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A STUDY TOWARDS THE REALIZATION OF GREEN TECHNOLOGY IN URBAN WATER SUPPLY SECTOR WITH LIFE CYCLE ASSESSMENT (LCA) METHOD AND FAULT TREE ANALYSIS (FTA) METHOD

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ABSTRACT

Water Treatment Plant (WTP) with conventional systems use pumps that work for 24 hours, and chemicals which produce residues or by products in water processing and have an impact on the environment and humans. This study aims to identify the quality and performance of the WTP treatment, Identify the impacts arising from the drinking water treatment process and determine the efforts made to reduce the impacts identified by the method *Life Cycle Assessment* (LCA). The *Life Cycle Assessment* (LCA) method is an assessment method regarding potential environmental impacts and evaluation of the environmental performance of a process to the product. *Life Cycle Assessment* (LCA) consists of four stages, consist of determinations *Goal and Scope*, *Life Cycle Inventory, Life Cycle Impact Assessment,* data interpretation. The software used in SimaPro 9.0.0 with the impact assessment method is CML-IA *Baseline*. The impacts discussed in this research are *Global Warming, Human Toxicity,* and *Eutrophication*. The way to reduce the impact based on literature studies. The results of the analysis found that the quality of raw water has not reach the quality standards as drinking water standards. While the quality of produced water has reach the quality standard. The performance of the processing unit at WTP has not worked well, need improvement with the addition of polymer in clearator, electricity usage in WTP is 11.220.195,47kWh/year. The analysis results using *Life Cycle Assessment* (LCA) method, showed that the highest contribution to environmental impact was *Eutrophication* of 287.644,1 kg PO_4—eq/year followed by *Global Warming* of 23.697.275 kg CO_2eq/year, and *Human Toxicity* of 9.190.241 kg 1,4-DBeq/year. The way to reduce the impact is take pretreatment on raw water, planning and buildsludge treatment, also recycle sludge from clearator unit, replace equipment, replace aluminum sulfate, and liquid chlorine into PAC and hypochlorite salts.

KEY WORDS : CML-IA, Drinking Water, Life Cycle Assessment, Sima Pro 9.0.0, Water Treatment

INTRODUCTION

Some public facilities such as the Waste Water Treatment Plant (WWTP) are categorized as a public facility that produces large amounts of emissions of methane (CH4) and CO2 with large amount of electricity consumption and chemicals (Riyanty and Indarjanto, 2015). The result of research by the method of *Life Cycle Assessment* (LCA) shows that the wastewater treatment process can result in environmental impacts in the form of Global Warming, Non-Renewable Energy, and Aquatic eutrophication comes from treatment processes and supporting tools but not showing a large and significant impact (Rachmani, 2019). Drinking water treatment plants are categorized as public facilities that are responsible for global environmental impacts such as the depletion of natural resources and the release of pollutants into water, soil, and air (Bonton *et al.*, 2012). The environmental impact produced from the reduction process of contaminants that contained inside the raw water treatment process in the drinking water treatment plant (Khan *et al.*, 2013). Drinking Water Treatment Plant (DWTP) in this resarch, utilizes Surabaya River as raw water and the processing unit consists of intake, Pre-Sedimentation, aerator, clearator, filtration, disinfection, and ends at the reservoir. In addition, DWTP uses a pump that works for 24 hours and chemicals, which will produce residues in the processing water. Conventional Drinking Water Treatment Plant produces the total CO_2 emissions from electricity consumption as much as 5.1% of the total emissions, so as to process 200,000 m^3 of raw water requires electricity by 3638 ± 503 kWh per day and the emissions produced by 2031 ± 281 kg CO_2/day (Kyung *et al.*, 2013).

Based on the above, then do the identification of the raw water quality, water production, and processing unit performance as well as the use of electricity so it can look for the impact that will result from conventional drinking water treatment. The analysis can be done through methods of *Life Cycle Assessment* (LCA), using SimaPro software 9.0.0, which can be used to help determine the basis for environmental improvement.

