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Regional Case Study

Effectiveness Evaluation of Alternative Technologies Applied in Centralized Domestic Wastewater Treatment Systems

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Abstract

The paper aims to determine the effectiveness of several alternative technologies that have been applied in centralized domestic wastewater management systems, especially in West Java and Banten provinces, in the removal of domestic wastewater pollutant parameters. The study was conducted in centralized domestic wastewater treatment systems (*Sistem Pengelolaan Air limbah Domestik Terpusat* - SPALD-Ts), including the Anaerobic Baffle Reactor (ABR) system, the Anobic Filter (AF) system, the combined ABR + AF system, and the Extended Aeration. The analysis was performed by sampling at the inlet and outlet points of the system for three consecutive years with sampling times from 2021 - 2023. The results of the research show that the efficiency of pollutant parameter separation based on the best technology in the separation of domestic wastewater pollutant parameters is the SPALDT extended aeration technology, where this technology can separate pollutant parameters up to an average of 88.25%, but in this technology requires more cost and periodic maintenance.

Keywords: Domestic wastewater; removal domestic wastewater; SPALD-T Technology

1. Introduction

The expansion of residential areas due to the growth of the population automatically leads to an increase in the amount of pollutants in domestic wastewater. An increase in the amount of pollutants in the form of domestic waste water has a direct impact on the quality of surface water, as well as an increase in the pollution index. New pollution problems will arise from improper management of domestic waste (Susanti and Miardini, 2017). Pollution is a direct result of uncontrolled and rapid population growth and human activities. Worldwide, patients with waterborne diseases account for 50% of hospital beds; injustice and poverty, as shown above, are consequences of water access problems in Africa, but they are also often the cause (Farolfi, 2011). Environmental pollution, especially water pollution, is a serious problem in large cities. This pollution is caused by industrial and domestic wastewater and settlements (domestic), which increase with the growth of the population (Yudo and Said, 2018). Environmental pollution is the entry or inclusion of living things, substances, energy, and/or other components into the environment by human activities so that it exceeds the established environmental quality standards (Government of the Republic of Indonesia, 2021). Indonesia has a population of 270 million people, making domestic wastewater one of the largest sources of wastewater generated by humans (Widyarani et al., 2022).

Most wastewater generated by human activities comes from domestic sources. More than 90% of the purified water is discharged as wastewater (Ghaitidak and Yadav, 2013). Domestic wastewater originates from daily life activities related to water usage (Ministry of Environment and Forestry, 2016). Population growth in developing countries such as Indonesia can cause various problems. Sometimes, social progress requires growth, which ignores environmental sustainability regulations. This raises issues that need to be addressed in relation to the social and environmental aspects. One of them is the pollution of river water by domestic waste (Prilly Ismi Arum et al., 2019). The quality of rivers in West Java has been polluted, such as research in the Cikapundung River, which is one of the tributaries of the Citarum River. The Cikapudung River is polluted with domestic waste due to the increasing population (Rahayu et al., 2018). In a study conducted in Situ Parigi, South Tangerang, in measuring the quality of the river water, it was found that the BOD parameter had the highest concentration value. This indicates that it comes from organic waste that enters the water body from domestic activities in the area (Zharifa, et al., 2019). Domestic wastewater contains many organic compounds. When the wastewater enters the water, the DO concentration in the water will decrease (Hakim et al., 2017). Discharges of domestic sewage into rivers and streams can have an impact on the BOD levels in the water. Sedimentation in rivers with high BOD levels can lead to siltation, which reduces the level of oxygen in the incoming water and kills off the biota (Suprihatin, 2014).

Wastewater Treatment Plants (*Sistem Pengolahan Air Limbah Domestik Terpadu*) can prevent domestic wastewater pollution by treating domestic wastewater before it is discharged directly into rivers or sewers (Anwariani, 2019). A management system for reducing pollutant loads in densely populated areas that is implemented by collecting domestic wastewater from its sources and conveying it to a centralized management subsystem for treatment SPALD-T prior to discharge into surface waters (Regional Government of Tasikmalaya City, 2021). Population projections for SPALD-T implementation are made using twenty-year projections. This requires population data from previous years, at least five years prior to the planning period, and for a minimum of twenty years (Kementerian PUPR, 2017). Centralized SPALD, hereafter referred to as SPALD-T, is a management system in which domestic wastewater is collected from the source and conveyed to a centralized treatment subsystem for treatment prior to discharge into surface waters. The treatment of domestic wastewater involves several steps. These stages are aimed at accelerating the natural degradation process of pollutants through engineering in operational units and processes (Hartoyo, 2018). Government is responsible for domestic wastewater management, including investment issues and its provision as a public good. Due to the limitations and scarcity of water resources, competition for access to water will become increasingly difficult, especially in terms of decisions on the allocation of water resources (Hakala, 2017).

