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TREATMENT OF WASTE WATER OF TEXTILE INDUSTRY BY USING OZONE TECHNOLOGY

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ABSTRACT

Textile industry is now growing rapidly but it does not go with waste processing techniques. This study analyzes TSS, pH, and color that aims to determine the effect of ozonization time (5-60 minutes) and the addition of dolomite or Active Carbon each with variations in the distribution of 0.1% -1% of the weight of the waste. The content of the initial waste after the analysis is, TSS = 1502 mg / l, pH = 12, color = 92 Pt-Co. The results obtained in this research notes that the maximum reduction in the time to come Ozonization is 60 minutes with the content of TSS = 141.60 mg/lt. or 90.64% in Dolomite addition of 1%, pH = 9.69 at Dolomite addition of 0.6%, while the color = 40.30 Pt-Co or 56.10% at a 0.1% increase Dolomite. Ozone concentration = 0.2 mg/sec, with a 100 Watt power Ozonizer, time Ozonization = 5-60 minutes. Calculation: Ozonization bathtub I and II rectangle with the same dimensions. From field data aeration unit is known the dimensions are: length Ozonisasi tub I and I = 70 meters, width bath Ozonisasi I and II = 15 meters, depth Ozonisasi tub I and II = 3,75 meters. Sedimentation = 390 m3 tub, bathtub diameter = 12 meters, the depth of bath = 3 meters. Ozonation time of 60 minutes, because the Ozonization time can result in a decrease of TSS efficiency and color. It is known from research data: In the research data ozone concentration of 0.2 mg/sec = 12 mg/min, the volume of waste in-Ozone is = 1 liter. Data Field: The volume of waste produced = 270.8 liters/min, then the need for Ozone in the Ozone = concentration x volume of waste = 54.16 mg/sec, if a 100 Watt Ozonizer Ozone is able to produce 0.2 mg/sec. Costs required for waste treatment: Assumption of the electricity cost per kWh is IDR. 900, -, Ozonization for 1 hour = IDR. 900, - x 26.4 Kwh = IDR. 23,760, -, and the cost for 1 month (30 days) is assumed to be IDR. 171.072 millions.

Keywords: Waste Water; Textile Industry; Ozone Technology

1. INTRODUCTION

Industry in Indonesia is growing rapidly, one of which is the textile industry. The textile industry generates liquid waste that comes from the process of weaving and bleaching (wet process), due to the need of solvent water and certain chemical substances. The chemicals contained in the solvent water from these processes will partly be disposed of as industrial waste. Waste disposed of if no processing will be able to pollute the receiving water body waste or the surrounding environment (Sugiharto, 1997).

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The textile wastewater parameters are TSS, pH, and color. Textile waste originating from the collecting basin in PT. Pekalongan, Co. based analysis initially contains TSS of 1502 mg/l, the color of 92 Pt-Co, and a pH of 12 (Anonim, Pengolahan zat warna Batik 1997). In order to reduce pollutant parameters a treatment alternative that is cheap and efficient is needed. One of the alternatives that can be applied is the process of ozonization with ozone generator devices (Ozonizer) (Basuki, K.T., 2007).

The research being developed by PSTA is expected to be the wastewater treatment system of the textile industry which is cheaper and efficient. Ozonnizer that is used will generate ozone gas (O_3) and expected to reduce the levels of TSS, color and neutralize the pH. *Ozone* (O_3) that are radical, would bind the Dolomite solution and activated carbon which has been added previously, the bond that is formed in the form of flock. Flock that is formed will precipitate together with TSS and color. So that the waste that releases out of the outlet into the environment is waste that does not pollute the surrounding environment (Basuki, K.T., 2007 and Widdi, 2006 & 2007).

In order to obtain the optimal results of the study, this research is limited to the Ozone technology that is used to reduce the concentration of pollutants TSS, pH and color in textile waste water PT. Pekalongan, Co. Ozonization time starts from 5 minutes - 60 minutes with the addition of activated carbon adsorbent dolomite and each with a weight variation of 0.1% - 1% (Waryati, 1999).

