

Conference Paper

Treatment of Household Grey Water Using a Series Anaerobic Biofilter - Wetland

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Abstract

The study aimed to treat household grey water, focusing on technology that is simple and low cost in terms of operation and maintenance. The treatment was conducted within laboratory scale based using a series continuous reactor of anaerobic biofilter and wetland. The anaerobic biofilter was equipped with plastic derived from Poly Ethylene Terephthalate (PET) as biofilter media. Subsequent wetland used vertical sub-surface flow constructed wetland (VSSF CW). Removal efficiency of TSS, BOD, COD achieved from anaerobic biofilter was 84%, 79%, 57% respectively, while wetland resulted TSS, BOD, COD removal of 81%, 84% and 67% respectively.

Keywords: anaerobic biofilter, BOD, COD, household grey water, TSS, wetland

INTRODUCTION

Domestic wastewater consists of grey water and black water. Grey water is domestic wastewater from showers, bathtubs, laundry facilities, kitchen sinks which comes from households, schools, offices, health facilities, commercial facilities and public facilities (Eriksson et al., 2002). Households produce about 50%-80% grey water from lavatory, kitchen and washing activities (Li et al., 2009). Some households discharge untreated grey water into receiving water bodies, contributing to water pollution in water sources. Accumulation of organic matter contained in grey water is potential to degrade quality of the receiving water bodies (Fulazzaky, 2010). Grey water dominantly consist of organic matter, suspended solid, nutrients and total coliform, therefore the characteristics of TSS, BOD, COD, NH₄-N, Total P, total coliform within grey water shows high concentration (Veneman & Stuart, 2002). Besides, grey water production per day considerably fluctuates, especially from household activities which depends on use of water (Ghunmi et al., 2008).

Grey water treatment is needed to achieve complied effluent standard of grey water discharged to receiving water bodies. The treatment should be designed to deal with quality and fluctuated production of grey water (Ghunmi, 2010). Grey water treatment should be simple operation, low energy use and low operation and maintenance cost. Treatment process of grey water is conducted either aerobic or anaerobic and within the microorganism growth system of either suspended growth or attached growth. Each process has advantages and disadvantages. Aerobic treatment needs oxygen supply otherwise anaerobic treatment needs no oxygen supply. Inamori et al. (1986) stated that aerobic treatment process uses more energy than anaerobic treatment process due to the use of aerator as oxygen supply equipment. The anaerobic treatment process, moreover requires low technology due to less equipment needed to supply oxygen, therefore the treatment operation and maintenance is simple and low cost (Kayombo, et al., 2000). In term of the characteristic of effluent quality, the anaerobic

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treatment results in high quality of grey water effluent comply with the standard. According to previous research, removal efficiency of organic matter from grey water which was treated using a series anaerobic biofilter and Upflow Anaerobic Sludge Blanket (UASB) was 81% (Sawajneh, 2010). The suspended growth system results in more sludges than the attached growth system as the suspended solids and suspended organic matter forms sediments which are accumulated (Bouza-Deano & Salas-Rodriguez, 2013). The sludges require treatment before disposed into environment. Conversely, the system of attached growth produces less sludgy because the organic matter and microorganism is attached in the media as biofilter.

Anaerobic biofilter is an alternative of grey water treatment applying attached growth anaerobic system which is able to treat organic matter content from high strength to low strength (Inamori, 1986). Factors influencing the growth of microorganism to degrade organic matter are pH, temperature, Hydraulic Retention Time (HRT), biofilter media (Inamori, 1986). To comply with standard of grey water effluent, the use of anaerobic biofilter is possibly continued to sequent natural aerobic treatment like wetlands as an alternative of grey water treatment. Natural aerobic treatment using wetlands results in simple operation and maintenance, low operator need, low energy use and low cost (Kayombo et al., 2000 and Mburu et al., 2013). Wetland is also appropriate to apply in tropical area (Mara, 2004). Varieties of plant used for wetland are *Cattail*, *Azolla pinnata*, *Lemna sp* and *Cyperus papyrus*. This research was purposed to treat household grey water using a series anaerobic biofilter and wetland, focusing on technology that results in simple and low cost in terms of operation and maintenance.

METHODS

The household grey water was obtained from grey water outlet pipe from 9 households at the area of Kejawan Gebang, Sukolilo, East Surabaya. The outlet pipes discharge grey water from showering, laundry and kitchen activities. The sampling was conducted in the morning every day. Debit collected per day was $0,3 \text{ m}^3$.

