THE EFFECT OF LOAD BOD AND HYDRAULIC TIME ON HOSPITAL WASTEWATER TREATMENT USING AF2B REACTOR

[1]PRAYITNO, [2]HARDJONO, [3]EKO NARYONO, [4]RULIANAH

[1,2,3,4]Chemical Engineering Department, State Polytechnic of Malang
E-mail: [1]prayitno@polinema.ac.id

Abstract - In Indonesia, The ability of Wastewater Treatment Plant (WWTP) of hospitals, especially the biological treatment system in processing waste water is relatively lowwhich only 52% meet the quality standards. It is necessary to research to obtain optimal processing efficiency through study of several factors that effect biological treatment.The aim of this research is to know the influence of load BOD and hydraulictimeto AF2B (Aerobic Fixed Film Biofilter) reactor performance in reducing BOD, COD, Ammonia-free and Phenol. The research used AF2B reactor that a continuously operating, wherein the AF2B reactor contains a biofilter shaped honeycomb and is connected to a diffuser as an air supplier. The experimental stage consists of: 1). Acclimatization of bacterial consortium and, 2). Wastewater treatment in AF2B reactor. While the variables used are load BOD (1,000 mg/h; 2,000 mg/h), and HydraulicTime(4 hours, 4.5 hours, 5 hours). At the acclimatization stage, endegeneous bacteria consortium isolates were developed by decanting into beaker glass, added aquadest 5% (v) and aerated for 3 days. Furthermore, wastewater 10% (v) is added gradually to optimal bacterial consortium growth.At the wastewater treatment stage in the AF2B reactor, the hospital wastewater is fed into the AF2B reactor that containing the biofilter and the acclimatized bacteria consortium and then aerated. By making changes of load BOD and hydraulictimeand analyzing the pollutant concentration on the influent and effluent of AF2B reactor so the AF2B reactor performance is known.The results showed that performance of AF2B reactor are influenced by load BOD and hydraulictimethe, where with BOD load of 2,000 mg /h and hydraulictimeof 5 hours can remove the BOD, COD, Ammonia-free and Phenol were 98%, 90%, 86% , and 82% respectively.

Keywords - Aerobic Fixed Film Biofilter, Endegeneous Bacterial Consortium, Hydraulictime, Load BOD

I. INTRODUCTION

Hospital wastewater contains toxic, pathogenic and biodegradative contaminants that have the potential to cause environmental pollution and health problems if not treated properly[1]–[5]. Some hospital wastewater pollutants often exceed quality standards, for example: BOD, COD, TSS, Ammonia-free, and Chlorine-free [2], [3], [6], [7]. Reference [2] mentions that 44% of hospitals have Waste Water Treatment Plant (WWTP) but 52% of effluent from WWTP that meet environmental quality standards. This shows that the effectiveness and performance of WWTP in hospital needs to be improved. Some hospital wastewater treatment technologies have been implemented, among others: Anaerobic Fixed - Bed and Suspended Aerobic Reactor with a Membrane,activated sludge combined with biological, Membrane Bioreactor, upflow anaerobic fixed-bed and suspended aerobic reactor[8]–[12]. However, the technological capability in reducing the concentration of pollutants is still varied, so it is necessary to study continuously to obtain efficiency and effectiveness process. The biological treatment is influenced by initial concentration, type and selection microbial, hydraulictime, reactor type, nutrition, inhibitor and pH[10], [13], [14]. Reference [15], [16]show that endegeneus bacterial consortium in the AF2B reactor that operate as bath can reduce contaminants in hospital wastewater by BOD (92%) COD (86%), Ammonia-free (76%), Phenol (88%) respectively.Reference [17], [18] mentioned that the bacterial consortium has a better ability to degrade organic materials than single bacteria. Therefore, this research aims to determine the effect of load BOD and hydraulic time in reducing the concentration of hospital wastewater pollutants using AF2B reactors that operate continuously.

II. METHODOLOGY

The research was conducted in 2 (two) stages, namely: 1). Acclimatization of bacterial consortium, 2). Hospital wastewater treatment in an AF2B reactor that operate continuously using a bacterial consortium. Materials used in the experiment were: Hospital wastewater, bacterial consortium (Pseudomonas capica, Pseudomonas diminuta, Bacillus sp1, and Nitrobacter sp2), Reagent for analysis (H_2SO_4, $K_2Cr_2O_4$, $Na_2S_2O_5$, Mn_2SO_4, KI, Ferro Amonium Sulfate). While the equipment for the experiment used, among others: AF2B Reactor, Microscope, Hemasitometer and equipment for sample analysis (UV-Vis Spectrophotometer, Reflux, Winkler Bottle, and Incubator shaker). Variables used in the experiment were: load BOD (1,000 mg/ hour, 2,000 mg/h) and hydraulic time (4 hours, 4.5 hours, 5 hours). While as a fixed variable (pH: 7; temperature: 27 - 29^oC; hospital wastewater; reactor volume: 25 liters; biofilter volume: 75% volume). Parameters tested include: BOD, COD, ammonia-free and Phenol.Method for analysis or sample test ie: Titration method using winkler bottle for BOD analysis, Open reflux method for COD analysis, and UV-Vis Spectrophotometric Method for Ammonia-free or Phenol analysis[19].

