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Combination Filtration - Ultraviolet Unit to Reduce the Organic Content and Pathogens of Domestic Wastewater for Clinical Activities

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Abstract. The rise of clinical activities is one of the health care facilities that have the potential to pollute wastewater on organic compounds and especially pathogenic microorganisms. Technology in reducing organic and pathogenic content using combined ultraviolet filtration in wastewater treatment systems is one the effective method. Filtration uses activated carbon and silica with a variation of the ratio 2:3 and 3:2, while ultraviolet use a power variation of 9 watts and 15 watts. The results obtained are the best composition from the filtration process, which is a ratio of 2: 3 with the ultraviolet process using 15 watts using an exposure time of 5 hours with the remaining total coliform as much as 200 MPN/100mL. The results of this research have complied with the quality standards.

Keywords: Filtration, Ultraviolet, Clinic, Total coliform

1. Introduction

Clinical service facilities in various areas of big cities have begun to grow. However, the treatment of wastewater also needs to consider. The wastewater produced is generally still domestic because it generally comes from the washing process of clinical laboratory equipment. Wastewater comes from the activities of health facilities, including clinics, which have the potential to contain microorganisms and other organic materials and substances [1,3]. Because the source of clean water produced also comes from well water, it has a high potential for pathogenic microorganisms. One way to kill bacteria is by using ultraviolet light [10]. Organic parameters include COD and physical parameters in the form of TSS and microbiological parameters, namely Coli bacteria /Total coliform. The use of

a filtration unit to find out how the composition works are good for reducing organic content. According to [4], activated carbon is able to reduce COD and TSS levels. In addition, knowing the unit performance of the composition can also determine the clogging time and the draining time, which is the most important thing. The results of the initial wastewater treatment in the inlet filtration process shown in Table 1 below:

Table 1. The results of the inlet filtration unit (after the sedimentation process)

Parameter	unit	Filtration Inlet	Standard	Description
Total coliform	MPN /100 mL	9,400.00	3,000.00	Does not comply with the standard
TSS	mg/L	32.30	30.00	Does not comply with the standard
pH	-	7.81	6-9	comply with standard
BOD_5	mg/L	15.20	30.00	comply with standard
COD	mg/L	130	100.00	Does not comply with the standard
Fat Oil	mg/L	0.90	5.00	comply with standard
Ammoniac	mg/L	0.52	10.00	comply with standard
Temperature	^oC	26.3	-	-

Source: research results, 2022
* Standard Quality Parameters follow the Regulation of the Minister of Environment and Forestry No. 68 Year 2016

From the test results at the initial inlet that there are COD, TSS, and Total coliform parameters that still do not meet the quality standards. Based on that data, if the wastewater is discharged into a water body, Even after aeration and sedimentation treatment, it is still too dangerous and disturbing, so further processing with filtration and sterilization is needed. Microorganisms can be inactivated in water using chemicals such as chlorine and ozone. However, chlorine also produces residual chlorine which is toxic to aquatic organisms [9]. Excessive use of chlorine will also produce toxic and potentially carcinogenic by-products. So it is necessary to develop research on the removal of pathogenic microorganisms by using ultraviolet light. As shown in Figures 1 and 2, in order to comply with the quality standards of wastewater according to regulations, it is allowed to be discharged into the river. In other research [6] this can be used as a reference for those who have used a filtration unit to reduce COD and TSS. The use of UVC in research [7] was also able to reduce total coliform. Figures 1 and 2 are clinical wastewater treatment units. This research focuses on filtration and sterilization units.