METHODS

Secondary data used were obtained from DWTP which consisted of raw water quality and production water with parameters (pH, TDS, TSS, BOD, COD, N, P, turbidity, residual chlorine, and total coliform), chemical consumption data, consumption of electrical energy and pumps generated from the processing unit's process performance, and emission data.The secondary data obtained will be processed according to the mass balance theory and analyzed using the SimaPro 9.0.0 application to analyze the life cycle or *Life Cycle Assessment* (LCA). This stage begins with determining the objectives and scope (*Goal and Scope*) with the scope of using the Ecoinvent System Process. The second and third stage is to conduct the inventory (*Life Cycle Inventory*) and conduct an assessment of the contamination (*Life Cycle Impact Assessment*). The impact assessment selection process in this study is based on the largest possible environmental impact resulting from drinking water treatment and the method used is the CML-IA *baseline*. The last stage is data interpretation, which is to evaluate and review a conclusion. The output in the form of the impact produced in kilograms of the product then identified how to reduce the impact through a literature review.

RESULTS AND DISCUSSION

Analysis the Quality of Raw Water and Production Water

DWTP uses raw water from Surabaya River according to its allotment. The quality standard for drinking water is PP No. 82 Of 2001 which quality standards are grouped into four classes, for use as drinking water Quality Standards required is class I, but for drinking water for this DWTP using Quality Standard Class II.

The results of the analysis in Table 1 (a) and (b) show that the TDS, pH, and N parameters accordance with the quality standards of PP No. 82 Of 2001 for class I and II, while the othersnot accordance with the standard. Before the treatment process, raw water flows into the intake through the canal by gravity. According to the design DWTP, detention time is 2.8 hours. TSS, BOD, and COD removal in the intake canal (Metcalf and Eddy, 2014) based on equation (1) is 59.9%, 37.8%, and 37.8%. According to Metcalf *et al.* (2014), COD removal in the primary treatment unit is 30% -40%. Meanwhile, Qasim and Zhu (2018), said that removal for N and P in the primary treatment removal is both 10% - 20%. Removal of N and P in this research is 10%.

$$R = \frac{t}{a + bt}$$

Where, R = Removal Efficiency .. (1)
t = Time Detention
a,b = The Emphirical Constatnt

Therefore with only the fulfillment of the parameters pH, TDS, and N only, does not guarantee that the water can be used directly. Water from the surface water needs to be treated properly in any process until appropriate with the standard quality.

In Table 2 (a) and (b), the results of the analysis of the quality of water produced by DWTP show that all parameters accordance to the quality standards of the Minister of Health Regulation No. 492 Year 2010 concerning Drinking Water Quality Requirements.

Table 1. (a) dan (b) HasilAnalisis Air Baku padaLaboratoriumDWTP

(a)

	TDS (mg/L)	Total Koliform Air Baku (MPN/100 ml)			pH Air Baku			BOD Air Baku (mg/L)			TSS Air Baku (mg/L)		
		Min	rata-rata	max	min	rata-rata	max	min	rata-rata	max	min	rata-rata	max
Januari	306	24000	422600	1100000	7,06	6,88	7,33	16	17	18	8,00	153,84	668,00
Februari	239	43000	277200	1100000	7,31	7,08	7,60	11	12	13	73,5	189,35	491,00
Maret	234	93000	349200	1100000	6,71	7,06	7,66	11	13	14	88,0	322,67	804,00
April	223	43000	416000	1100000	7,33	7,12	7,60	12	13	14	72,0	228,40	664,00
Mei	282	43000	1240600	4600000	7,26	7,15	7,60	12	14	15	32,0	132,91	484,00
Juni	300	15000	284000	1100000	7,46	7,06	7,64	13	15	16	20,0	99,25	484,00
Juli	292	4300	199717	1100000	7,16	7,13	7,69	11	13	16	12,0	14,67	24,00
Agustus	332	4600	24120	46000	7,28	7,24	7,81	12	11	15	12,0	15,39	34,00
September	324	3300	60383	280000	7,73	7,43	7,91	11	13	14	4,00	13,20	28,00
Oktober	356	17000	114200	280000	7,68	7,52	7,99	12	11	15	8,00	10,83	16,00
November	320	11000	23500	39000	7,29	7,32	7,97	15	13	17	12,0	17,82	28,00
Desember	320	11000	23200	39000	7,29	7,73	7,97	15	13	17	12,0	19,09	28,00
Range	**223-356**		**3300-4600000**			**6.71-7.99**			**8-18**			**4-804**	

