The Effectiveness of Grease Trap, Carbon Active and Aerobic Biofilter Methods to Clean The Waste Water of The Canteen

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Abstract. Most of the wastewater contains of oil, grease, detergent and soap, and other organic waste substances. This study purpose is to examine the effectiveness of grease trap, carbon active and aerobic biofilter (bioball) methods in cleaning the waste water of the canteen. Methods. A Quacy Experiment with Non Equivalent Control Group Design approach was implemented to examine the grease, oil, BOD, and TSS levels of the canteen's waste water samples of Campus 7 of Health Polytechnic of the Ministry of Health Semarang. Pre-and post tests applied to the samples from dish washing-process. HATRI (researchers' name) was performed for the analysis and the number were calculated using efficiency formula and paired t-test. The examination was applied on the sample before and after three day-treatment. The result was that the oil, grease, TSS, and BOD level in the waste was reduced and the equipment used was efficient. With large coverage and effect, activated carbon functions as color, flavor, and smell remover as well as purification agent. The data revealed the decreased on BOD level (83,74%), TSS level (24,56%), and oil level (98,7%) while for the grease showed - 0,03%. Conclusion. HATRI was able to reduce the level of BOD 83,74%, TSS 24.56%, and oil 98,7%. It was not for reducing grease level. Therefore, it is needed to maximize the treatment on the grease trap.

1. The first section in this paper

The World Health Organization (WHO) states that "The Best of All Things is Water". Water is needed for domestic needs, irrigation, farming, industry, and recreation (Sastrawijaya, 2009). Indonesian government regulation No.82/2001 on Water Quality Management and Water Pollution Control stated that water pollution occurs when the water is contaminated by living beings, substances, energy, and other contaminants as a result of human activities that in some degree causing the water is not suitable for use. Every human activity will produce waste which will not cause any harm if it is only in a small amount because of nature has capability in decomposing waste compound. But when the waste accumulates vastly, it will disrupt the environmental balance(Herlambang A, 2002).

The environmental problem occurring nowadays mostly comes from wastewater produced by households and industries. The waste yields in oil, grease, detergent and soap, and other organic waste substances resulted from industrial, hotel, health facilities, slaughterhouse, and domestic activities. Domestic waste is wastewater originating from household activities such as cooking, washing, bathing and other restroom activities (Fajar Kurniawan, 2010). Domestic wastewater includes waste from houses, offices, business centers, apartments, restaurants, and dorms. According to the regulation by Indonesian Ministry of Environment and Forestry No.P.68/MenLHK/Setjen/Kum.1/8/2016 on Domestic Wastewater Quality Standard, the BOD and TSS level in the waste is not exceed of 30 mg/L and the oil and grease level in the waste is not exceed of 5 mg/L (Kementrian Lingkungan Hidup Indonesia, 2016).

Oil and grease waste is organic waste that can accumulate in pipe and may cause clog (Islam MS, Saiful, Hossain M, 2013). It is also dangerous for the water wildlife and also potentially causes mutagenic and carcinogenic in human (Lan Wu, 2009). Organic waste in the waters might come from food, detergent, plastic, or other substances. A research conducted by Nur Hidayah Kurniawati (2018) on wastewater physical quality at Campus 7 of Health Polytechnic of the Ministry of Health Semarang found that, in the temperature of 23 – 25 C, it was colorless, smelly and fishy, and contained solid waste or other organic substances like rice and noodle leftover, vegetable pieces, and plastic. It was also found the large amount of biodegradable organic substances endangers water organism life and holds dissolved oxygen in the water whereas the micro-organism needs much oxygen for degrading the organic substances. This may lead to the death of the living beings in the water that causes bad smell and can decrease the quality of the water (National Small Flows Clearinghouse, 1997).