To ensure the success of the program, Indonesia is one of the countries that participated in the 2030 Sustainable Development Goals (SDGs) agenda. The National Medium Term Development Plan (RPJMN) for 2020-2024 was approved by Indonesia with the following goals and targets. 100% access to safe drinking water and 90% access to good sanitation including 15% access to safe sanitation and 0% free from open defecation are the goals of the program (Bappenas, 2019). In Indonesia, there are several central wastewater treatment plants built using biodigester technology. However, the treatment results have not reached the target or do not meet the quality standards of domestic wastewater, making it unsuitable for direct discharge into the environment (Rochmadi et al., 2010). Local environmental conditions, socio-economic conditions, community perceptions and culture, and available wastewater treatment technologies are factors that influence the selection of wastewater management systems (Nayono, 2010). The technology of centralized domestic wastewater management system is one of the technological considerations chosen to reduce the concentration of domestic waste in the environment. The stricter the threshold value of treated water, the higher the effectiveness and efficiency of each domestic wastewater treatment process required. The determination of this technology, greatly determines the effectiveness of the Centralized Domestic Wastewater Management System in achieving domestic wastewater quality standards (Hartoyo, 2018). In some cases, people in Indonesia still dispose of untreated or partially treated wastewater directly into open water, canals, rivers, or ponds. Many people still use groundwater as a source of raw water, which, if left untreated, will lead to fecal contamination of urban groundwater resources as well as environmental pollution and cause water-related and sanitary diseases such as diarrhea and typhoid (Prihandrijanti and Firdayati, 2011).

There have been several studies related to the effectiveness of several Centralized Domestic Wastewater Management Systems applied in several places in Indonesia as well as Putra et al., (2021), Rochmadi *et.al.* (2010), Sururi *et.al,* (2023) and Hermansyah (2023) but there has been no study that comparatively compares several technologies of Centralized Domestic Wastewater Management Systems applied in Indonesia in the removal of domestic wastewater quality standard parameters. The writing of this scientific article aims to determine the effectiveness of several alternative technologies that have been applied in Centralized Domestic Wastewater Management Systems, especially in West Java and Banten in the removal of domestic wastewater pollutant parameters.

2. Material and Method

2.1 Research Location

The study was conducted in SPALD-Ts in West Java and Banten Provinces. The selection of SPALD-Ts for the study was done using purposive sampling of SPALD-Ts based on the SPALD-T technology installed. The SPALD-T technologies sampled were the Anaerobic Baffle Reactor (ABR) System, Anaerobic Filter (AF) System, Combination ABR + AF System, and Extended Aeration. The SPALD-T locations used as research based on technology type are SPALD-T Kampung Malela, Depok City for ABR System technology, SPALD-T Bekasi Jati, Margahayu Sub-district, Bekasi City for AF System technology, SPALD-T Cibabat RW.08, Cimahi City for ABR+AF System technology and SPALD-T Cluster Newton, Tangerang City for Extended Aeration System technology.

The water quality standard for domestic wastewater quality regulates seven parameters, namely pH, TSS, BOD, COD, oil and grease, ammonia, and total coliform. In Indonesia, there are 2 treatments that can be used to reduce the pollutant value of domestic waste, namely local SPALD (SPALD-S) and centralized SPALD (SPALD-T). According to research conducted by Sururi et al., (2023) that centralized management systems or SPLAD-T can prevent environmental pollution from untreated domestic wastewater, it is important to develop SPLAD-T treatment for more optimal results in the future.in this study, centralized domestic waste treatment (SPALD-T) is used. The SPALD-T with Anaerobic Baffle Reactor (ABR) System technology that was used as research was the SPALD-T Kampung Malela Depok City, West Java Province. SPALD-T serves 35 households. SPALD-T Kampung Malela uses an Anaerobic Baffled Reactor (ABR) process system or a Stacked Septic Tank where there are 8 (eight) baffles/compartments. ABR is a modified septic tank technology by adds several compartments to produce upflow through anaerobic activated sludge and increase contact time between activated biomass and wastewater.

