD	89,1	180	Eligible
phosfat	5,66	2	Not eligible

*****_Regulation of the Ministry of Environment of the Republic of Indonesia N. 5 of 2014 concerning wastewater wastewater for soap, detergents and oil products industry enterprises and/or activities_.

Table 3. Results of Parameter Research on Wastewater Laundry

Dosage TiO_2 (gram)	Dosage H_2O_2 (mL)	Dumping Time of UV (Minute)	pH	TSS	BOD	COD	Phosphate
0	0	-	8,6	180	12,7	89,1	5,61
0	0	30	8,1	160	134	88,1	4,79
1	10		7,8	30	300	39,1	3,90
2	20		7,9	150	67	41,2	4,13
3	30		7,8	160	67	66,2	1,24
4	40		7,2	230	134	68	0.05
0	0	60	8,3	50	167	87,1	4,22
1	10		7,9	20	266,7	36,8	3,24
2	20		7,6	70	133	39,2	3,77
3	30		7,3	160	134	62,3	4,06
4	40		6,5	250	267	67,2	0,75

Dosage TiO_2 (gram)	Dosage H_2O_2 (mL)	Dumping Time of UV (Minute)	pH	TSS	BOD	COD	Phosphate
0	0	90	7,8	110	334	87,2	3,10
1	10		7,5	40	166	32,5	0,92
2	20		7,4	120	168	36,8	0,53

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Dosage TiO_2 (gram)	Dosage H_2O_2 (mL)	Dumping Time of UV (Minute)	pH	TSS	BOD	COD	Phosphate
3	30		7,5	180	267	40,5	5,15
4	40		7,8	290	400	64,9	5,15

According to Azizah., (2017) The pH value is the result of the measurement of ion activity in a water and shows the balance between acid and water base. In this study, the results of measuring the pH level in the waste water Laundry at Dina laundry 8.6 has met the standard of quality: (6-9). The results of pH values after UV light exposure and the combination of TiO2 and H2O2 doses can be seen in Table 3.

Chemically Laundry waste contains the active chemicals detergent (surfactant) Alkyl Benzene Sulfonate (ABS) as well as Linier alkyl sulphonate (LAS), Physically has a dark color (White Chocolate), odor, scratch and foam. And biologically, the waste also contains a variety of bacteria and other microorganisms.

This pH measurement is important as a parameter of water quality because it can control the type and speed of reaction of some substances in the water. According to the Regulations of the Minister of the Environment of the Republic of Indonesia No. 5 of 2014 on wastewater storage for the business and/or activities of the soap, detergents and oil products industry.

The results of the laboratory analysis of the pH quality of the wastewater Laundry has met the standard of the raw quality of wastewater 6-9, in the initial testing (control test) of the washing water that was taken at the end of the channel Dina laundry enterprise obtained a result of 8.6.

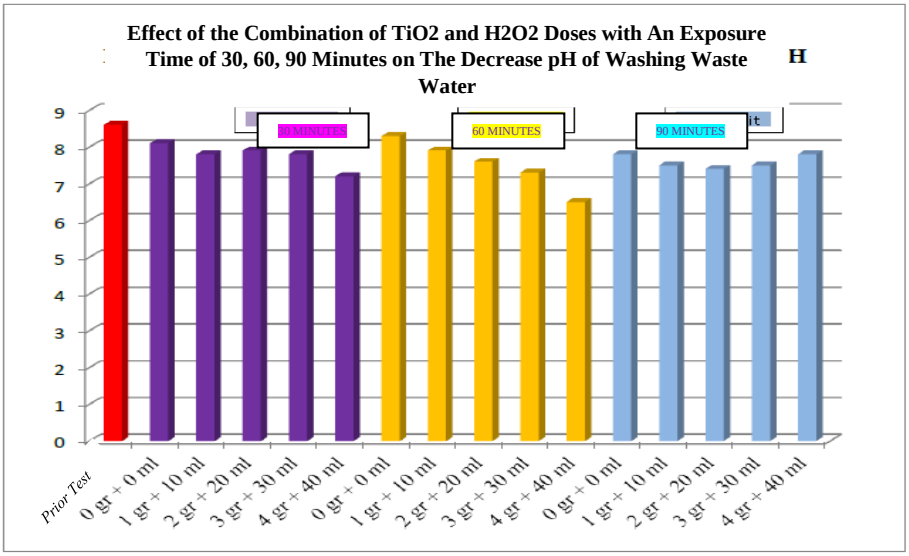

Figure 2. Effects of combined doses of TiO2 and H2O2 with exposure times of 30, 60, and 90 minutes on a decrease in the pH value of laundry sewage

Based on Figure 2. The TSS experimental test results show that the longer exposure to UV rays affects the TSS value. The washing waste water control test taken at the end of the Dina Laundry enterprise channel obtained TSS results worth 180. After 30 minutes of UV exposure without the addition of TiO2 and H2O2 doses, the

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ISSN 3046-885X

chart shows that the separation of TSS values is increased to 160, where the process of exposure to UV light continues leading to the formation of hydroxyl radicals. This is also the case with the treatment of exposure to UV lights for 60 minutes which is obtained TSS value of 50 mg/l and also at the time of 90 minutes exposure value of TSS is 110, the result is already somewhat below the control test value.