A research by T.A. Zaharah (2017) reported that wastewater output resulted from grease trap contained 1217,6 mg/L of COD; 645 mg/L of BOD; 156 mg/L of TSS; and 88,45 mg/L of oil and grease. Then the grease trap was modified with a 10 cm-column containing activated carbon. Furthermore, the result showed that the wastewater output contained 2,5 mg/L of COD; 19 mg/L of BOD; and 3,4 mg/L of TSS while the oil and grease was undetected. Another research was conducted by Khusnul Amri dan Putu Wesen. They used anaerobic biofilter with medium (bioball). The research yielded an optimum result of removal efficiency for 90,29% of COD and 92,93% of BOD in 5 days with the recirculated ratio was 100%.

It was observed that at the canteen of Campus 7 of Health Polytechnic of the Ministry of Health Semarang, before the dishes were washed, the leftover food was not directly thrown away to the disposal system but was collected in a plastic basket. In the washing process, the wastewater was directly flow to the disposal ditch. Thus, it allowed oil, grease, dishwashing detergent and other compounds from the leftover food flowed into the trench then cause unpleasant odors and scenery. This study aimed to design wastewater treatment equipment using grease trap, activated carbon, and aerobic biofilter (bioball) to reduce the level of BOD, TSS, oil, and grease in the canteen wastewater.

Waste water treatment is an important deed to meet the standardized criteria of the wastewater disposal quality. A simple way of waste treatment that can be applied is grease trap. It is an equipment known as waste pre-treatment. As the name suggests, the equipment traps oil and grease and prevents waste from being discharged into the waste disposal system. It works by using baffles and chambers to slow the wastewater flow as it passes. The chambers maximize retention time, allowing solids to settle at the bottom of the trap while lighter substances rise to the top to allow easy separation process (Kosciuzko National Park, 2012).

Another method in wastewater treatment is using activated carbon. With its large application effect, activated carbon functions as color, flavor, and smell remover as well as purification agent. Activated carbon is commonly used as water purification in mineral water production process and in wastewater treatment (Lan Wu, 2009). Organic waste treatment is aerobic applied using biofilter reactor with media. This media is for microorganism breeding process (Indriyati, 2007).

The Quacy Experiment with Non equivalent group control Pre-test and Post-test design was performed to test the efficiency of wastewater treatment plant in reducing BOD, TSS, oil, and grease. The unit analysis of the research was 3 samples the domestic waste generated from the canteen of Campus 7 of Health Polytechnic of the Ministry of Health Semarang.

The instruments used in this research were DO Meter to measure the BOD level, Oil in Water meter to measure the oil and grease content, and Water Quality Control to measure the temperature, pH, and TSS. Then the result was analyzed using efficiency formula.

The independent variable in this study is the design of the liquid waste treatment equipment. The dependent variable in this study was the levels of BOD, TSS, oil and fat in canteen wastewater. Confounding variables in this study are pH, temperature. The control variables in this study were the thickness of activated carbon, the number of bioballs, residence time, and flow rate.

The sample in this study was the domestic waste of Campus VII canteen. The parameters examined were BOD, TSS, oil and grease by taking samples once each before in the collection tub and after at the end of the tub (outlet).

This research was conducted in 3 repetitions, by the steps:a. Sampling on day 1, 15.00 WIB, b. Sampling on day 2, at 15.00 WIB, and c. Sampling on day 3, at 15.00 WIB. In addition, Water Quality Monitoring System (WQMS) which can be accessed via a laptop, used to measure pH, TSS and water temperature parameters. Checking the levels of oil and fat was carried out at the health laboratory of Banyumas district and level of BOD in Regional Technical Implementation Unit (UPTD) of the Purbalingga district health laboratory. For oil checking with Oil in water TD 500 D and for grease checking with gravimetric. The research data were tabulated for further analysis using the SPSS program with the Paired t Test statistical test.