The SPALD-T with Anaerobic Filter (AF) System technology that was used as research was the Bekasi Jati SPALD-T. The Bekasi Jati SPALD-T was built in 2012 by the Public Works and Public Housing Agency (PUPR). Currently, the Bekasi Jati SPALD-T serves around 20 households. The next SPALD-T to be studied is the Cibabat SPALD-T. SPALD-T Cibabat serves 215 active households. SPALD-T Cibabat was built in 2017 by the Public Works and Spatial Planning Agency (PUPR). The last SPALD-T that was used as research was SPALD-T Cluster Newton, Tangerang City with installed technology using the Extended Aeration system. This SPALD-T was built in 2010 and is managed by Summarecon Serpong Management.

2.2 Sampling

Sampling was carried out by taking samples at the inlet and outlet points of the SPALD-T, for three consecutive years with sampling times from 2021 - 2023. Samples were then analyzed at a KAN-accredited laboratory with testing methods for each parameter with the following testing methods:

Table 1. Analysis methods of the observed parameters

No	Parameters	Units	Methods
1	pH	-	SNI 6989.11-2019
2	BOD_5	mg/L	SNI 6989.72-2019
3	COD	mg/L	SNI 6989.73-2019
4	TSS	mg/L	SNI 6989.3-2019
5	Oil and Grease	mg/L	SNI 6989.10-2019
6	Ammonia	mg/L	SNI 6989.30-2005 and SM APHA 23rd. Ed., 9223B, 2017

2.3 Evaluation of the Efficiency of SPALD-T

Evaluation of the effectiveness of removal of domestic wastewater quality parameters based on the technology in the installed SPALD-T is calculated by equation (1)

$$\text{Efficiency} = \frac{C\ In - C\ Out}{C\ In} \times 100\ \% \quad (1)$$

Annotation:
C in : Inlet Parameter Levels
C out : Outlet Parameter Levels

The efficiency value of each domestic wastewater quality parameter is then calculated as the average of 3 sampling years, namely from 2021 to 2023. The efficiency of each parameter is then compared with the minimum efficiency calculated by the efficiency formula with the Parameter Level at Inlet (Cin) is a characteristic based on the medium range of domestic wastewater characteristics with levels of BOD 300 mg/L, COD 500 mg/L, TSS 300 mg/L, Oil and Fat 60 mg/L, Ammonia 60 mg/L, and Total Coliform 1,000,000 numbers/100 mL (Tchobanoglous et al., 2014). Paramater levels at the Outlet (Cout) use the standard value of domestic wastewater parameters by the domestic wastewater quality standard Permen LHK No. 68 of 2016 which includes the parameters BOD 30 mg/L, COD 100 mg/L, TSS 30 mg/L, Oil and Fat 5 mg/L, Ammoniac 10 mg/L, Total Coliform 3000 number/100 mL, and Discharge 100 L / person/day (Permen LHK No. 68 of 2016). Based on this formulation, the efficiency of each parameter is presented in Table 1 below:

Table 2. Minimum efficiency of domestic wastewater parameters

No.	Parameter	C_{in}	C_{out}	Unit	Minimum Efficiency
1	BOD	300	30	mg/L	90.00%
2	COD	500	100	mg/L	90.00%
3	TSS	300	30	mg/L	90.00%
4	Oil and Grease	60	5	mg/L	91.67%
5	Ammonia	60	10	mg/L	83.33%
6	Total Coliform	1,000,000	3000	mg/L	99.70%

3. Result and Discussion

3.1 Evaluation of SPALD-T effectiveness based on installed technology

The effectiveness of SPALD-T based on the installed technology was evaluated based on the performance of SPALD-T in the removal of domestic wastewater quality standard parameters by Permen LH No. 68 of 2016, namely: BOD; COD; TSS; Ammonia and Total Coliform. For the Fatty Oil and pH parameters, an effectiveness evaluation was not carried out because the influent results of oil and fat levels had entered the basin. The level of fatty oil in the influent is 1.4 mg/L and the quality standard for oil and fat parameters is 10 mg/L. The influent pH parameter value is in the neutral range of 6.76 - 8.51 with a quality standard for pH parameters of 6 - 9. Evaluation of the effectiveness of removal of BOD; COD; TSS; Ammonia and Total Coliform parameters in three types of WWTP technology is presented in Table 1 and Figure 1.