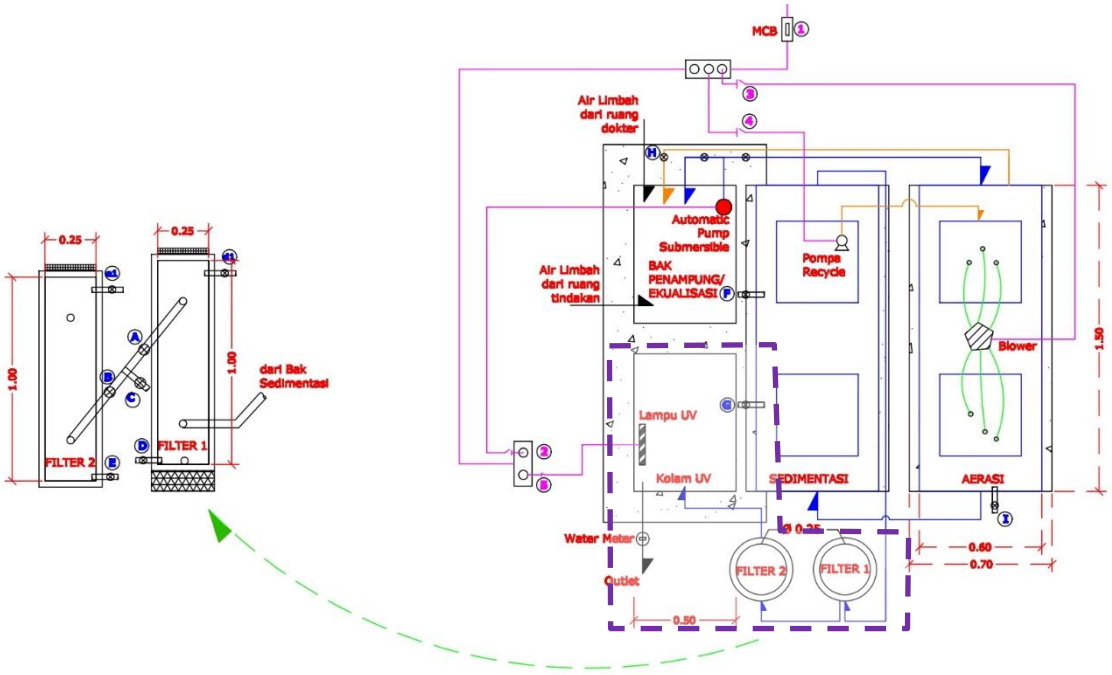

Figure 1. The layout of Clinical Wastewater Treatment and research scope (dotted line)

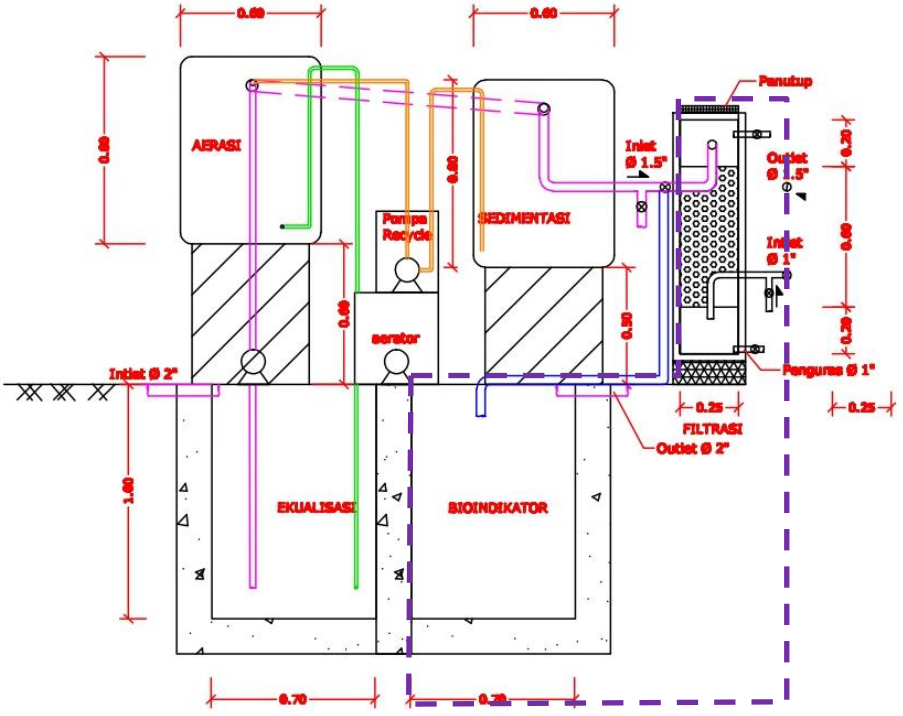

Figure 2. Side view of clinical wastewater treatment and research scope (dotted line)