2. Another section of your paper

The design of wastewater treatment plant consists of a. collecting basin of 60cm x 70cm x 30cm in volume with input pipe (pipe1) of 0,5 inch which functions for conveying the wastewater to the collecting basin, and output pipe (pipe2) of 0,5 inch which functions for connecting the wastewater from the collecting basin to the grease trap basin; b. grease trap basin of 35cm x 60cm x 45cm in volume size with three chambers which functions for holding grease, c. filtration basin of 35cm x 60cm x 45cm in volume size which is divided into three parts. The first part contain bioball to decompose organic substance with aerobic system. The second part is applied with activated carbon to absorb certain substances in the wastewater. The third part has silica sand to filter solid substance in the waste water.

1.1. The main parameter is in canteen wastewater

The result of measuring the quality of canteen wastewater include levels of BOD, oil, fat, and TSS. The results of the measurement of these parameters are explained in the form of numbers in the table.

Table 1. Main parameter is canteen wastewater

Parameter	Inlet (mg/lt)	Outlet (mg/lt)	Removal (%)
BOD	777, 68	126,38	83,74
Oil	69,27	0,9	98,7
Grease	9945	9948	-0,03
TSS	233,3	176	24,56

The accuracy of the BOD drop is shown in the 1st and 2nd time. It occurs because of biofilm that is consctructe from some of the decomposing aerobic bacteria which are needed for the microorganism growth and development. This microorganism lies in biofilter basin to decompose organic substances. As the organic substances decreases, it affects the microorganism substrate as the influencing factor of growth and metabolism limit. BOD is also decreased because there is activated carbon absorption as the final wastewater treatment. Activated carbon takes place as further biological process to reduce dissolved organic substances. The flow in biofilter aerobic basin goes bottom-up. This is for the residual particles or biofloc to settle at the bottom due to the gravitational pull and for the wastewater to have direct contact with the bioball medium. This biofilter medium contains a lot of aerobic decomposing bacteria for decomposition of canteen wastewater. At the final treatment process in absorption basin, wastewater directly apply with activated carbon element. This is a final absorption of organic substances that might be still dissolved from the previous process.

The table shows that TSS level decreases although the number does not seem maximum. It happens because the pipe column modified with activated carbon is 7,5 cm. Compared to what T.A. Zaharah (2017) did that she found no trace of oil and grease in the wastewater with 10 cm PVC pipe. The size of the carbon really affects the absorption strength since TSS is trapped by the carbon's structural pores. Activated carbon works by directly absorbing the molecules of the pollutants once they meet (Wijaya, 2002).

The oil and grease level decreases significantly from time 1 to time 2. But from time 2 to time 3 was the contrary. The oil and grease content increases. This occurs because some of the oil and grease float on the water and discharge from biofilter then flow to the third basin, the activated carbon, through the connecting pipe. The oil floats since it is less dense than the water. The oil mass weight is 0,8 gr/ cm^3 whereas the water mass weight is 1 gr/ cm^3. The authors found that the biofilter and activated carbon in the wastewater treatment had not yet worked maximally since the decreased output of the oil and grease in the canteen wastewater did not reduce significantly. The authors, then, did some anticipating actions in the third measurement by removing the remaining oil and grease from the biofilter and activated carbon basins and by repairing the baffles and chambers in the grease trap in order to not affect the next treatment procedures. Yet in the oil and grease removal process, some of the oil and grease fell down and were discharged into the biofilter basin. Extra carefulness was needed.

According to Cameron, William and Frank L. Cross (in Safitri, 2017), the result is considered efficient if the decrease level is in the range of 80 – 90% or above 90%. The table shows that the waste treatment applied on the wastewater is efficient to lower the BOD, TSS, oil, and grease.The average efficiency points are 83,74% for BOD; 24,56% for TSS; and 98,7% for oil and -0,03% grease. That means the wastewater treatment in Campus 7 canteen is more effective in reducing oil and BOD level. The condition was obtained because there were early food residual sedimentation and filtration that occurred in the first basin by micro screen. Furthermore, the smaller substances were trapped in grease trap making them stop flowing. Bioball is a buffer media or as a place for the growth and development of bacteria that will coat the surface of the media to form a thin layer (biofilm). Biofilms require nutrients for the growth of microorganism populations and help prevent the release of cells from the surface in a flowing or continuous system (Herlambang A, 2002). The research used Enzymes,Bacteria and Nutrient Concorcium TCM – 4143 WE , can be function as activator and catalisator to speed up bacterial metabolism of waste water treatment process. This makes COD/BOD of waste water reduce more significant, will function in broad range of pH 5 – 8.5 and temperature 35°C–60°C, making it a product very adaptable to most waste water treatment processes. Benefits are a. reduces COD/BOD, TSS in waste water treatment systems, b. break down the organic materials into water soluble compounds, c reduces filamentous organism that can give a negative effect (excess foam & sludge bulking) on excess amount, d. speed up bacterial metabolism by increasing biosynthesis, assimilation & ingestion, cell maintenance .