Table 3 Removal efficiency of basin parameters based on installed SPALD-T technology

Type of Technology Parameter		**SPALD-T Kp. Malela, Kota Depok**				**SPALD-T Bekasi Jati - Margahayu, Kota Bekasi**				**SPALD-T Cibabat Kota Cimahi**				**SPALD-T Cluster Newton, Kota Tangerang**			
		ABR System				**AF System**				**ABR+AF System**				**Extended Aeration System**			
		Years Sampling			**Average of Removal**	**Years Sampling**			**Average of Removal**	**Years Sampling**			**Average of Removal**	**Years Sampling**			**Average of Removal**
		2021	2022	2023		2021	2022	2023		2021	2022	2023		2021	2022	2023	
BOD (mg/L)	Influent	1025	43	23		211	153	28		265	781	51		218	62	118	
	Effluent	29	26	19		23	15	12		23	29	6		11	14	8	
	%Removal	97.17%	39.53%	17.39%	51%	89.10%	90.20%	57.14%	79%	91.32%	96.29%	88.24%	92%	94.95%	77.42%	93.22%	89%
	Quality Standart*	**30**	30	30		**30**	30	30		**30**	30	30		**30**	30	30	
COD (mg/L)	Influent	3512.8	142.1	71.7		701.1	505.9	56.2		893.4	2597.3	164.1		944.4	205.6	394.3	
	Effluent	95.2	85.7	52.8		77.2	51.3	42.7		77.2	96.9	16.8		21	46.6	27.3	
	%Removal	97.29%	39.69%	26.36%	54%	88.99%	89.86%	24.02%	68%	91.36%	96.27%	89.76%	92%	97.78%	77.33%	93.08%	89%
	Quality Standart*	**100**	100	100		**100**	100	100		**100**	100	100		**100**	100	100	
TSS (mg/L)	Influent	33	174	40		18	844	76		25	251	64		21	313	280	
	Effluent	8	12	18		15	7	10		11	17	4		9	10	7	
	%Removal	75.76%	93.10%	55.00%	75%	16.67%	99.17%	86.84%	68%	56.00%	93.23%	93.75%	81%	57.14%	96.81%	97.50%	84%
	Quality Standart*	**30**	30	30		**30**	30	30		**30**	30	30		**30**	30	30	

NH_3-N (mg/L)	Influent	55.079	88.655	56.566		68.887	267.486	60.858		25.813	57.467	65.028		59.997	93.169	51.247	
	Effluent	51.372	64.856	2.084		40.699	49.183	50.341		24.828	27.612	57.887		0.01	0.353	13.587	
	%Removal	6.73%	26.84%	96.32%	43%	40.92%	81.61%	17.28%	47%	3.82%	51.95%	10.98%	22%	99.98%	99.62%	73.49%	91%
	Quality Standart*	**10**	10	10		**10**	10	10		**10**	10	10		**10**	10	10	
T. Coliform (mg/L)	Influent	33000	11000	8200000		11000	220000	1700000		43000	100000	130000		15000	16000	230000	
	Effluent	26000	7000	340000		9200	19000	88000		24000	23000	310000		920	2400	31000	
	%Removal	21.21%	36.36%	95.85%	51%	16.36%	91.36%	94.82%	68%	44.19%	77.00%	-138.46%	-6%	94%	85.00%	86.52%	88%
	Quality Standart*	**3000**	3000	3000		**3000**	3000	3000		**3000**	3000	3000		**3000**	3000	3000	

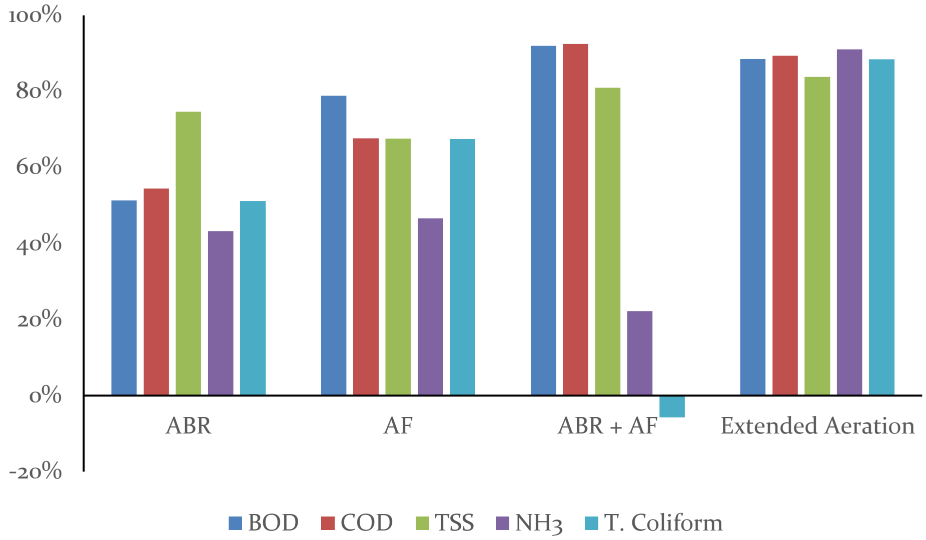

Figure 1. Removal efficiency chart of basin parameters based on installed SPALD-T technology