This study aims to examine the organic content and bacteria of the Coli class from domestic wastewater in clinical wastewater treatment plants, especially filter units and sterilization units. So that processing operations can find out the performance and evaluation of the wastewater treatment plant (WWTP).

2. Research Method

This research was conducted in one of the clinics in the city of Surabaya. The object of the research is to use wastewater to be treated in an activated sludge unit, sedimentation, and filter, followed by ultraviolet treatment. Before taking measurements in the sterilization unit, measurements were made on the unit after the filtration process as the inlet of the sterilization unit. In the process of each filter 1 and filter 2, variations in the composition of activated carbon and silica are carried out with the compositions being variations of 60%: 40% and 40%: 60%. The measurement results were carried out before the inlet on filter 1 and the outlet on filter 2. The results of the best composition were continued by examining the processing using a sterilization unit with the ability to vary 9 and 15 watts with a wavelength of 254 nm [7]. The variation of exposure time used is 10, 15 [10], 20, and 25 minutes. During this time, E. coli microorganisms were tested. In the implementation of this research, the discharge was adjusted to the residence time. The dimensions of the 2 filtration units each have a diameter of 25 cm and a height of 100 cm and a freeboard space of 20 cm. Full filter media is only 80 cm. For filter composition as shown in Figure 3 as follows:

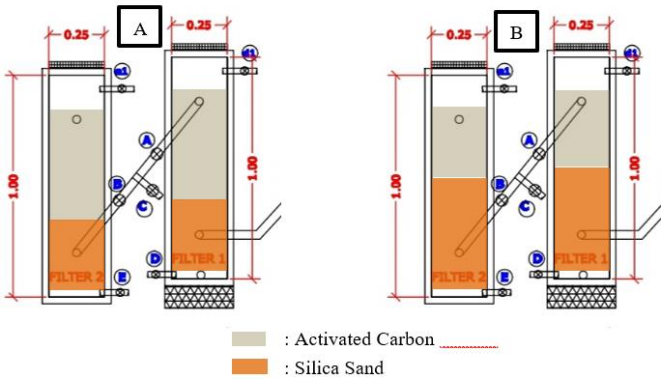

Figure 3. Composition scheme for activated carbon and silica sand A (60%:40%) and B (40%:60)

3. Result and Discussion

In this clinic wastewater treatment uses filtration to reduce organic content and uses ultraviolet to remove pathogenic bacteria. The results of the study can be seen in Table 2 and Table 3 as follows:

Table 2. Filtration unit outlet results

Composition of Activated Carbon and Silica	Parameter	Unit	Filtration Inlet	Detention Time on Filter					Standard
				1h	2h	3h	4h	5h	
2:3	COD	mg/L	128.00	99.98	95.26	78.98	70.24	65.38	100.00
	TSS	mg/L	32.30	7.90	6.90	6.60	5.80	5.50	30.00
3:2	COD	mg/L	130.0	90.00	88.68	75.38	69.46	53.62	100.00
	TSS	mg/L	34.00	7.20	6.10	5.20	4.80	4.30	30.00

Table 2 shows the COD and TSS values after leaving the sedimentation tank or becoming an inlet filtration tank of 128 mg/L and 32.30 mg/L under conditions of running active carbon and silica composition 2:3 and 130 mg/L COD and 34 mg. /L TSS on the composition of activated carbon and silica 3:2. After carrying out the filtration process, it was seen that the decreasing value for the best COD and TSS parameters for each composition with a time of 5 hours. for the best reduction composition using 3:2 of 58.75 % for COD and 87.35 % for TSS.