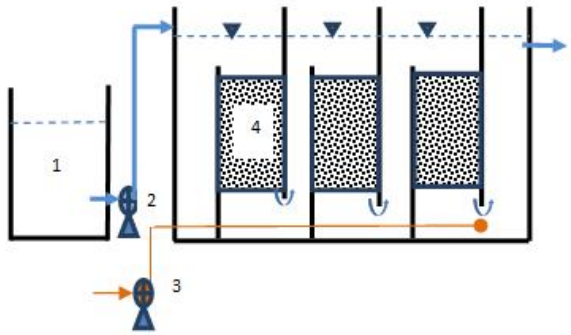


Fig1. Skets of AF2B reactor

III. EXPERIMENTAL PROCEDURES

A. Acclimatization of bacterial consortium

In the experiment acclimatization bacterial consortium: the consortium of bacterial isolates obtained from bacterial isolation in hospital waste water by the Biotechnology Laboratory – ITB, Bandung conducted acclimatization which a number of isolates of bacteria consortium added in Erlen meyer and then added as much as 2 liters of distilled water and aerated for 2 days.

Further into Erlen meyer added nutrients as much as 5% (v) every day up to 7 days and sampling to show the growth of bacteria consortium. Furthermore starter bacteria consortium that has been growing optimally transferred to the reactor AF2B which contains a biofilter shaped honeycomb then added hospital wastewater as much as 10% (v) gradually over 2 weeks until the growth of bacteria consortium to reach optimal growth or bacterial consortium has adapt to a hospital wastewater.

B. Wastewater Treatment In The AF2B Reactor Continuously Operates

Into the AF2B reactor which has contained an biofilter shaped honeycomb and a bacterial consortium that has been acclimatized with the hospital wastewater. Set influent flowrate at a certain flowrate so as to have hydraulic time for 4 hours; 4.5 hours; 5 hours. Futhermore, the influent flowrate is measured BOD concentration to obtain BOD loading of 1,000 mg/h; 2,000 mg/h. Set the pH at normal conditions ie 6.5 - 7.5. Set the air flowrate of the blower at a certain flowrate and setting the recycle flowrate of 10% of the influent flowrate, then sampling the influent and effluent of the AF2B reactor to be analyzed BOD, COD, Ammonia-free and Phenol.

IV. RESULT AND DISCUSSION

The experimental results acclimatization on bacterial consortium showed that the bacteria had good growth, where a consortium of bacteria have growth increasing with increasing time until optimal growth which the bacterial consortium is growing with growth patterns: lag phase, log phase, stationary phase and phase of death. In the log phase, bacteria have growth from 135 - 210 minutes, and are at peak growth at 240 minute (4 hours). Thus the maximum growth period of the bacterial consortium is 4 hours (240 minutes), which is then used as a reference in determining the hydraulic time in continuous processing in the AF2B reactor.

The Effect of Load BOD

The experimental results of the AF2B (Aerobic Fixed Film Biofilter) reactor operating continuously and by changing the BOD Loading (1,000 mg/h; 2,000 mg/h) for hydraulic time for 5 hours were obtained experimental data as Figure 2.

Figure 2 shows that hydraulic time of 5 hr, the longer the process will decrease the concentration of pollutants in the waste water (BOD, COD, free ammonia, and phenol) where at 5 hours the pollutant concentration tends to drop stagnantly.This indicates that with increasing process time the more pollutants are decomposed (biodegradation) by the bacterial consortium contained in the AF2B reactor, and in the first 5 hours there is a significant decrease in the pollutant concentration (biodegradation of the pollutant) that is BOD (82- 98%), COD (80 - 90%), Ammonia free (76 - 86%), Phenol (77 - 82%).