3.1.1. SPALD-T with Anaerobic Baffle Reactor (ABR) System technology

The anaerobic baffled reactor (ABR) is one of several types of upflow anaerobic sludge bed reactors (UASB). ABRs continue to play an important role in the wastewater treatment industry (Ran et al., 2014). In the ABR, different compartments perform anaerobic digestion (AD) steps such as hydrolysis, acidogenesis, acetogenesis, and methanogenesis in sequence (Amouamouha et al., 2022). SPALD-T with Anaerobic Baffle Reactor (ABR) System technology in the removal of domestic pollutant parameters is still quite low compared to the minimum efficiency, where the efficiency of removing BOD parameters is 51.37% compared to the minimum efficiency of 90.00%, COD 54.45% compared to the minimum efficiency of 80.00%, TSS 74.62% compared to the minimum efficiency of 90.00%, NH_3-N 43.30% compared to the minimum efficiency of 83.33%, T. Coliform 51.14% compared to the minimum efficiency of 99.70%. The low retention time caused by the lack of hydrodynamics, the amount of agitation, or the presence of contact between the substrate and bacteria to control mass transfer and reactor performance can all contribute to removal efficiencies of BOD and COD parameters below the minimum removal efficiency target. In addition, unformed sludge blanket layers that accumulate at the bottom of each compartment may also be to blame (Hastuti et al., 2017).

Anaerobic suspended wastewater treatment (ABR) systems consist of vertically bounded compartments. Using compartmentalized ABR designs, microorganisms suitable for anaerobic digestion, liquid-solid phase separation, and system stability are established. ABR does not require energy or chemicals for treatment, and all the potential energy it produces is greater than what is needed for operation. Hence, ABR techniques are easy to use and produce methane efficiently at low temperatures (Hahn and Figueroa, 2015). ABRs are capable of handling a wide range of influent types and typically consist of compartments arranged in series. The series arrangement of overhanging and upright baffles allows the effluent to flow toward the bottom of the baffles, and the influent pressure allows the effluent to flow from the inlet to the outlet (Ajakima and Soedjono, 2016). The highest efficiencies of the ABR system occur for TSS parameters up to 74.62. This is influenced by the treated organic load exceeding the design criteria and the wastewater residence time (HRT) (Kurnianingtyas et. al., 2020), resulting in precipitation in each basin.

A graph of the average efficiency of each SPALD-T domestic wastewater parameter with ABR technology is shown in Figure 2.