Table 3. Ultraviolet unit outlet results

Sterilization	Parameter	unit	inlet Pond Indicator	Ultraviolet Light Exposure (Indicator Pool Outlet)				Standard
				10 minute	15 minute	20 minute	25 minute	
9 Watt	Total coliform	MPN /100 mL	9200	4800	3400	2100	1700	3000
15 Watt	Total coliform	MPN /100 mL	9400	2300	1200	800	200	3000

Table 3 describes the use of the sterilization process using 9 and 15 watts of power. With an indicator pool inlet of about 9200 to 9400 MPN/100mL. then processed with residence time of 10, 15, 20 and 25 minutes, the best obtained using 15 watts of power obtained with a value of 200 MPN/100mL. This value has comply the required quality standards. This reduction process is because ultraviolet radiation is able to penetrate to reach the cell walls of microorganisms. Ultraviolet radiation is absorbed by proteins causing cell damage [8].

Figure 4. Collection Tank (X), the result of unit filter process 2 (Y) and sterilization (Z)

Figure 4 above shows that the visual conditions for the condition of Figure 4X are clinical wastewater collection tanks after going through the aeration and sedimentation processes. This indicates that the wastewater treatment plant process has been running well. This can be seen in the processing results such as the Figure 4X and 4Y images as follows:

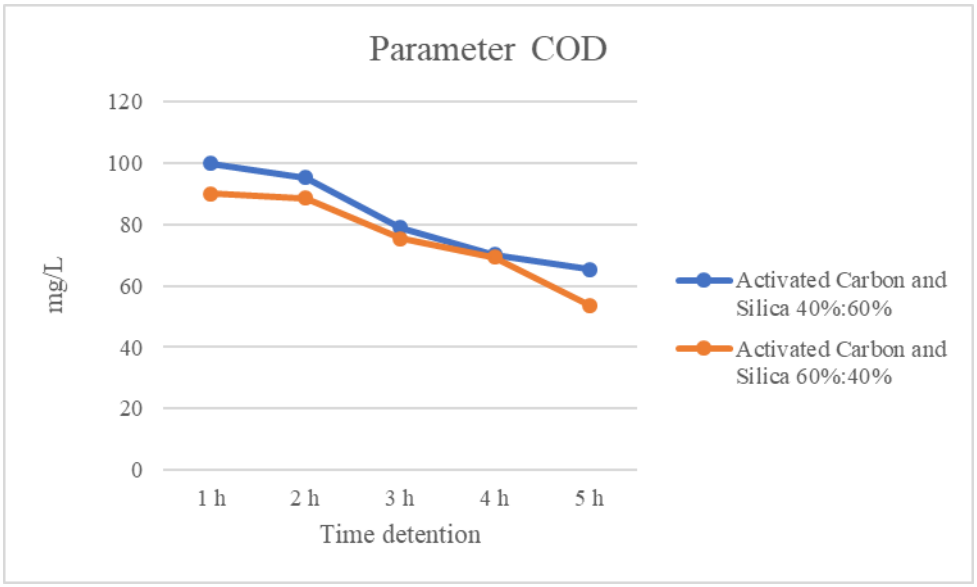

Figure 5. Comparison of variations of activated carbon and silica (40% : 60%) with activated carbon and silica (60% : 40%) in COD parameters.

Figure 5 above shows the results of the performance of the filtration unit on the COD parameter that the combination of activated carbon and Silica 3: 2 in decreasing COD parameters is better than a ratio of 2: 3. This is because the function of activated carbon is more capable of reducing organic content. As for the Silica content to reduce TSS and the content of microorganisms [2].