In accordance with the above problems this study has the objective, namely: Knowing or gaining the efficiency of decrease in TSS concentrations, pH, and color of textile waste PT. Pekalongan, Co. Knowing the influence of time Ozonization of 5-60 minutes and the addition of dolomite and activated carbon each with a weight variation of 0.1% - 1% of the decrease in TSS, pH, and color of textile wastewater (Potter, 2004).

Textile industry production process at PT. Pekalongan, Co covers several steps: 1. Spinning, 2. Weaving (a. Weaving Preparation, b. Weaving Lom, c. Weaving Inspecting) 3. Finishing (Completion / bleaching) (Cooper, 1998).

At the PT. Pekalongan, Co. INDONESIA, wastewater is treated at a waste treatment unit derived from Finishing Unit, where water is one of the main supporters in the process. The source and characteristics of the liquid waste Finishing Unit are Combustion fur (Singeing) and *Kanji* decomposition (Desizing) (Cooper, 1998).

From sources of liquid waste producers in general, the characteristics of liquid waste has a high pH, high temperature, low DO, high BOD and COD, high dissolved solids content, a little smell and brownish red color (Anonim, 1986, 1991 and 2005).

Wastewater is alkaline pH of 11 - 12. The process of textiles using alkaline chemicals, such as caustic soda is used in the process, cleaning, bleaching and strengthening the fabric by using the compound:

1.1 Adsorption

Adsorption is the attachment of chemical substances or molecules in the surface between the two forms of the substance. The adsorbed materials are called adsorbant and adsorbent materials which adsorbs called. In general, the adsorption is used as a final treatment process for the deposition of colloids in low concentrations or in the process of physics - chemistry, the last use of adsorption as the main technique for lifting solution - organic solvent in the liquid waste. In the water treatment process, adsorbent is used to remove organic dirt particles that cannot be described, smell, taste and color (Soundstrom and Klei, 1979).

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Adsorption process design criteria according to Reynolds (1982) is as follows:

1. The contact time = 0-40 minutes (effective 17-20 minutes)
2. The depth of the bath = 0.5 to 10 meters
3. Water discharge ≤ 38 liters / min
4. The diameter of the flow of ≥ 2.5 cm
5. Efficiency tool = 90%
6. The grain diameter = 0.1 to 0.5 mm

1.2 Understanding Ozone Gas

Ozone is a triatomic allotrope of oxygen gas. Oxygen can be formed by the recombination of oxygen atoms. Ozone is a gas that is nearly colorless with a distinctive odor that can be detected by the olfactory senses (Anonymous, CCOHS, 1999).

Ozone before or after reacting with other elements will produce oxygen (O_2) so the technology is environmentally friendly ozone or ozone is often said to be the future of green chemistry.

Ozone gas (O_3) can serve as cleaning, deodorizing as well as a disinfectant that can kill all microorganisms such as Escherichia coli, Salomonella, viruses, fungi, and other pathogenic bacteria (Anonymous, 2005). Ozone is a powerful oxidizing materials both after fluorine and chlorine when compared to the power of ozone as a disinfectant power can reach 3250 times faster and 50% more powerful than the oxidative force (K. Patel, 2006).

Ozon is now still be used for the sterilization of water, air, and preserve raw materials of food such as meat, fish also in vegetables and fruits by inhibiting the development of the fungus so that these materials can be durable and safe for consumption (Basuki, KT, 2007).

Extension of the scope of ozone use does not depend on the nature of ozone which is known to have reactive properties (easily react with surrounding compounds) as well as having the oxidation potential of 2.07 V. Ozone oxidation ability can decipher various toxic organic compounds contained in wastewater such as benzene, atrazine, dioxins and various organic dyes (Anonymous, 2005).

On the other hand, ozone is also a dangerous toxic gas. Ozone is a substance which reacts readily with the surrounding molecules. Ozone in the air in a concentration of about 1 ppm (part per million) can lead to difficulty breathing person. At contents above 50 ppm it can cause death. For the concentrations of 1.00 ppm was considered harmless origin is not inhaled in 10 minutes. While the ozone generator tool below, ozone is generated by 0.2 mg/dt so it is safer to use (Basuki, KT, 2007).