The research was conducted in laboratory scale based using a series continuous reactor of anaerobic biofilter and wetland. Anaerobic biofilter consists of 1 settler compartment and 5 sequent anaerobic biofilter compartment. Media biofilter was located in the first sequent anaerobic biofilter compartment following settler compartment. Debit used in the anaerobic biofilter reactor was $0,3 \text{ m}^3/\text{day}$ within HRT of 9 hours. Sequent constructed wetland was conducted using vertical sub-surface flow. Details anaerobic biofilter reactor are described as follows:

- 1 settler compartment, length 25 cm, width 40 cm, height 50 cm, freeboard 10 cm;
- 5 anaerobic biofilter compartment, each compartment consists of length 15 cm, width 40 cm, height 50 cm, freeboard 10 cm;
- Media biofilter was derived from Poly Ethylene Terephthalate (PET) of mineral water bottle which was formed to string ring lace.

Household grey water was treated in anaerobic biofilter through 3 steps, consisting start up, seeding and acclimatization, running. Starter added to the anaerobic biofilter reactor in this research was sludge taken from oxidation ditch at septic tank sludge treatment unit of IPLT Keputih Surabaya. The ratio of grey water and sludge as the starter was 70%: 30%. Period of running the anaerobic biofilter reactor was started after biofilm was formed at media biofilter. This research was conducted within about 8 weeks, with approximately 5 weeks of seeding and acclimatization period. Biofilm started to grow at biofilter media at 5 weeks, then the research was followed by 3 weeks of running period. Grey water characteristics measured were TSS, BOD, COD, at which observed before treatment; 5 weeks of seeding and acclimatization period; and 3 weeks of running period. Besides, the grey water characteristics of constructed wetland effluent were also analyzed for TSS, BOD, COD parameters.

RESULT AND DISCUSSION

Characteristics of grey water influent before treated were 230 mg/l of TSS, 208 mg/l of BOD and 513 mg/l of COD. This characteristics were not complied with the standard stated at Governor Regulation of East Java Number 72, 2013. In accordance with this regulation, the standard of TSS, BOD, COD contained in grey water effluent discharged into receiving water bodies were 50 mg/l, 30 mg/l dan 50 mg/l, respectively. Characteristic of COD within influent used for in the research was high due to laundry and washing activities in the morning at each household sampled. The following figures show detailed grey water characteristics of TSS, BOD, COD measured within anaerobic biofilter reactor at either seeding and acclimatization period or running period.