High TSS values can inhibit the penetration of light into wastewater (Andini dkk., 2015). At 30 minutes contact time treatment there was a decrease in the TSS value of 30 mg/L after TiO2 of 1 g and H2O2 of 10 ml is combined and with exposure to UV lamps for 60 minutes the TSS of 20 mg/ L is obtained. On treatment exposure lamp for 90 minutes applied the result of TSS decreased to 40 mg/l which met the quality standard as specified in PERMEN LH No. 5 Year 2014. This is because the process of combination will produce OH radical, OH radical this is acquired from the Fenton process through the reaction H2 O2, in this case it is necessary light and catalysts to proceed (to accelerate) chemical transformation (Linsebigler, dkk, 1995).

With the addition of 2 g TiO2 and 20 ml H2O2 in 30, 60 and 90 minutes of UV exposure, TSS values increased to150 mg/L at 30 minutes of contact, 70 mg/ L at 60 minutes and 120 mg/ l at 90 minutes. As the combined photocatalytic doses increased to 4 g Ti O2 and H2 O2 at 40 ml, the TSS value increased, reaching 290 at 90 minutes of contact. According to Soraya, (2012), this is due to the increasing amount of TiO2 added caused by the blocking of incoming rays, besides it also occurs the accumulation of tiO2 powder so that the absorption of light by the photocatalytic is reduced and cannot work to the maximum.

Biological Oxygen Demand (BOD) is the biological oxygen requirement required by microorganisms (such as bacteria) to break down organic materials aerobically in a water (Santoso, 2018) where decompression of organic material is understood to mean that microorganisms obtain energy from the oxidation process and eat organic matter found in water. If contamination occurs in a water, it can damage the water's chemical levels and cause the oxygen level of the water to become critical (reduced). Below are the effects of UV light exposure relationships with a combination of photocatalytic TiO2 and H2O2 can be seen in Table 3.

Based on Table 3. it can be seen that the initial value of BOD before the clearance of UV lamps is 12.66 has already met the Quality Standard of PERMEN LH No. 5 Year 2014 on Baku quality wastewater for the enterprises or activities of the industry of soap, detergents, and products of vegetable oil. In this study will be seen the effect of the combination of TiO2 and H2O2 with the help of UV light (photocatalyst) on BOD parameters.

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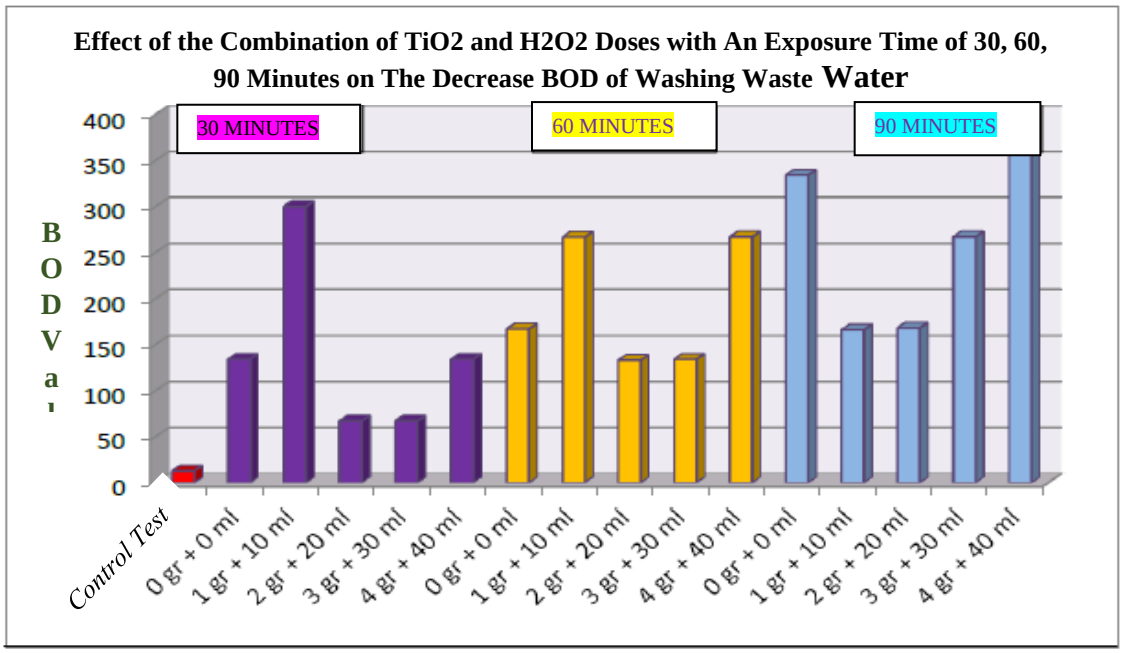