1.3 Ozone Generator (Ozonizer)

Ozonizer as shown in Figure 2. Using the external voltage is high voltage AC. Charged in the silent discharge ozonizer electrode tube so that there is a gap discharge i.e. in the area between the dielectric layer with electrode discharge will occur that are micro-electrical discharge as a whole can be translated to mean quantity (Kogelsschatz, 2006). In this case the ozone-making technology used is the dielectric hindered discharge plasma method (Kogelsschatz, 1999) or because the discharge is barely audible then this method is often said silent discharge plasma method. To support the improvement of the application, with this method it will be designed for the ozonizer with a power output of 100 watts. Silent discharge technological advantages compared to UV light technology is the efficiency of ozone generated is greater (Widdi, et al, 2007).

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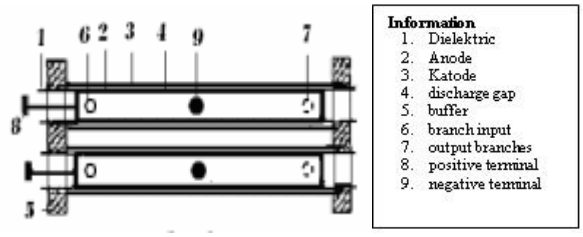

Figure 1 Ozonizer Tube (Source: Widdi, et al, 2007)

The rate of ozone production can be determined by using the absorbance on the basis of the nature of ozone which is capable in absorbing radiation. Comparison between the transmitted radiation power (P) of the initial radiation (P0) is called transmiation (T) which can be formulated:
Transmiation (Widdi, et al, 2007)

$$T = P / P0 \quad (1)$$

2. METHODOLOGY/ EXPERIMENTAL

2.1. Research Sites

The research location is housed in the College of Environmental Engineering Laboratory Yogyakarta and also in the Chemistry and Technology of Materials Process at PSTA BATAN Yogyakarta.

2.2. Research Object

Object of this research is the textile industry wastewater PT. Pekalongan, Co. Central Java, which comes from the collection basin after the production process. With the initial concentration of TSS = 1502 mg / L, pH = 12, and color = 92 Pt-Co.

2.3. Method of collecting data

a. Primary data, i.e. data obtained directly in the field observations and laboratory data. This data is used to determine the concentration of TSS, pH and color of waste PT. Pekalongan. Co before and after the process of Ozonization.

b. Secondary Data, which is collecting data from agencies or departments associated with the source. The data is in the form of maps and other information.

2.4. Research variable

a. The Variables of this research are:

1. Dolomite levels: 0.1% - 1% of the weight of the waste types, with variations (distribution) of 0.1%, 0.2%, 0.4%, 0.6%, 0.8%, 1%
2. Levels of Activated Carbon: 0.1% - 1% of the weight of the waste types, with variations (distribution) of 0.1%, 0.2%, 0.4%, 0.6%, 0.8%, 1%
3. Ozonisasi time: 5 minutes, 10 minutes, 15 minutes, 20 minutes, 40 minutes, 60 minutes.

b. The dependent variable is: Parameter TSS, color and pH

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2.5 Research Materials

a. Ozonization Process
   1. dolomite
   2. activated Carbon

b. Analysis of pH
   1. Distilled water
   2. 4,004 pH buffer solution
   3. 7.415 pH buffer solution
   4. 9.183 pH buffer solution

2.6. Analysis of Color

a. The mother liquor color scale of 500 mg / l PtCo
b. Standard solution with a color scale 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, and 70
c. Distilled water

2.7. The research process

a. An example taken from the wastewater treatment plant of PT. Pekalongan. Co, the unit Gatherer.

b. Samples were taken by using 10 pieces of 25 liters black jerrycan
c. Measure the volume of waste that will be used in the process of ozonization.
d. Determine the levels of dolomite (0.1% -1%) or activated carbon (0.1% -1%) to be mixed.
e. Set up the Ozone Generator (Ozonnizer).
f. Examination of wastewater before and after treatment.