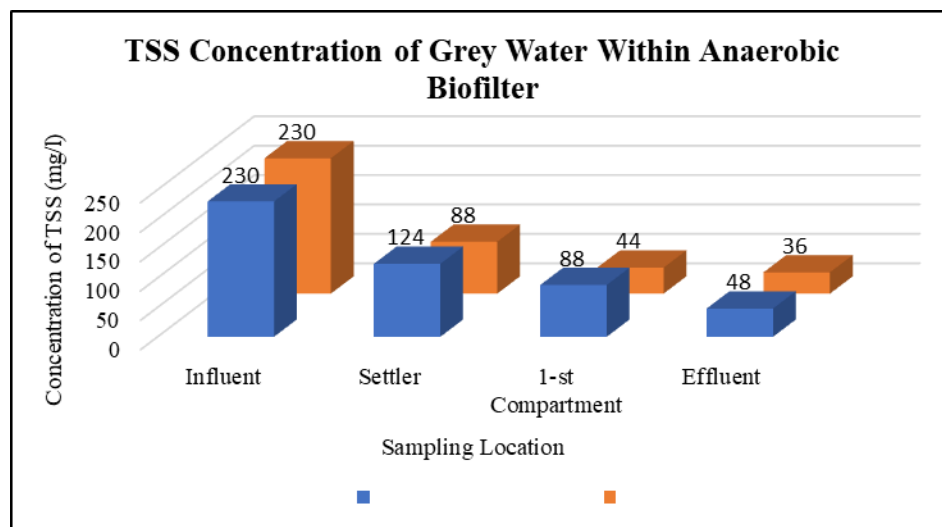


Figure 1. TSS concentration of grey water within anaerobic biofilter

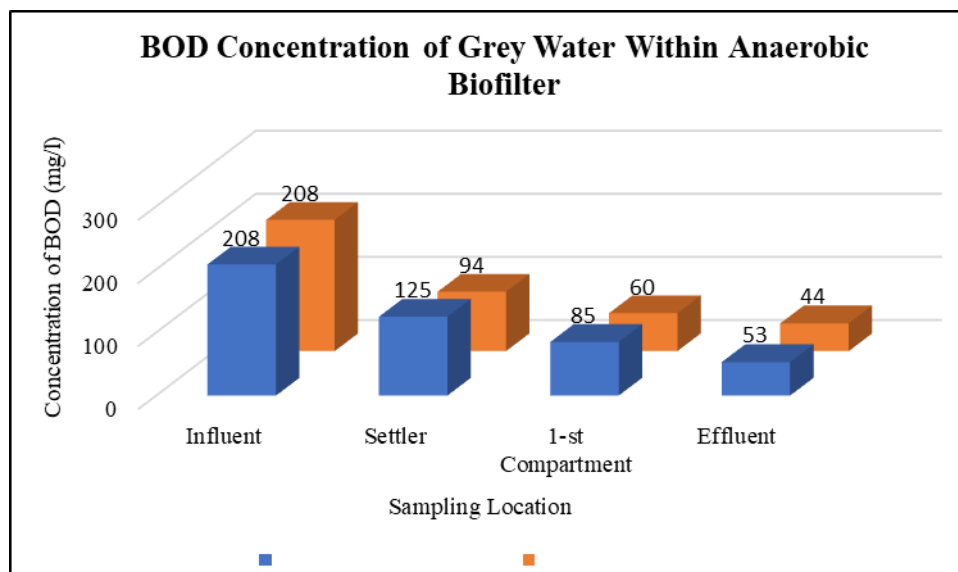


Figure 2. BOD concentration of grey water within anaerobic biofilter

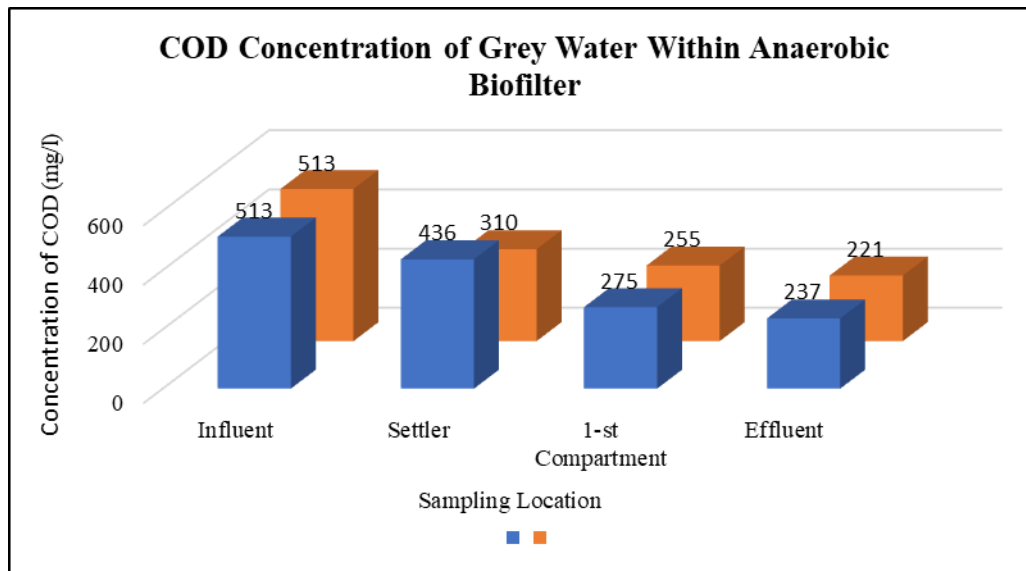


Figure 3. COD Concentration of Grey Water within anaerobic biofilter

According to Figure 1, Figure 2 and Figure 3, these show removal of TSS, BOD, COD of grey water, either at the period of seeding and acclimatization or running. At the end of running period, the concentration of TSS complied with the standard of grey water allowed discharging into receiving water bodies. BOD and COD, however, were still slightly higher than the allowed standard value. Grey water required additional treatment to improve the effluent quality from anaerobic biofilter. Natural treatment with constructed wetland reactor was sequentially conducted. Removal of TSS, BOD, COD achieved within constructed wetland were 81%, 84% and 67% respectively. The following figures show the concentration and the removal of TSS, BOD, COD achieved within anaerobic biofilter and constructed wetland.