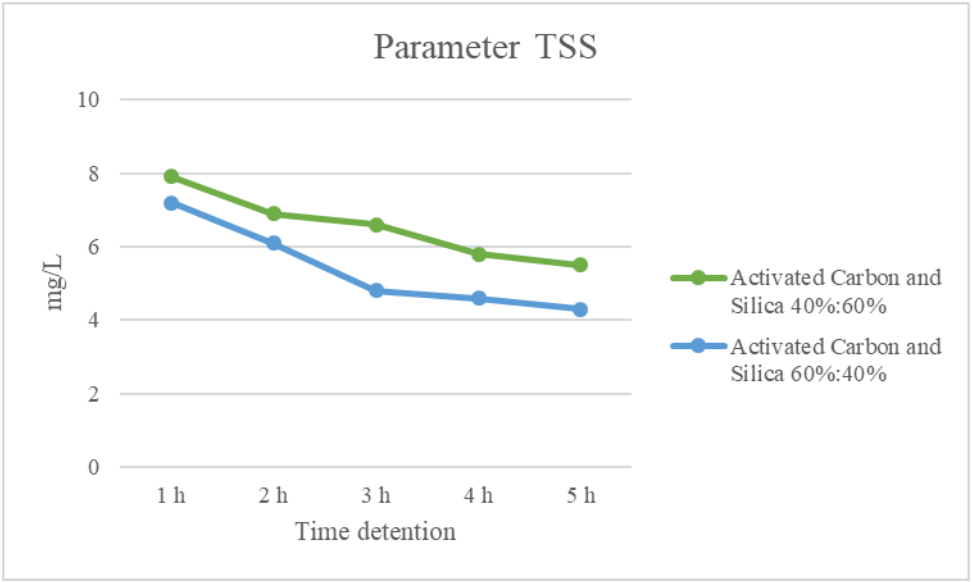

Figure 6. Comparison of variations of activated carbon and silica (40% : 60%) with activated carbon and silica (60% : 40%) in TSS parameters.

Figure 6 shows the ability of the best composition of activated carbon and silica, namely 60% and 40% respectively, that with every hour it decreases from the initial 34 mg/L to 7.2 mg/L every hour to 4.3 mg/L after 5 hours. hours on the best composition. This composition is able to reduce pollutants because according to [5] with a composition of 1:1 it is also able to reduce the content of COD and TSS. If you look at the character of activated carbon and silica at 60% and 40% at 3 hours, it has shown effectiveness,

but in the next 4 and 5 hours it looks slightly sloping, this could potentially cause blockages in the filter unit.

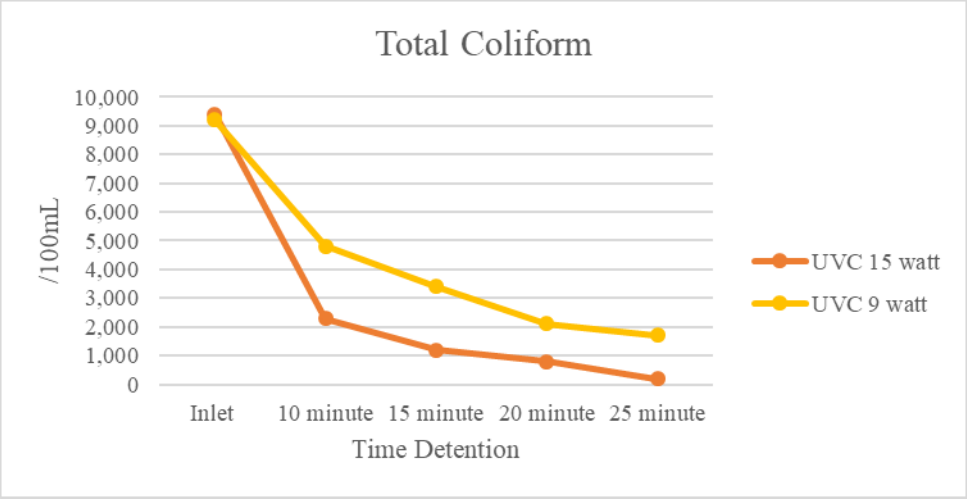

Figure 7. Comparison of the variation of 9-watt UVC with 15-watt UVC on the Parameters of Coli Group Germs.