(b)

	Kekeruhan Air Baku (NTU)			N			P			COD		
	min	rata-rata	max	min	rata-rata	max	min	rata-rata	max	min	rata-rata	max
Januari	27,00	132,39	370,00	0,50	0,83	1,47	0,04	0,13	0,26	40,06	46,33	51,58
Februari	219,14	219,14	453,00	0,42	0,96	1,47	0,05	0,16	0,50	36,44	43,94	47,97
Maret	196,39	196,39	497,00	0,49	0,76	1,22	0,08	0,13	0,24	27,83	39,12	44,64
April	146,30	146,30	379,00	0,25	0,94	1,58	0,03	0,14	0,32	37,00	39,86	42,69
Mei	68,03	68,03	327,00	1,22	1,86	3,58	0,05	0,16	0,28	30,58	41,61	51,17
Juni	13,00	20,67	36,00	0,67	1,09	1,63	0,08	0,19	0,36	41,31	49,73	59,36
Juli	14,26	14,26	19,00	0,64	1,09	1,45	0,06	0,20	0,44	22,42	35,78	42,42
Agustus	13,45	13,45	16,00	0,60	0,93	1,36	0,10	0,27	0,35	37,14	40,68	44,64
September	13,03	13,03	18,00	0,46	0,65	0,74	0,13	0,28	0,36	33,25	37,07	39,64
Oktober	10,39	10,39	13,00	0,65	0,71	0,76	0,18	0,34	0,50	25,47	26,31	28,11
November	8,47	8,47	15,00	0,53	0,68	0,83	0,22	0,34	0,53	40,19	41,93	44,64
Desember	44,03	44,03	307,00	0,53	0,69	0,83	0,22	0,32	0,53	40,19	41,93	44,64
Range		**8.47-497**			**0,25-3,58**			**0.03-0.53**			**22.42-59.36**	

Table 2. (a) and (b) Analysis Result of Water Production in DWTP Laboratory

(b)

	TDS (mg/L)			Total Koliform (MPN/ 100ml)	pH			sisa chlor (mg/L Cl2)			Kekeruhan Efluen Prasedimentasi (NTU)		
	min	rata	max		min	rata-rata	max	min	rata-rata	max	min	rata-rata	max
Januari	127	119,2	173	0	6,74	6,79	7,37	0,2	0,42	0,8	20,0	50,81	83,0
Februari	161	211,5	368	0	7,19	5,74	7,52	0,3	0,43	0,6	36,0	53,86	76,0
Maret	244	215,2	304	0	6,76	6,88	7,41	0,3	0,45	0,6	31,0	62,29	107,0
April	204	216	328	0	7,19	6,95	7,48	0,3	0,41	0,5	30,0	57,40	109,0
Mei	243	231	323	0	7,14	7,00	7,52	0,3	0,37	0,5	14,0	36,32	114,0
Juni	299	229,75	314	0	7,26	6,93	7,58	0,1	0,25	0,5	11,0	16,00	24,0
Juli	272	244,67	320	0	7,09	7,01	7,59	0,0	0,14	0,3	8,0	10,94	14,0
Agustus	328	267,2	344	0	7,11	7,02	7,65	0,1	0,19	0,4	9,0	13,45	13,0
September	296	269,33	340	0	7,00	7,22	7,77	0,1	0,15	0,2	7,0	13,03	13,0
Oktober	296	258,4	348	0	7,41	7,37	7,85	0,1	0,29	0,5	7,0	8,81	11,0
November	324	274	340	0	7,38	7,21	7,80	0,4	0,49	0,6	6,0	7,37	13,0
Desember	324	264	340	0	7,38	7,21	7,80	0,5	0,54	0,7	6,0	22,10	82,0
Range		127-368		0		6.74-7.80			0.1-0.8			6-114	