2.8. Process Ozonization

a. Prepare an example that will be in the Ozone with a volume of 500 ml.
b. Add Dolomite or Activated Carbon with tela amounts before calculated.
c. Put sample in a tube Ozonization.
d. Turn ozonizer, input hose into the tube, the length of time Ozonzation in accordance with the specified time.
e. Analyze of the data in accordance with the parameters studied

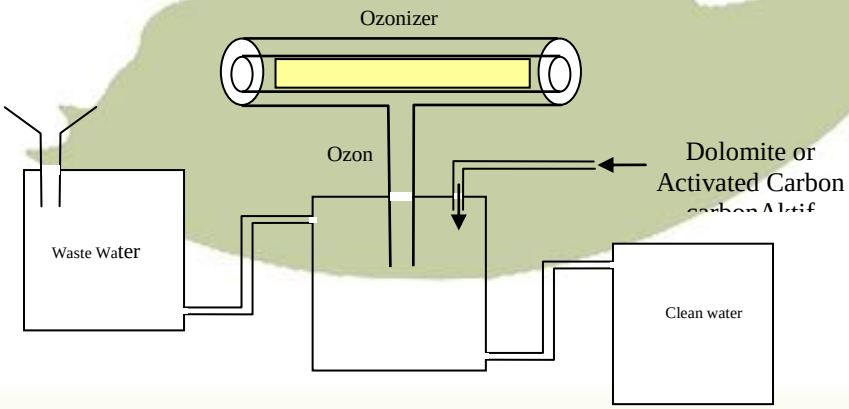

Figure 2 The working principle research

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3. RESULTS

3.1 Ozonization without Additional Adsorben

Table 1 Results TSS, pH and color Analysis on Waste Materials at PT. Pekalongan.Co

TSS (mg/lt)	pH	Color (Pt-Co)
1502	12	92

Source: Results of Laboratory STTL "YLH" / primary data, 2013

Table 2 Results of Analysis Ozonization for 5-60 minutes without addition to the 3x Repetition, initial concentration of TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

No	Ozonation time	pH	TSS Analysis			Color Analysis		
			I	II	III	I	II	III
1	5 Minutes	10	487,60	461,00	487,40	44,22	43,35	46,39
2	10 Minutes	10	413,60	460,40	475,00	41,83	42,70	44,65
3	15 Minutes	10	366,20	427,40	400,40	40,50	42,05	43,13
4	20 Minutes	10	363,40	423,00	387,00	40,31	41,39	42,26
5	40 Minutes	10	318,20	422,00	352,40	40,13	40,96	41,39
6	60 Minutes	10	310,00	421,20	332,00	40,09	40,74	40,74

Source: Results of STTL "YLH" Laboratory / primary data, 2013

Table 3 Results The mean and Efficiency Ozonization without additions, the initial concentration of TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

Time Ozonation (minute)	pH	TSS (mg/lt)	Eff (%) TSS	Color (Pt-Co)	Eff (%) Color
5 minutes	10	478,60	68,12	44,65	51,45
10 minutes	10	449,53	70,05	43,06	53,19
15 minutes	10	398,00	73,49	41,89	54,45
20 minutes	10	391,13	73,95	41,32	55,08
40 minutes	10	364,20	75,74	40,82	55,60
60 minutes	10	354,40	76,40	40,52	55,90

Source : Results primary data, 2013

Table 4 Results of Ozoniation Analysis with Dolomite Addition (0.2%) with 3 X repetition, the initial concentration of TSS = 1502 mg/L, pH = 12, color = 92 Pt-Co

Ozonation Time	Dolomite (0,2%)	pH	TSS Analysis			Color Analysis		
			I	II	III	I	II	III
5 Minutes	1 gr	9,92	317,40	333,20	298,00	43,50	44,00	43,50
10 Minutes	1 gr	9,92	300,00	307,40	276,00	43,10	43,00	42,50
15 Minutes	1 gr	9,92	250,00	298,00	253,00	42,50	42,20	42,00
20 Minutes	1 gr	9,92	232,00	268,40	230,00	41,60	42,00	41,80
40 Minutes	1 gr	9,92	220,40	250,00	219,40	41,40	41,39	40,90
60 Minutes	1 gr	9,92	201,00	233,00	211,00	41,20	40,50	40,30