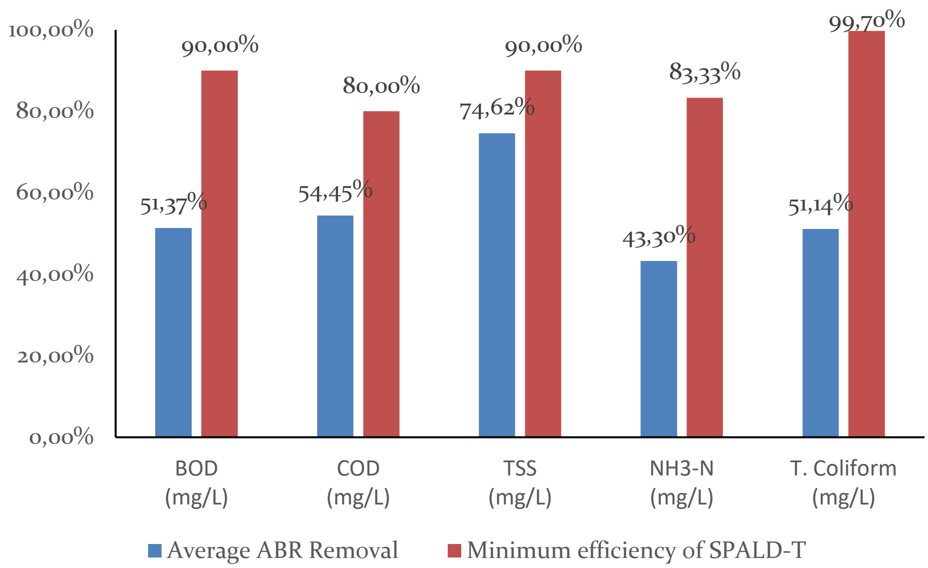

Figure 1. Efficiency chart of SPALD-T ABR technology

3.1.2. SPALD-T with Anaerobic Filter (AF) System technology

SPALD-T with Anaerobic Filter (AF) System technology in the removal of domestic pollutant parameters is still quite low compared to the minimum efficiency but slightly higher than SPALD-T with Anaerobic Baffle Reactor (ABR) System technology, AF efficiency is higher than the ABR system, especially for organic pollutant parameters, namely BOD, COD where the efficiency of removing BOD parameters is 78.81% compared to the minimum efficiency of 90.00%, COD 67.62% compared to the minimum efficiency of 80,00%. While the TSS parameter is 67.56% compared to the minimum efficiency of 90.00%, NH3-N 46.60% compared to the minimum efficiency of 83.33%, T. Coliform 67.52% compared to the minimum efficiency of 99.70%. High removal efficiency of suspended solids (SS) and turbidity makes the filtered effluent more pure (Musazura and Odindo, 2022). Sludge and particulate matter are leached out because of the physical filtration effect of the fillers in the AF, thereby improving the effluent quality (Al-Isawi et al., 2017). In a study conducted by Arrubla et al. (2016), the separation efficiency of organic material parameters using anaerobic filter technology (AF) was higher than 50% of the minimum value of separation efficiency. Wastewater treatment systems that use anaerobic filters are fixed-bed biological growth reactors. Microorganisms attached to the surface of the media decompose organic matter as household wastewater passes through the filters in this reactor, trapping particulates. To reduce the amount of organic matter in the effluent, household wastewater flows or passes between the media and bacteria that break down suspended and dissolved organic matter. The bacterial enzymes that ferment the organic matter in the wastewater may leave the media that supports bacterial growth and form a slime or film (Hartoyo, 2018).

A graph of the average efficiency of each SPALD-T domestic wastewater parameter with AF technology is shown in Figure 3.

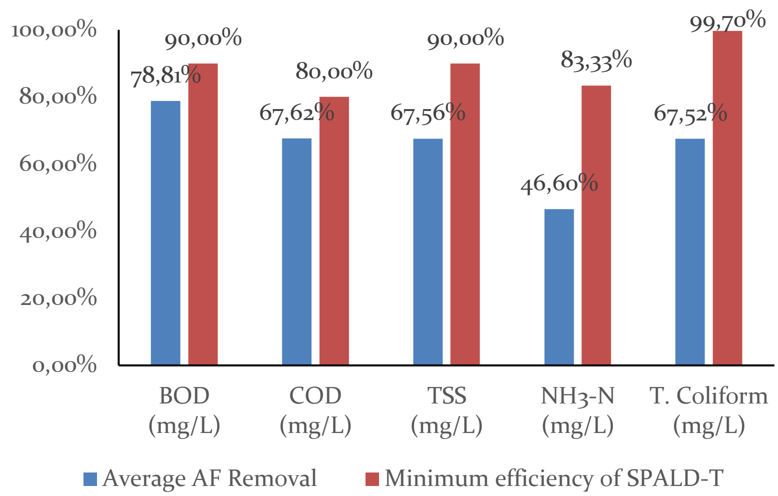

Figure 2. Efficiency chart of AF technology SPALD-T

3.1.4. SPALD-T with Anaerobic Baffle Reactor (ABR) technology + Anaerobic Filter (AF) System

The SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System technology in the removal of domestic pollutant parameters is quite high compared to the minimum efficiency, especially for organic pollutants, namely BOD, COD, and solid pollutants, namely TSS. However, the SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System technology is still low in the removal of nutrient parameters, namely NH_3-N, because the SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System technology does not have an aerobic process in the SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System technology. This technology is the good combination where the sewage treatment process has high efficiency, does not require a lot of energy, and the sludge produced is small (Kurnianingtyas et al., 2020). Aerobic processes involve the presence of soluble oxygen in wastewater reactors. Ammonium nitrogen is nitrated in an aerobic state and then converted to nitrate ($NH_4^+ \rightarrow NO_3$), and in an anaerobic state there is a denitrification process in which nitrate is formed in the nitrogen gas ($NO_3 \rightarrow N_2$) (Rita Krishymartani H and Setiyono, 2015).