Figure 7 compares ultraviolet light with power capacities of 9 and 15 watts for 10 to 25 minutes. There was a significant decrease in 25 minutes of 97.87% for 15 watts and 81.52% for 9 watts. The same study [11] using 25 minutes using 20-watt UVC achieved the best value.

4. Conclusions

It can be concluded that the use of the composition of activated carbon and silica sand (3:2) for 5 hours can reduce the COD content by 58.75 % and TSS by 87.35 % in the filtration process. Furthermore, the total coliform can be reduced by 97.87% at a light power of 15 watts for 5 hours. These results have met the required quality standards.

5. References

[1] Sulistiyawati, I. 2019. Kuantitas Total Bakteri Coliform pada Instalasi Pengolahan Cair Medis Laboratorium Klinik. *Jurnal Ilmiah Universitas Batanghari 19 (3)* pp 675-677.

[2] Purwoto, S., Purwanto, T., Hakim, L., 2015. Penjernihan Air Sungai Dengan Perlakuan Koagulasi, Filtrasi, Absorbsi, dan Pertukaran Ion. *Jurnal Teknik Waktu volume 13 Nomor 02* pp 45-53

[3] Apriyani, N., dan Novrianti., 2020. Penggunaan Karbon Aktif dan Zeolet Tak Teraktivasi dalam alat penyaring air limbah laundry. *Jukung Jurnal Teknik Lingkungan. 6(1)* pp 66-67

[4] Dewi, Y., S., dan Buchori, Y. 2016. Penurunan COD, TSS Pada Penyaringan Air Limbah Tahu Menggunakan Media Kombinasi Pasir Kuarsa, Karbon Aktif, Sekam Padi dan Zeolit. *Jurnal Universitas Satya Negara Indonesia Vol. 9 No.1* pp 74-80

[5] Assiddieq, M., Darmayani, M. & Kudonowarso, W. (2017). The use of silica sand, zeolite and active charcoal to reduce BOD, COD and TSS of laundry waste water as a biology learning resource. *Jurnal Pendidikan Biologi Indonesia, 3(3),* pp 202-207

[6] Utari, A. W., and Herdiansyah, H. 2020. Filtration as a water treatment method: Used to remove TSS and COD in household wastewater. *AIP Conference Proceedings 2245*, pp 6-14

[7] Fikri, E., Putri N, Y., Djuhriah, N., Hanurawaty, N, Y., Khair, A. S. E. 2022. The Effectiveness of Melt-Blown Filter Cartridge and UV-C Rays on the Reduction of Total Coliform and Water Hardness in Production Process Water. *Journal of Ecological*

Engineering 23(4), pp 181–190

[8] Cahyonugroho, H. C. 2010. Pengaruh Intensitas Sinar Ultraviolet dan Pengadukan Terhadap Reduksi Jumlah Bakteri *E.coli*. *Jurnal Ilmiah Teknik Lingkungan Vol 2. No.1* pp 34-35

[9] Naimah, S., Ermawati, R. 2011. Efect Of Photocatalyst Nano Tio2 on Antimicrobial Mechanisms *E. coli* and *Salmonella*. *Jurnal Riset Industri Vol. V, No.2*. pp 20-25

[10] Risky, D. P., Ratnawati, I Gst. AA. Kawuri, R. 2020. The Effect of Ultraviolet Rays on The Growth of Enterotoxigenic *E. Coli* (Etec) Bacteria Causes of Diarrhea Disease. *Bioma Volume 6 (1)* pp 66 – 73

[11] Labina, H. F and Purnomo, Y. S. 2022. Penyisihan Bakteri *E. Coli* Menggunakan Radiasi Sinar Ultraviolet dan Semikonduktor TiO2 Pada Air Sumur Desa Kenongo, Sidoarjo. *Jurnal Envirous Volume 2 Nomor 2*. pp 20-25