Figure 3. Effects of a combination of TiO2 and H2O2 doses with UV exposure times of 30, 60, and 90 minutes on a decrease in washing waste water BOD

Based on the results of PERMEN LH No 5 Year 2014 on wastewater for the business or industrial activities related to the soap, detergents, and oil products, the threshold value of the standard quality parameter of BOD that can be disposed of in the environment is 75 mg/L and after testing in the laboratory, it is obtained the BOD value on the waste water from the laundry still meets the standard quality limit of 12.67 mg/L.

In the tables above, it can be seen that after testing with a combination of TiO2 and H2O2 assisted with exposure to UV rays the BOD value increased significantly, the increase in BOD values due to the binding of organic compounds. This results in a decrease in the amount of organic matter so that the need for oxygen to degrade organic compounds biologically and chemically decreases. Or in other words, BOD and COD values decreased (Yuningrat N.W, et al, 2012)

The time of exposure to UV light and also the addition of excessive H2O2 will decrease the percentage of degradation due to the occurrence of the phenomenon of -OH that reacts with H2 O2 so that the HO2 radicals are less reactive than the -OH radicals and the formation of O2 gas molecules in the system. These gas molecules are insoluble, so they will react and block the transfer of photon energy to the surface. (Sibarani, Purba, Suprihatin, & Manurung, 2016).

COD (Chemical Oxygen Demand) is the amount of dissolved oxygen needed by living organisms to oxidize waste materials in water. This COD measurement is necessary to measure the oxygen requirement of oxygeneous substances that are difficult to destroy by oxidation, so it requires the help of an oxidator to lower the COD levels in a water and not to interfere with the life of the aquatic biota. (Fachrurozi M, dkk, 2010). Here are some tables of the photocatalytic effects of TiO2 and H2O2 in the degradation of wastewater Laundry with exposure times of 30, 60, and 90 minutes.