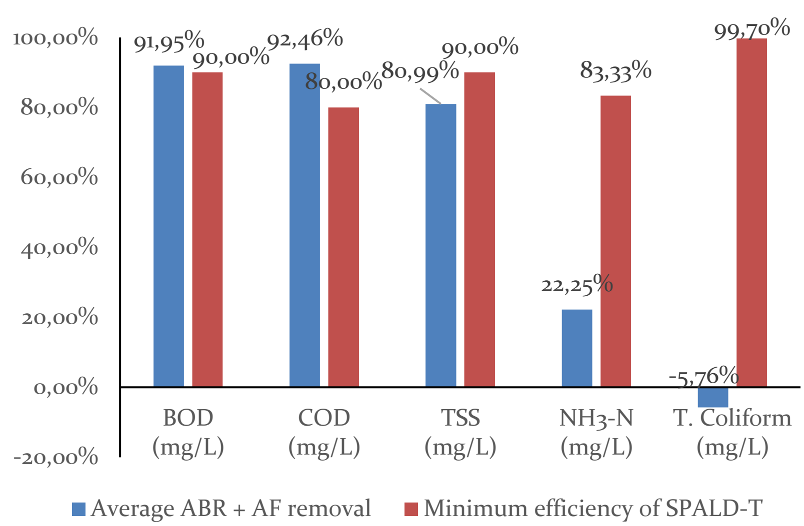

Figure 3. Efficiency chart of ABR+AF technology SPALD-T

The removal efficiency of SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System parameter BOD 91.95% compared to the minimum efficiency of 90.00%, COD 92.46% compared to the minimum efficiency of 80.00%. While the TSS parameter is 80.99% compared to the minimum efficiency of 90.00%, NH3-N 22.25% compared to the minimum efficiency of 83.33%, T. Coliform -5.76% compared to the minimum efficiency of 99.70%. The efficiency of the T. Coliform parameter is negative because there is no disinfection process in the SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) system technology. A graph of the average efficiency of each domestic wastewater parameter in SPALD-T with AF technology is shown in Figure 4.

Fecal coliforms, which are organisms of intestinal origin, naturally die when exposed to the environment, which is why the total coliform concentration obtained from ABR+AF technology is negative. Microbial mortality can also be caused by other variables, including chemical, physical, biological, and metabolic factors, and the use of chlorinated water can cause a decrease in bacterial concentration in addition to the previously mentioned variables that can increase the risk of coliform mortality. Chlorine is one of the most popular materials used in wastewater and water treatment. Its ability to disinfect is largely due to the way it oxidizes cellular material. Chlorine compounds react with water to form hypochlorous acid (HOCl), which then breaks down into hydrogen ions (H+) and hypochlorite ions (OCl-).

3.1.5. SPALD-T with Extended Aeration technology

SPALD-T with Extended Aeration technology is an extended aeration system. An extended aeration system is a better technology than a continuous SBR process where wastewater is poured into a tank. This indicates that there was no interruption in the influent flow throughout the stages of the cycle. Each cycle of this system consists of three stages: aeration, settling and decanting (Gupta et al., 2012).Suspended biological processes are water treatment methods that use the activity of microorganisms to break down pollutants. The microorganisms are either produced or used and are suspended in the reactor (Putra et al., 2021). SPALD-T with extended aeration technology requires a blower unit to provide soluble oxygen. This means that periodic electricity and maintenance costs are required to operate the SPALT-T with extended aeration technology (Ayoub and El-Morsy, 2021). As a result, the SPALN-T with extended aeration technologies has higher operating costs than the SPALD-T with ABR, AF and ABR+AF technologies, which do not require an absorber in the process unit.