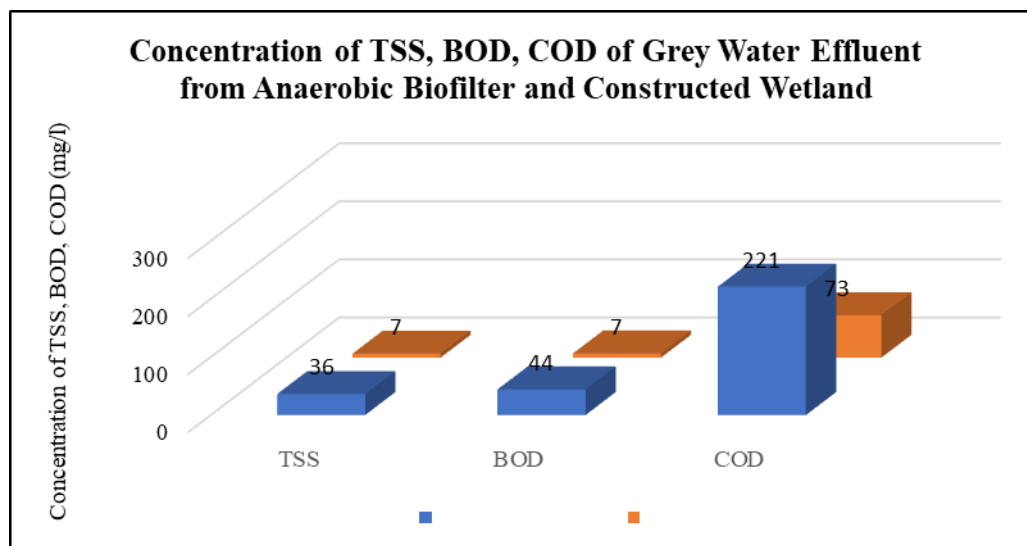


Figure 4. Concentration of TSS, BOD, COD of Grey Water Effluent from Anaerobic Biofilter and Constructed Wetland

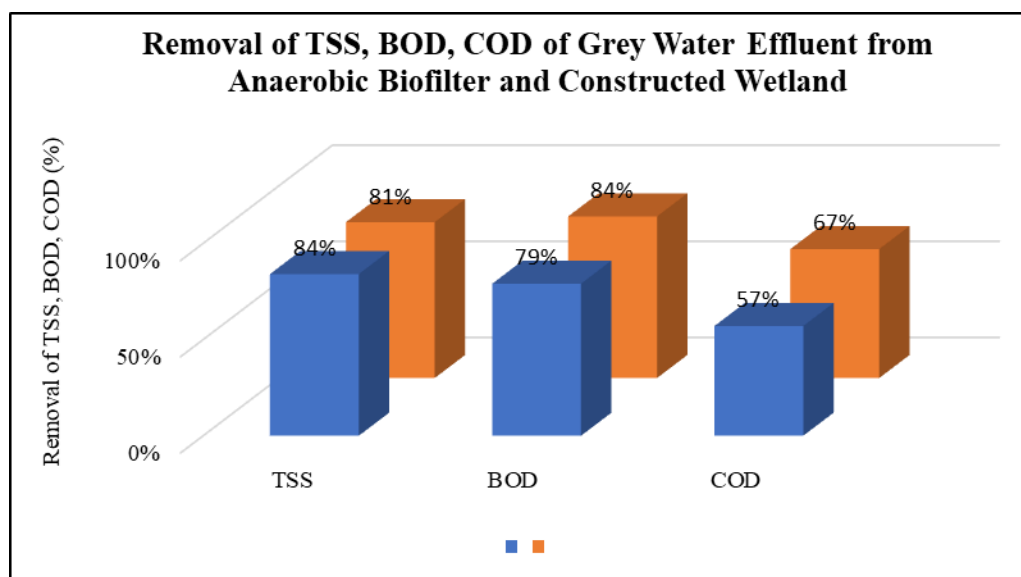


Figure- 5. Removal of TSS, BOD, COD of Grey Water Effluent from Anaerobic Biofilter and Constructed Wetland

From Figure 4, it can be seen that TSS and BOD concentration of grey water from constructed wetland had achieved the quality complying with standard of grey water effluent, whereas, COD concentration was still about higher than the standard value. COD removal reached both from anaerobic biofilter and constructed wetland were the least removal compared to the removal of TSS and BOD. TSS removal of anaerobic biofilter reached the highest value compared to the removal of BOD and COD. High removal of TSS within anaerobic biofilter showed that settler compartment of anaerobic biofilter reactor operated in good performance to settle solid particle. This led to reduce organic loading in subsequent compartment as anaerobic biofilter. The high content of solid particle potentially disturbs the biological process within anaerobic biofilter compartment. If the sedimentation process within settler compartment operates effectively, then the removal of organic content resulted within subsequent compartments of anaerobic biofilter is potentially high.

CONCLUSION

Characteristics of grey water influent before treated were 230 mg/l of TSS, 208 mg/l of BOD and 513 mg/l of COD. Characteristics of grey water effluent from anaerobic biofilter were 36 mg/l of TSS, 44 mg/l of BOD and 221 mg/l of COD. Characteristics effluent from constructed wetland were 7 mg/l of TSS, 7 mg/l of BOD and 73 mg/l of COD which comply with the standard. Removal efficiency of TSS, BOD, COD within anaerobic biofilter was 84%, 79%, 57% respectively. Removal efficiency of TSS, BOD, COD within constructed wetland was 81%, 84% and 67% respectively.

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