In the previous research that was almost the same with this research was domestic wastewater treatment using a Bio sand Filter, the efficiency of reducing the BOD concentration ranged from 62.92% - 67.01% and TSS ranged from 78.40% - 81.99% with an initial BOD content of 60.71 mg / l and TSS 103 mg / l (Rhenny Ratnawati dan Sakbanul Lailatul Ulfah, 2020). Researchers analyzed that this Bios and Filter research did not use bacterial nutrients but seeding and acclimatization or adaptation was carried out naturally by entering domestic wastewater into the filter media. The seeding and acclimatization process is carried out to see the growth of microorganisms in the form of a biofilm layer that appears (Ratnawati dan Kholif, 2018). When compared with the aerobic biofilter process (bioball) it is still possible to be more reliable in reducing the BOD level of domestic waste (canteen) from 777,68 mg / lt to 126,38 mg / lt (83,74%) while TSS levels are still not optimal. because of the oil and fat content in the canteen waste.

Organic Micropollutants (OMP) in wastewater affected the performance of the domestic waste treatment process. Organic micropollutants are synthetic chemicals found in water sources and treated wastewater at concentrations in the range of micrograms per liter or lower. Micropollutants tend to be resistant to biodegradation and many are bioactive. Most wastewater treatment plants are not designed to completely remove micropollutants. Sources of micropollutants include pesticides, solvents, detergents, pharmaceuticals, and personal care products. Most of the micropollutants found in wastewater come from household sources. Because freshwater scarcity is becoming a problem worldwide, the reuse of treated wastewater is becoming more important, as is the need to remove micropollutants in the wastewater treatment process. The effects of micropollutants depend on their specific chemical properties. For example, some are classified as endocrine-disrupting compounds because above critical exposure levels, they can alter the hormonal balances of complex organisms. A well-known example of the endocrine-disrupting effects of some micropollutants is the feminization of male fish, which have been shown to lose some of their male characteristics and gain some female ones as a result of pollution. (Access Science Editors, 2016).

Emerging micropollutants (EMPs) are defined as synthetic or natural compounds released from point and nonpoint resources and end up to the aquatic environments at low concentration. EMPs are not commonly monitored and measured; and therefore, they impose adverse effects on human health and aquatic world. The EMPs include pharmaceuticals and personal care products, detergents, steroid hormones, industrial chemicals, pesticides, and many other contaminants. Bioaccumulation, toxicity, and resistance to degradation are reasons for potential risks of EMPs. Most of the conventional wastewater treatment plants (WWTPs) are not designed to completely remove EMPs at low concentration, and this subject makes the treatment processes vulnerable to remove the dangerous compounds (Afsane Chavoshani. ; Suresh C. Ameta, 2020). Neither drinking nor wastewater treatment processes are specifically designed to remove PCPs from water. Several technologies were developed to provide more efficient removal, including advanced oxidation processes (AOPs) and membrane filtration and activated carbon (Liang et al., 2014; Nakada et al., 2017).