Extended aeration is more effective for organic parameters such as BOD and TSS. However, extended aeration is not intended for long-term use (Mohammad, 2019). Extended aeration provides biological treatment in an aerobic environment to remove biodegradable organic waste. The oxygen required to maintain aerobic biological processes can be provided by air through mechanical aeration or dispersed aeration. Microbial organisms must be kept in contact with the dissolved organic matter for mixing to occur, which is provided by aeration. Once the aeration tank has reached full stability, a separate sludge processor is not required (Zhan et al., 2013). The removal efficiency of domestic wastewater pollutant parameters for SPALD-T with Extended Aeration technology for all domestic wastewater parameters, where all domestic wastewater parameters are not only organic pollutant parameters (BOD, COD) and solids parameters (TSS); however, for nutrient parameters (NH_3-N), the removal efficiency is quite high, but does not reach the minimum efficiency for BOD parameters. The removal efficiency of SPALD-T with Extended Aeration technology for BOD parameters was 88.53% compared to the minimum efficiency of 90.00%, COD was 89.40% compared to the minimum efficiency of 80.00%. While the removal of TSS parameters was 83.82% compared to the minimum efficiency of 90.00%, NH3-N 91.03% compared to the minimum efficiency of 83.33%, T. Coliform 88.46% compared to the minimum efficiency of 99.70%. Different from the research Ayoub and El-Morsy (2021) conducted by that the percentage of minimum efficiency removal values for BOD 24%, COD 20%, and TSS 88%. In the research carried out by Noor et al. (2021), removal using the extended aeration technology in the two reactors achieved a minimum removal efficiency for COD parameters of 86.2% in Reactor A and 88.9% in Reactor B Removal efficiencies for TSS parameters in Reactor A and Reactor B were 45.3% and 51.2%, respectively, and the removal efficiency for NH3-N parameters in Reactor A and Reactor B were 63.06% and 66.86%, respectively.

SPALD-T with Extended Aeration technology allows the oxidation process of organic material to be achieved with aerobic processes so that the efficiency of removing organic material pollutants (BOD, COD) is maximized, and also the Nitrification and Denitrification processes that allow the removal of NH_3-N parameters can be maximized. A graph of the average efficiency of each SPALD-T domestic wastewater parameter with AF technology is shown in Figure 5.

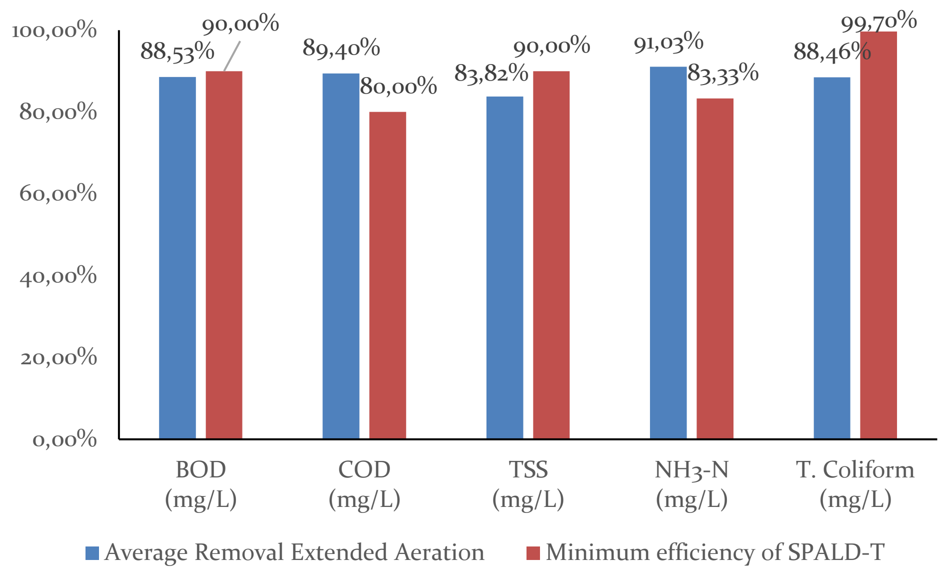

Figure 4. Efficiency chart of extended aeration SPALD-T

4. Conclusion

The effectiveness of SPALD-T in the removal of domestic wastewater quality standard parameters was evaluated using installed technology. The performance was analysed for the parameters BOD, COD, TSS, Ammonia and Total Coliform. The SPALD-T with Anaerobic Baffle Reactor (ABR) system technology showed low efficiencies in the removal of BOD and COD parameters, with a low retention time and unformed sludge cover layers. The highest efficiencies occurred for TSS parameters up to 74.62. The SPALD-T with Anaerobic Filter (AF) System technology showed slightly higher efficiencies, especially for organic pollutants such as BOD and COD. The SPALD-T with Anaerobic Baffle Reactor (ABR) + Anaerobic Filter (AF) System technology had high efficiencies for organic pollutants but low efficiencies for nutrient parameters such as NH3-N. SPALD-T with Extended Aeration technology was found to be better than a continuous SBR process, as it requires less energy and produces less sludge. The SPALD-T with Extended Aeration technology is a better option than a continuous SBR process.

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