	Kekeruhan Efluen Clearator (NTU)			Kekeruhan Air Produksi (NTU)		
	min	rata-rata	max	min	rata-rata	max
Januari	4,1	4,22	4,3	1,2	1,30	1,5
Februari	4,1	4,17	4,3	1,1	1,24	1,4
Maret	4,0	4,17	4,3	1,1	1,25	1,4
April	4,0	4,15	4,3	1,1	1,25	1,4
Mei	3,8	4,01	4,4	1,1	1,24	1,4
Juni	3,8	3,90	4,0	1,1	1,22	1,4
Juli	3,8	3,85	3,9	1,1	1,20	1,4
Agustus	3,7	3,76	3,8	1,1	1,21	1,5
September	3,3	3,42	3,7	1,1	1,20	1,3
Oktober	3,3	3,36	3,4	0,1	1,16	1,9
November	2,7	3,22	3,4	0,1	1,19	1,9
Desember	2,8	3,38	3,9	1,2	1,25	1,4
Range		**2.7-4.4**			**0.1-1.90**	

(b)

Performance Analysis of Installations, Pumps and Electrical Energy Consumption

The approach used is based on literature because there are data limitations with the assumption that the processing load on raw water still contains parameters TSS, BOD, COD, N and P.

Pre-Sedimentation

Removal of TSS, BOD, and COD in pre-sedimentation according to equation (1) is 61.5%, 39.3%, 39.3%. Comparison of DWTP design with design criteria can be seen in Table 3.

Table 3. Comparison of DWTP Design with Design Criteria

Aspek	Satuan	Kriteria Desain	Desain DWTP
Waktu Retensi	Jam	1,5-2,5	3,3
Kedalaman	Meter	3-4,9	2,4
Panjang	Meter	15-90	106
Lebar	Meter	3-24	10,7
Removal BOD	%	30-35	39,3
Removal TSS	%	60-65	61,5

The pre-sedimentation effluent ranges from 6 - 82 NTU so that% removal of turbidity in the pre-sedimentation is 60.25%. N and P removal is 20% (Qasim and Zhu, 2018).

Aerator

The velocity gradient is 771 / second, while the DWTP design has a gradient speed of 1000 / second (meeting the design criteria, namely between 100-1000 / second) (Kawamura, 1991). The turbidity removal efficiency of the aerator is 89% (Suaidy, 2010). The high turbidity removal indicates that the aerator is performing well.

Clearator

Turbidity removal was 87% (based on influent and effluent laboratory data). TSS, BOD, and COD removal on the clearator were 45.3%, 25.4% and 25.4% (Metcalf and Eddy, 2014). Removal of N is between 30-60% (Suchowska-gratingelewicz *et al.,* 2018). P removal efficiency in this modified unit is 76% (Ismail *et al.,* 2012). The removal efficiency of the flocculation and sedimentation modification unit for TSS and BOD is 70-90% and 50-85% (Subramani, 2012). Then the addition of Polyacrylamide which makes the floc bigger and settles faster.

Filtration

The backwash discharge is the same as the pump discharge, which is 200 L/second with a duration of 7 minutes for each unit. The blower filter has a discharge of 15 m^3/ min. Removal of TSS, BOD and COD for filtration with anthracite media is 60%, 50% and 50% (Ramadhani, 2017). In this study, it is assumed that COD removal is the same as BOD removal and due to data limitations. Removal of N and P were 37.27% and 30.37% (Purnama, 2012).

Reservoir

DWTP has a standard for residual chlorine, which is a maximum of 0.5 mg / L. The total distribution pumps in DWTP are 15 which are divided based on the number of reservoirs. The use of processing electricity comes from the pumps and blowers that are used during the production process. The amount of electricity used by DWTP in 2019 is 11,220,195.47 kWh / year.