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ISSN 3046-885X

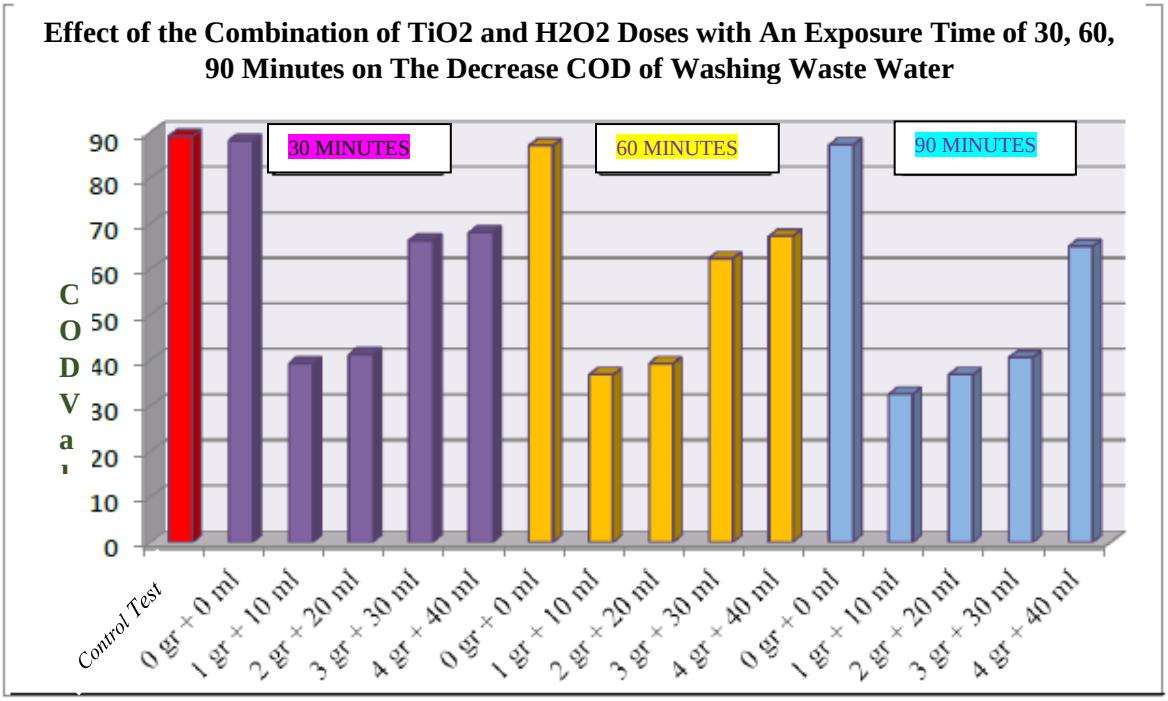

Figure 4. Effects of combined doses of TiO2 and H2O2 with UV exposure times of 30, 60, and 90 minutes on reduced COD values in laundry sewage

Based on the above graph, it can be seen that the initial value of the parameter COD (control test) before treated with the photocatalytic process is 89.1 mg/and has already qualified Quality Standard PERMEN LH N 5 Year 2014 on Quality Standard Wastewater for Enterprises or Activities of the Soap, Detergents, and Natural Oil Products Industry. When the lamp is exposed for 30 minutes without the addition of a combination of TiO2 and H2O2 doses, the COD rate drops to 88.1 mg/L, this is due to the UV light exposure process that causes the formation of hydroxyl radicals. When the TiO 2 combination is added of 1 g and H2O2 of 10 ml, there is a decrease in the value of COD to 39.2 this is because of the photocatalyst TiO2, exposed to UV rays so that there is an electron transfer from the valence tape to the conduction tape, the electron excitation process produces e- on the conductive tape and leaves a hole (h+) in the valency tape. The resulting hole (h+) then interacts with OH- of the solvent (water) to form the hydroxyl radical (OH).

In addition to the addition of consecutive doses of 2,3, and 4 g TiO2 and combined H2O2 of 20, 30, and 40 ml respectively the increase in the COD value occurs due to the increasing of the solution H2O2 will decrease the percentage of degradation because of the occurrence of the phenomenon •OH that equates with H2O2 so that HO2 radicals are formed less reactive than the radicals •OH (Darmadi, 2014). And also in the combination of TiO2 of 4g is obtained a less good percent due to too many doses TiO2, so that the formation of excessive ions will react with the hydroxyl radicals (OH), thus forming hydroxy radical (OH) will be reduced resulting in the decreased percentages of separation.

The element of phosphorus in water is not found in free form as an element, but in the form of soluble organic compounds (ortophosphate and polyphosphates) and

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particulate organic compositions (Effendi, 2003). Phosphorous itself forms a complex with iron ions and calcium in aerobic conditions, is insoluble, and can settle on sediments so that it cannot be exploited by aquatic algae. Below can be seen Table 3. effects of TiO2 and H2O2 combination on photocatalytic processes in lowering phosphate levels in wastewater Laundry in Dina Laundries.

In table 3. below can be seen that the phosphate value of the wastewater analysis Laundry tested at the Chemical Instrumentation Analysis at Laboratory of Syiah Kuala University, obtained the results of the control test of 5.61 mg/L and has not met the standard quality PERMEN LH No. 5 Year 2014 about wastewater standard quality for the enterprises or industrial activities related the soap, detergents, and products of the oil industry. Therefore, it is necessary to reduce the level of phosphate in wastewater by purification (photocatalytic process), the process of testing the phosphate levels with the combination process of TiO2 and H2O2 can be seen in Figure 5.