Additionally, from a water management perspective, the elimination of organic micropollutants (OMP) is increasingly important. In Europe, the most commonly used process technologies to remove OMP are ozonation or active carbon (AC) technologies. The reduction of OMP can be realized by different technologies: Oxidative technologies such as ozonation and advanced oxidation processes, adsorptive technologies like powdered activated carbon and granulated activated carbon (GAC) or physical technologies like nanofiltration and reverse osmosis (Gretzschel, Oliver et.al, 2020,). The primary treatment had no effect on OMPs (removals < 20%), whereas the biological treatment removed OMPs that can be easily sorbed onto sludges or biodegraded (>60%). The adsorption conditions (10 g/m3 fresh activated carbon addition) were not sufficient to achieve the 80% removal targeted in Switzerland for compounds suggested as indicator substances for wastewater treatment. A higher dose of activated carbon or the combination with another advanced treatment should be used to achieve a satisfactory removal of those compounds (Ronan Guillossou, et.al, 2019).

To improve the waste water treatment efficiency, implementing more pre-treatments and or more treatments is needed. It can maximize the decrease of BOD, TSS, oil and grease level. Efficiency may depend strongly on the type of compound to be removed. None of the technologies can remove all of the compounds (Ravina et al., 2002; Schröder, 2002; Wenzel et al., 2008). Membrane Bioreactor (MBR) -based treatment steps show potential as a cost-effective method for clearance of many micropollutants from waste waters. MBR-based treatment steps show potential as a cost-effective method for clearance of many micropollutants from wastewaters. Besides MBR processes, other membranes and membrane processes have been widely used for wastewater treatment. Micropollutants can be removed by direct membrane filtration processes, such as low-pressure microfiltration (MF), ultrafiltration (UF), and high pressure nanofiltration (NF) and reverse osmosis (RO) (Kamaz, Mohanad; Wickramasinghe, S Ranil; Eswaranandam, Satchithanandam; Zhang, Wen; Jones, 2019). The using of water quality monitoring system (WQMS) and bioball in domestic waste water treatment which is consists of equalization basin, grease trap, aerobic biofilter, bioball, activated carbon filter, silica sand filter, characterized by the presence of bioball an sensors for for parameters pH, TDS and temperature. The results of the paired sample t test showed that for BOD level, the significant value is 0,256, the TSS is 0,153 and the oil is 0,159. Everything above 0,05 (5%). This means that the correlation between the average input and output is weak and not significant.

1.2. Factors of pH and temperature parameters on microbial growth

Table 2. Parameter of pH and temperature

Parameter	Inlet	Outlet
pH	7,02	6,94
Suhu (°C)	28,52	27,39

pH is the key factor of microorganism growth. Some bacteria can live at pH 9,5 while others can live below pH 4,0. In general, the average pH for microorganism to live is 6,5 – 7,5 (Nusa Idaman Said, 2002). Fresh water has a pH of 7 or neutral pH. A pH less than 7 is acidic. A pH greater than 7 is basic.

According to the attachment of the regulation of the Ministry of Environment and Forestry number P. 68/2016 about domestic waste quality standard, the standard pH in wastewater is 6-9. The pH test result from the canteen inlet basin is 7,04 at 03.52 p.m, 7,01 at 04.31 p.m, and 7,03 at 05.12 p.m. the average point was 7,02. This shows a non-fixed result. The pH test result from the outlet basin is 7,04 at 03.52 p.m, 7 at 04.31pm, and 6,8 at 05.12 p.m. the average point is 6,94. In brief, the pH of day 1 today 3 is considered neutral because it is below the maximum standard level.

The table shows decrease in the temperature from inlet basin to outlet basin. It occurred because of the weather. Rain causes wastewater temperature change. Yet it does not affect the microorganism growth. Herlina Safitri (2017, p. 53) said that bacteria grow well in the temperature of 25°C–40°C (mesophilic). If the temperature is less than that, it may derail the bacteria's growth or even may bring the bacteria to die. The optimal temperature for microorganism in aerob process is similar to that in aerobic process (Nusa Idaman Said, 2002).
Thermophilic, can grow in the temperature of 35 to 75 degree Celcius. Therefore the best growth showed in the temperature of 55°C to 65°C (Nusa Idaman Said, 2002).

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