Based on the description above, it can be concluded that the performance of the DWTP unit in processing raw water into drinking water is in good condition if it is based on the design criteria and literature approach. But the clearator unit has not yet fulfilled it, so a chemical in the form of Polyacrylamide is added to increase the removal efficiency. So it can be said that the performance of the DWTP processing unit has not been good and requires increased efficiency.

Emission Load Analysis

The process of drinking water treatment can emit greenhouse gases, both from processing, use of supporting equipment and use of chemicals (Kyung *et al.,* 2013). The calculation of CO_2 emissions resulting from the process uses the approach of kg CH4 / kg BOD and kg CH_4/kg COD which will later be converted into units of greenhouse gases, namely kg CO2eq, where the ratio of CO_2 and CH_4 is 1:23. The emission factor used is the IPCC default (2006) in wastewater treatment, namely 0.48 kg CH_4 / kg BOD and 0.25 kg CH_4/kg COD (Michiel *et al.,* 2006). The weakness of this calculation method is that it does not take into account the conditions. environment in the processing unit, so the need for direct measurements in the field (Nuraeni and Ashuri, 2018). The calculation of emissions is based on equation (2) below (Sagala, 2012):

Emission Load (E) = Emission factor (EF)×Activity Data (amount of materials that produce emission

Life Cycle Inventory (LCI)

In the LCI or *Life Cycle Inventory* (LCI) stage is the process of inputting data on raw materials, chemicals, and electricity use as well as emissions resulting from the production process. Mass Balance or mass balance will be arranged at this stage. The processing load used was TSS, BOD, COD, N and P. The TSS value used was a maximum value of 804 mg/l. While the BOD value used was 18 mg/l based on DWTP laboratory data, the maximum BOD value during 2019. The COD value used was 59.36 mg /l. N and P are 3.58 mg /l and 0.53 mg /l, respectively. This value is then converted into mass units so that the TSS value becomes 49,616,270.32 kg / year, the influent BOD in raw water is 1,110,812.02 kg / year. The COD value in raw water is 3,663,211.20 kg / year. The N and P values for raw water were 220,863.21 kg / year and 32,548.70 kg / year.

Life Cycle Impact Assessment (LCIA)

After carrying out the *Life Cycle Inventory* (LCI) stage, the next stage is the *Life Cycle Impact Assessment* (LCIA) which is an impact assessment stage based on inventory. The method used in the impact magnitude assessment is the CML-IA baseline. The impact assessment at this stage is to compare the results of the *Life Cycle Inventory* (LCI) with each category. However, this study focused on three categories of impact assessment, namely Global Warming (GWP 100a), Human Toxicity, Eutrophication.

Characterization Analysis

This stage aims to determine and compare the results of the *Life Cycle Inventory* (LCI) data input in each category.

Figure 1 shows a diagram of the impact contribution generated from each processing unit in

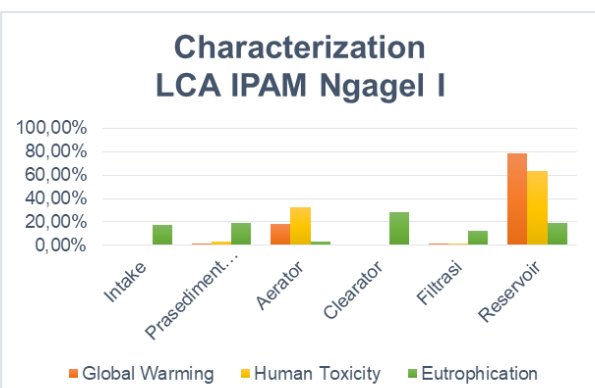

Figure 1. Diagram of Impact Contributions

DWTP with the overall Impact Assessment results can be seen in Table 5.

Normalization Analysis (Normalization)

This stage is the stage to facilitate comparison between Impact Categories by multiplying the Characterization results and the normalization factors. The output from this stage is that all Impact Categories use the same unit or units so that they can be compared.