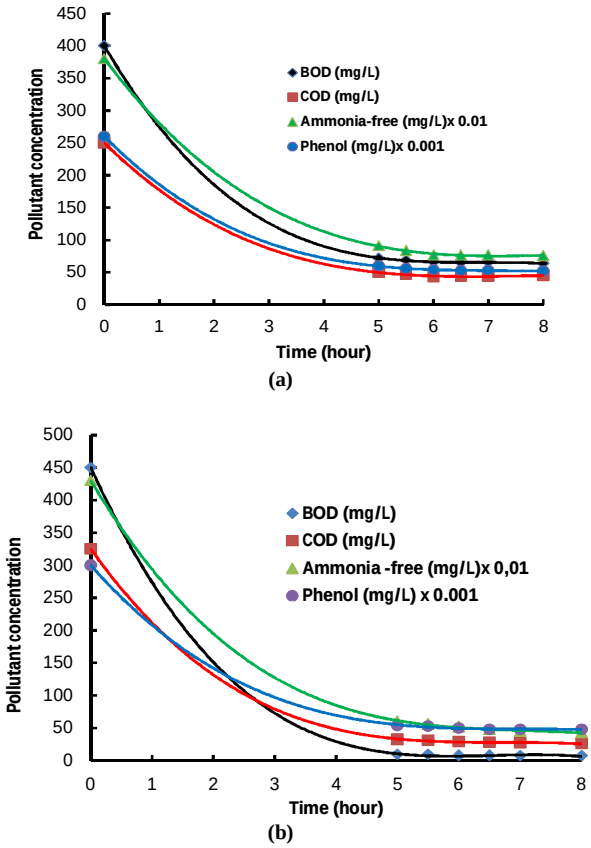


Fig2. The concentration of pollutants in the AF2B reactor at hydraulic time: 5 hours with various load BOD
(a). Load BOD:1,000 mg/h
(b). Load BOD: 2,000 mg/h

Figure 2 also shows that the greater the BOD load causes the greater decrease in the concentration of pollutants in the AF2B reactor or in other words the greater the BOD loading causes more pollutants to undergo biodegradation by the bacterial consortium which in 5th hour for load BOD of 1,000 mg/h obtained decrease of pollutant concentration are BOD (82%), COD (80%), Ammonia-free (76%), and Phenol (77%). While the load BOD of 2,000 mg/h, the reduce of pollutants concentration are BOD (98%), COD (90%), Ammonia-free (86%) and Phenol (82%). Thus the greater the load BOD, the more substrate contained in the wastewater or the biodegradable organic materials (biodegred) by the bacterial consortium so the greater the decrease in the concentration of pollutants in the AF2B reactor.

The pollutants are biodegradated by a bacterial consortium into CO2, N2, new cell and energy [13], [14], [18], [20], [21]. In this experiment, the decrease of phenol concentration is smaller than other organic pollutants (BOD, COD and Ammonia-free), this is because phenol is an aromatic organic compound (circular chain) which is more difficult to biodegradable by bacteria than organic compounds with straight chain [22]–[26].