Source : Result taken from Laboratory of BATAN Yogakarta, primary data 2013

From the data above, we can look mean and efficiency for TSS, pH and color as presented below:

Table 5 Results of the Mean and Efficiency of Ozonization with Addition Dolomite (0.2%), the initial concentration TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

Ozonization Time	Addition Dolo-mite (0,2%)	pH	TSS (mg/L)	Eff TSS %	Color (Pt-Co)	Eff Color
5 minutes	1 gr	9,92	316,20	78,94	43,60	52,60
10 minutes	1 gr	9,92	294,40	80,39	42,80	53,40
15 minutes	1 gr	9,92	267,00	82,22	42,20	54,00
20 minutes	1 gr	9,92	243,46	83,79	41,80	54,50
40 minutes	1 gr	9,92	229,93	84,69	41,20	55,18
60 minutes	1 gr	9,92	215,00	85,68	40,60	55,79

Source : Result from Laboratory of BATAN Yogakarta, primary data 2013

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Table 6 Results of Analysis Ozonizayion with addition of activated carbon (0.2%) with 3X repetition, initial concentration of TSS = 1502 mg / L, pH = 12, color = 92

Ozonisasi Time	Activated Carbon (0,2%)	pH	TSS Analysis			Color Analysis (Pt-Co)		
			I	II	III	I	II	III
5 Minutes	1 gr	9,90	455,80	440,00	438,40	45,50	44,70	46,00
10 Minutes	1 gr	9,90	435,00	420,00	427,00	45,10	44,00	45,60
15 Minutes	1 gr	9,90	395,00	401,40	380,00	44,80	43,50	45,00
20 Minutes	1 gr	9,90	341,20	367,00	366,00	44,00	42,70	44,00
40 Minutes	1 gr	9,90	217,00	262,00	240,00	42,90	42,00	43,10
60 Minutes	1 gr	9,90	180,00	207,00	198,00	42,00	41,20	41,20

Source : Result form of Laboratory BATAN Yogakarta, primary data 2013

From the data above, it can look mean and efficiency for TSS, pH and color as presented below:

Table 7 Results the Mean and Efficiency of Ozonization with addition of activated carbon (0.2%), concentration initial TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

Ozonization Time	Adition Activated Carbon (0,2%)	pH	TSS (mg/L)	Eff (%) TSS	Color (Pt-Co)	Eff (%) Color
5 minutes	1 gr	9,90	444,70	70,39	45,40	50,60
10 minutes	1 gr	9,90	427,30	71,50	44,87	51,20
15 minutes	1 gr	9,90	392,13	73,90	44,40	51,70
20 minutes	1 gr	9,90	358,06	76,00	43,57	52,70
40 minutes	1 gr	9,90	239,60	84,00	42,67	53,60
60 minutes	1 gr	9,90	195,00	87,00	41,60	54,78

Source: Primary data, 2013

3.2 The addition of Dolomite with a time of 60 minutes

Table 8 Results of Analysis Ozonization with a time of 60 minutes and the addition of dolomite (0.1% - 1%) with 3X repetition, the initial concentration of TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

Ozonization Time	Dolomite (gr)	pH	TSS Analysis			Color Analysis		
			I	II	III	I	II	III
60 Minutes	0,5 gr	9,92	220,00	241,00	226,00	41,00	40,00	40,00
60 Minutes	1 gr	9,92	201,00	233,00	211,00	41,20	40,50	40,30
60 Minutes	2 gr	9,69	185,00	172,00	170,00	43,50	42,30	43,00
60 Minutes	3 gr	9,69	162,00	158,00	167,00	44,60	43,40	44,00
60 Minutes	4 gr	9,86	151,00	151,00	145,00	46,00	45,10	45,30
60 Minutes	5 gr	9,77	140,00	147,00	138,00	46,80	46,00	46,00

Source: Primary data, 2013

4. DISCUSSION

Table 1. Result the data generated from this study is that the reduction in TSS concentration, pH and color in content with the old waste after ozonization time of 5-60 minutes without addition of adsorbent. Here is a table that presents the concentration of pollutants in raw sewage and ozonization proceeds without the addition.