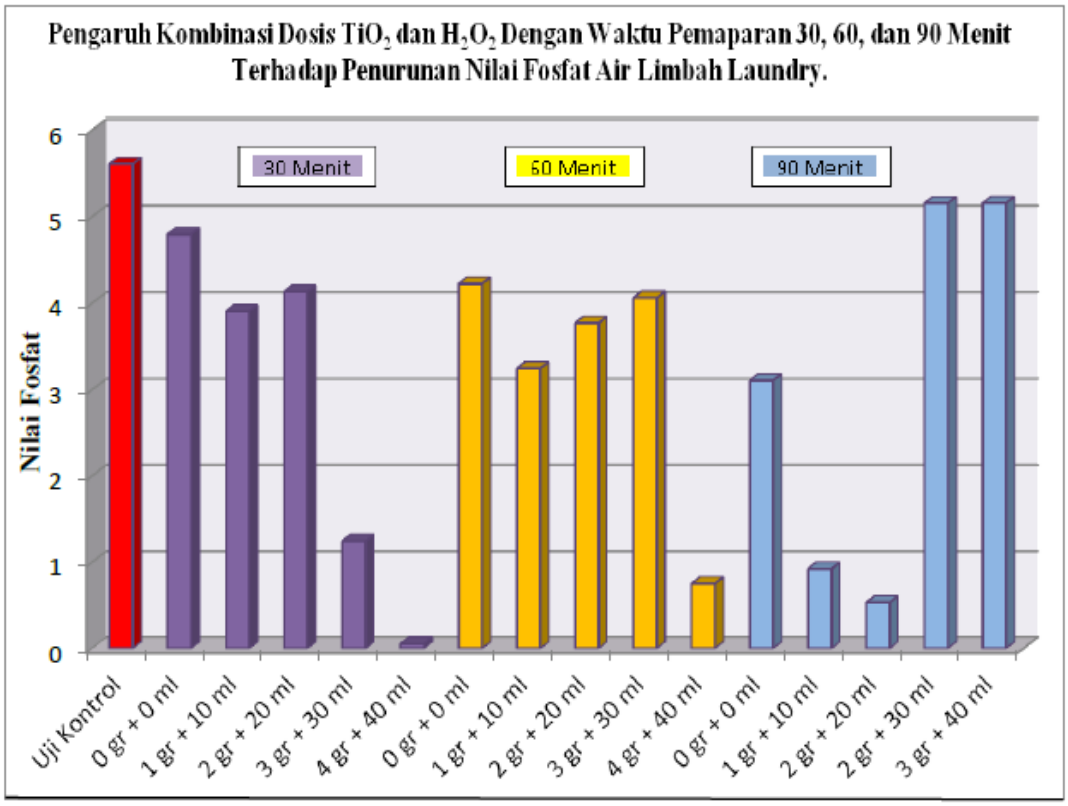

Figure 5. Effects of combined doses of TiO2 and H2O2 with UV exposure times of 30, 60, and 90 minutes on decreased phosphate values in laundry sewage

At the time of exposure of the UV light to the contact time of 30 minutes there was a decrease in the phosphate value to 4.79 mg/L before the concentration of TiO2 and H2O2 was added, but after the addition of the combination TiO2 and H2O2 in succession until along with an increase in the content of TiO2 by 4 g combined with H2O2 of 40 ml can reduce the phosphat value to 0.05 mg/ L, decreases in the level of phosphate in the waste water after a photocatalytic process due to the formation of the

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hydroxyl OH radical that acts as a reducing agent of the compound of the Phosphat. (Suryandari, et al. 2019).

Further UV light exposure for 60 minutes without addition of TiO2 and H2O2 concentrations is 4.22 mg/L where the phosphate level is still high but slightly lower than the initial test (control test), after the addition of combination TiO 2 and H 2 O 2 in a row until along with the increase in the content of Ti O 2 by 4 g combined with H2 O 2 of 40 ml there is also a decrease in the phosphat values at the highest doses namely Ti O2 4 gr and 40 ml, this is also due to the presence of interaction between OH radicals with phospaths so that at the treatment of the combination of Tio 2 4 gr added H 2O2 40 ml resulted in phospha values of 0.75 mg / L

In the treatment of exposure to UV light 90 minutes there was an increase in the phosphate value, i.e. in the combination of TiO2 3, 4 ml and H2O2 30, 40 ml of the phosphat value reached 5.15, according to the study (Suryandari, A.S, 2019) Long-term irradiation can also affect phosfat levels tend to experience an increase due to saturation of the active side of the catalyst.

Conclusion

Based on the results of research and analysis carried out, it can be concluded that, the pH parameters of waste water discharge from laundry wastewater still meet the quality standard with pH between 6 and 9. Testing of a well-qualified TSS level at the 60th minute with a dose of 1 g TiO2 and in combination with 10 ml H2O2 can reduce TSS levels to 20 mg/l from the initial level of TSS with a residual weight of 180 mg/L. A decrease in good-qualified COD levels at 90 minutes with a dosage of 1 gr TiO2, in a combination of 10 ml, can reduce the COD level to 32.5 mg/ l from the original COD value of 89.1 mg/ L. Decreases in the quality of the phosphate levels are obtained at the time of 30 minutes at a TiO2-dose of 4 gr in the combination H2O2 40 ml can lower the phosphate quality level by 0.05 mg/L from the initial value of 5.61mg/L and already meets the quality standard of wastewater from laundry.

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