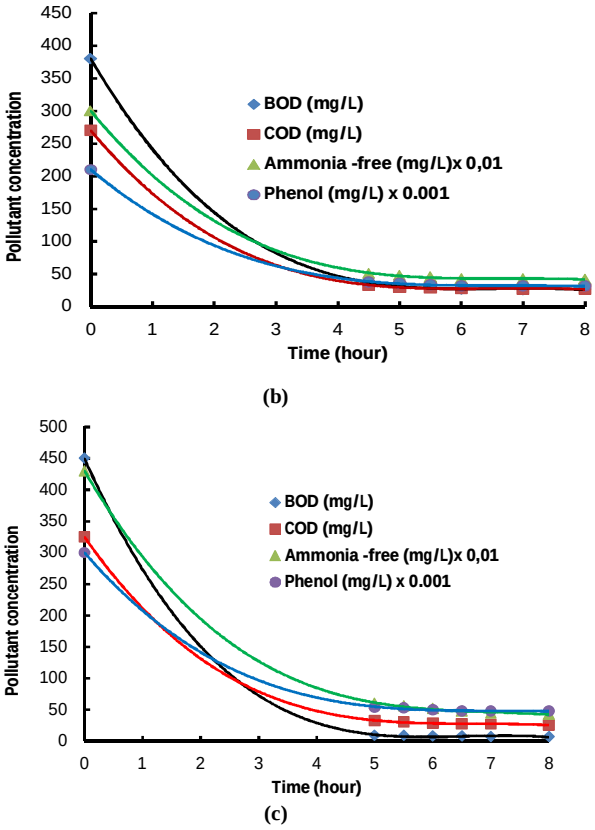


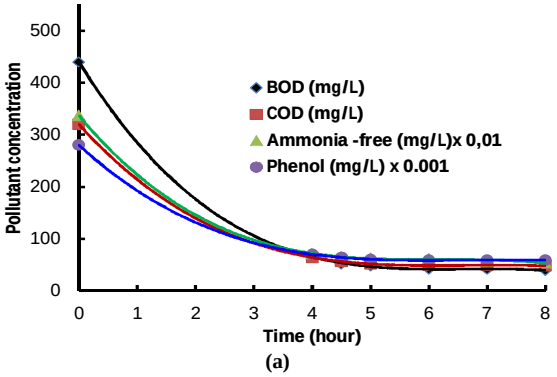
Fig3. The concentration of pollutant in AF2B reactor at load BOD of 2,000 mg/h with various hydraulic time. (a). Hydraulic time: 4 hours ; (b). Hydraulic time: 4.5 hour; (c). Hydraulic time: 5 hour

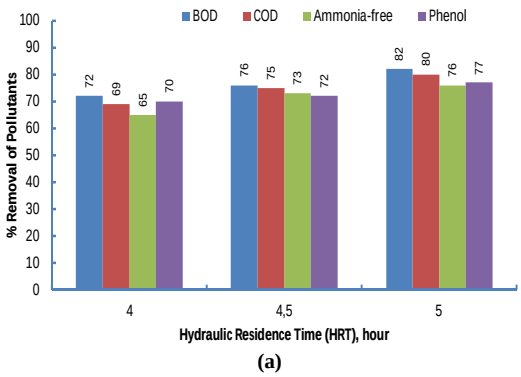
The Effect of hydraulic time

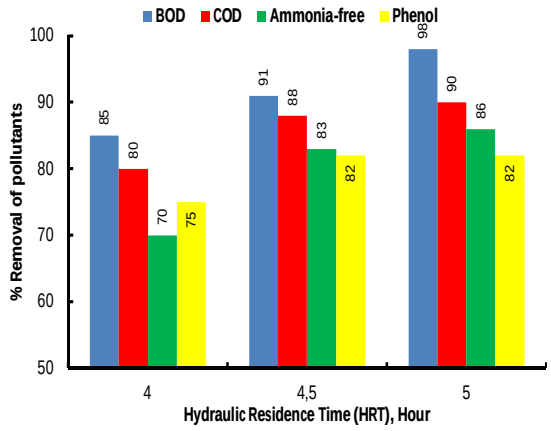
By making changes to hydraulic time for 4 hours, 4.5 hours and 5 hours obtained experimental data as Figure 3, which Figure 3 shows that the larger the hydraulic timethe longer the wastewater contact with the bacterial consortium in the AF2B reactor. This is causes more biodegradable pollutants into biochemical products, including: CO_2, H_2O, energy and biomass (new cells).

At hydraulic time: 4 hours there was a decrease of pollutant concentration as BOD (85%), COD (80%), Ammonia-free (79%) and Phenol (75%). While at hydraulic time: 5 hours there was a decrease of pollutant concentration of BOD (98%), COD (90%), Ammonia-free (86%) and Phenol (82%) respectively.

On the other hand, the ASBC process is able to reduce COD and coliform by 87.8% and 99.98%[8]. The A2F2B process is able to decrease BOD, COD and coliform by 89%, 82% and 90% respectively [27]. While the combination of Up Flow Anaerobic Fixed Bed (UAF-B) process - Suspended Aerobic Reactor (SAR) with Membrane (Micro Filtration, MF) can decrease COD concentration (94 - 98%) [28]. Thus AF2B reactors have a better performance in reducing the concentration of pollutants in hospital wastewater compared to some previous process.







(b)

Fig4. Percentage of pollutant removal at hydraulic time and load BOD various
(a). Load BOD: 1,000 mg/h ; (b). Load BOD: 2,000 mg/h

Furthermore, previous experiments showed the same trend which phenol concentrations decreased smaller than BOD, COD and Ammonia-free. This is because phenol is an aromatic organic compound and is an inhibitor of bacteria. Besides, phenol biodegradation by microorganisms is affected by the shape of the phenol compound, hydraulic time, initial concentration and form of the enzyme[13], [25], [29], [30].Reference[15] mentioned that AF2B reactor at HRT: 3 hours get phenol concentration decrease of 62% with biodegradation time for 12 hours.

CONCLUSION

Reactor AF2B containing bacterial consortium and biofilter shaped honeycomb have the ability to decrease the concentration of pollutants in hospitals wastewater, among others: BOD, COD, Ammonia-free, Phenol, where HRT of 5 hours and load BOD of 2.000 mg/h can decrease BOD, COD, Ammonia-free and Phenol concentrations by 98%, 90%, 86% and 82% respectively.

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