Figure 2 shows the contribution of the impact per processing unit while the results of normalization can be seen in Table 4.6 which shows that the greatest environmental impact as a whole comes from the Eutrophication impact category of 2.18 x 10-5.

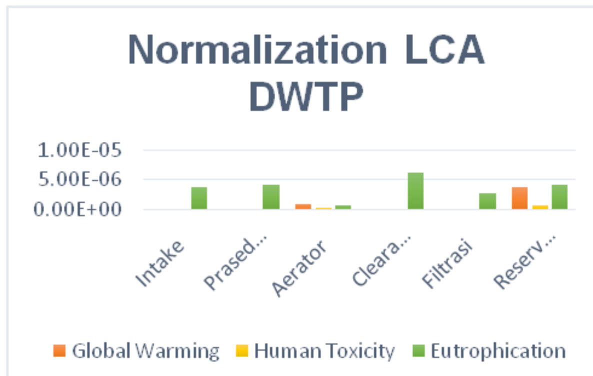

Fig. 2. Impact Contribution Normalization Diagram per Processing Unit

Process Hotspot Analysis and Impact Hotspot

The process hotspot is the point that has the greatest impact on the process system. Table 6 shows the hotspots of the processing at DWTP, namely the Reservoir unit of 8.57 x 10-6. The order of the largest impact contribution to the DWTP drinking water treatment process is the reservoir unit (8.57 x 10-6), the clearator unit (6.26 x 10-6), the pre-sedimentation unit (4.27 x 10-6), intake (3.77 x 10-6), filtration unit (2.83 x 10-6), and aerator unit (2.01 x 10-6). The impact hotspot is the point that has the greatest impact in this study, which is Eutrophication.

Data validation was carried out by using Sensivity Check, which is a systematic process to check whether the final results and conclusions are affected by the uncertainty of the data and the selected evaluation method. Variations are carried out by increasing and decreasing the processing load, chemicals used, energy, and emissions by 25%

which refers to SNI ISO 14044 (2017).

In Table 7 it is known that by doing variations there is a change in value, so it can be said that the data used in this study is sensitive to change. As for the significance analysis, the deviation value is sought for each data variation. The results of deviation data for all impact categories can be seen in Table 8.

Based on Tables 7 and 8, the results of the sensitivity check in this study are ± 0 or 0%. Based on SNI ISO 14044 (2017), because the deviation calculation results are below 10%, it can be concluded that the data processed in SimaPro is sensitive but not significant.

Impact Reduction Efforts

Global Warming

Based on the results of the analysis, that the second biggest impact resulting from the DWTP water treatment process is Global Warming due to CO2 gas produced from greenhouse gases which has a major contribution to fuel combustion for electricity supply. This impact comes from pumps running for 24 hours and emissions from the use of chemicals. An alternative that can be done to reduce the impact

Table 4. Emission Factors

	FaktorEmisi	Sumber
Konsumsilistrik	0,725 kgCO_2/kWh	FaktoremisiketenagalistrikanJamali (Jawa-Madura-Bali) oleh PLN
Aluminium Sulfat	0,395 kg $CO_{2\text{-eq}}$ / kg Aluminum Sulfat	Kyung, 2013
Polyacrylamide	1,5 kg CO_2e/kg Polyacrylamide	(Chai, 2015)
Klorcair	1,08 kg CO_2e/kg klorcair	Winnipe.ca
BOD	0,48 kg CH_4/kg BOD	IPCC, 2006
COD	0,25 kgCH_4/kg COD	IPCC, 2006

Table 5. Results of Impact Assessment (*Characterization*) per Treatment Process

	Global Warming (kg CO2 eq)	Human Toxicity (kg 1,4-DB eq)	Eutrophication (kg PO4— eq)
Intake	23.814	0.00	49.699,42
Prasedimentasi	333.774,6	280.161,04	54.955,61
Aerator	4.343.514,18	2.970.449,46	10.055,84
Clearator	55.519,9	15.334,10	82.408,54
Filtrasi	375.701,9	115.123,80	36.095,90
Reservoir	18.564.950,4	5.809.173	54.428,77
TOTAL	23.697.275	9.190.241	287.644,1