Table 2. Results of Analysis Ozonization for 5-60 minutes without addition to the 3x Repetition, initial concentration of TSS = 1502 mg / L, pH = 12, color = 92 Pt-Co

From the data in the tables above may be prepared table analysis results mean for TSS, pH and color with ozonization time for 60 minutes and the rate of speed of ozone 0.2 mg/sec.

From the data in Table 3 above it shows that the longer the time ozonization (60 minutes) then there is a decrease in TSS concentration, pH and color. TSS concentration early in the raw sewage of 1502 mg/L after ozonization for 60 minutes fell to 354.40 mg/L, efficiency of 76.40%, the pH of the raw waste is 12 after ozonization for 60 minutes down to 10. The concentration of the color of raw sewage by 92 Pt-Co after ozonization for 60 minutes fell to 40.52 Pt-Co, the efficiency of 55.90%.

Research for Finding The Optimum Time of Ozonization

The study aims to find the optimum time of ozonization is lower than the concentration of TSS, pH and color of textile wastewater by using adsorbent which Dolomite and Activated Carbon.

Using Addition Dolomite (0.1% -1%)

In this study, authors prefer the Dolomite i.e. 0.2% of the weight of the waste. This is done based on the research plan is choosing the weight adsorbent of 0.1% -1% of the weight of the waste. Here is a table that presents the data analysis results of research:

From Table 4 we have been time of ozonization and using addition of dolomite.

From the table 5 it appears that the concentration of TSS, pH and color decreased after experiencing ozonization and the addition of dolomite 0.2% of the weight of the waste. TSS concentrations decreased on ozonization for 60 minutes with the addition of dolomite 0.2% from the initial waste 1502 mg/L drop to 215.00 mg/L or down to 85.68%. The initial pH of waste from 12 down to 9.92. Color concentration also decreased from 92 Pt-Co at the beginning of the waste, after a 60-minute ozonization and the addition of dolomite 0.2% drop to 40.60 Pt-Co, down 55.79%.

Using Addition Activated Carbon (0.2%)

In this study, authors choose Activated Carbon 0.2% weight by weight of waste. It is based on the research plan in the previous chapter. The following will be presented table analysis results of research.

Table 6. Results of Analysis Ozonizayion with addition of activated carbon (0.2%) with 3X repetition, initial concentration of TSS = 1502 mg / L, pH = 12, color = 92.

From the table 7, it appears that the concentration of TSS, pH and color decreased, as is evident from its initial TSS concentration of 1502 mg / l after a 60-minute ozonization and activated carbon addition of 0.2% by weight of waste TSS concentration dropped to 195.00 mg / lt, with efficiency of 87.00%. The initial pH of 12 after 60 minutes of ozonization and activated carbon addition of 0.2% by weight of waste into 9.90. The concentration of the color of 92 Pt-Co at the beginning of waste dropped to 41.60 Pt-Co and efficiency of 54.78%.

Calculation of Ozone

To obtain optimal results in the treatment process required an adequate amount of ozone, and therefore needs the amount of ozone necessary.

From the research data:

- Concentration Ozone = 0.2 mg / sec
- Ozone Power Generator = 100 Watt
- The volume of diozon waste = 500 ml
- Selected ozonization time of 60 minutes, because it is known that at the time of the ozoniztion can make efficiency decrease in TSS and color.

5. CONCLUSION

Based on the results of research and discussion, the authors can draw the following conclusion:

1. Liquid waste in textile industry at PT. Pekalongan. Co can be minimized by using ozone technology.
2. The content of pollutants such as TSS, pH and color will decrease in line with the length of ozonization time, TSS content dropped from 1504 mg/L be 141.60 mg/L or 90.64% in Dolomite addition of 1%, a pH of 12 down to 9.92 on Dolomite addition of 0.1%, the color fell from 92 Pt-Co became 40.30 Pt-Co or 56.10% on a 0.1% increase Dolomite.
3. Calculation of Ozone
   The price of electricity per kWh is IDR. 900, -,
   Ozonization for 30 days is: IDR. 171,072 millions
   .

6. ACKNOWLEDGEMENT

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