Table 6. Impact Normalization Result of Treatment Process DWTP

	Global Warming (kg CO_2 eq)	Human Toxicity (kg 1,4-DB eq)	Eutrophication (kg PO4- eq)	Total
Intake	4.74E-09	0.00E+00	3.77E-06	3.77E-06
Prasedimentasi	6.64E-08	3.61E-08	4.17E-06	4.27E-06
Aerator	8.64E-07	3.83E-07	7.62E-07	2.01E-06
Clearator	1.10E-08	1.98E-09	6.25E-06	6.26E-06
Filtrasi	7.48E-08	1.49E-08	2.74E-06	2.83E-06
Reservoir	3.69E-06	7.49E-07	4.13E-06	8.57E-06
Total	4.72E-06	1.19E-06	2.18E-05	

Table 7. Impact Assessment Results

Kategori Dampak	-25%	Normal	+25%
Global Warming	13.958.372	18.564.950	23.240.846,1
Human Toxicity	4.356.880	5.809.173	7.261.466,3
Eutrophication	40.821,57	54.428,77	68.035,96

of Global Warming due to high emissions of electricity is to make equipment efficiency by replacing equipment with new equipment which can save energy by 22% (Saygin *et al.,* 2011). The impact of CO2 emissions due to the use of aluminum sulfate chemicals is to replace it with PAC (Poly Aluminum Chloride) which is a coagulant which requires 15-20 times lower doses and has a large removal efficiency of suspended solids with less sludge production (Kung *et al.,* 2013).

Table 8. Deviation data per Impact Category

KategoriDampak	Deviasi	% Deviasi
Global Warming	±0,00	0%
Human Toxicity	±0,00	0%
Eutrophication	±0,00	0%

Human Toxicity

In this study Human Toxicity comes from the use of chemicals. Efforts to reduce this impact are by substituting chemical substances. In this type of disinfectant, the disinfectant of the Hypochlorite salt type in liquid form does not cause toxicity effects on humans (Utami, 2019). Chlorine in the form of salt is safest to use as a disinfectant (Hasan, 2006). Meanwhile, a coagulant substitute is PAC (Poly Aluminum Chloride) which produces a denser floc with a high settling rate in a large fluctuation of processing range.

Eutrophication

DWTP's drinking water treatment process contributes to the eutrophication impact that comes from the use of chemicals and processing costs in the form of sludge and contributes to emissions to the environment. This processing sludge in DWTP is discharged directly into the river, without any treatment.To reduce the impact of eutrophication, it can be done by adding a sludge treatment unit which aims to remove water content from the sludge. and adding pretreatment to raw water, so that the raw water has a level that is in accordance with the class I and II quality standards in PP. 82 of 2001. Another effort can be made by recovering sludge from the coagulation-flocculation process through the sludge recirculation process. This can reduce the use of coagulants by 60% of the dose (Halifrain and Karnaningroem, 2012).

CONCLUSION

The conclusion of this study is:
The quality of DWTP raw water not accordance with (PP No. 82 of 2001), the production water accordance with (Regulation of the Minister of Health No. 492 of 2010) for parameters TSS, TDS, pH, Turbidity, Total Coliform, BOD, COD, N, and P, DWTP's performance is not good. Consequently, it is necessary to add polymers to the clearator unit to increase removal efficiency. The amount of electrical energy used by DWTP is 11,220,195.47 kWh / year. The biggest environmental impact using the *Life Cycle Assessment* (LCA) approach is Eutrophication of 287,644.1 kg PO4 - eq / year and followed by Global Warming of 23,697,275 kg CO2eq / year, Human Toxicity of 9,190,241 kg 1.4 -DBeq / year. There are several ways that can be used to reduce the resulting environmental impact, namely pretreatment of raw water, planning sludge treatment buildings and reusing sludge clearators, replacing old equipment with new ones, replacing aluminum sulfate and liquid chlorine into PAC and hypochlorite salt.

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