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Explore the Pollution Load of Slaughterhouse Wastewater and Their Treatment Potential Using Biofilm Reactor

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Abstract - High-strength slaughterhouse process carries significant concentrations and wide variations of blood and organic pollutions which cause serious deterioration of the surrounding living environment and aquatic ecosystem. This experiment examined the operation of two reactors a novel acrylic fiber carrier with conventional activated sludge (AS+BF) and conventional activated sludge (AS) reactors. Slaughterhouse contains a large amount of blood and organic pollution, which causes contaminant loading. Therefore, the biological treatment might be effective option with success. Experiments were conducted with two 10 liter reactors were arranged as sequencing batch reactor (SBR) at room temperature (20–25°C) and pH 7.0±0.5. Performances of treated slaughterhouse from both the experiments were evaluated in terms of chemical oxygen demand (COD) and biochemical oxygen demand (BOD_5) in 5th days. The reactor with AS+BF is higher than AS treatment due to aerobic and anaerobic circumstance under AS with BF which occurred with parallel treatment while the aerobic condition is occurring with AS treatment. Bio-reactor is arranged with AS + BF efficiently removed BOD and COD from the slaughterhouse.

Keywords - High-strength wastewater, Attach-growth, Biofilm, Biofringe, slaughterhouse wastewater, Biochemical oxygen demand (BOD_5), Chemical oxygen demand (COD).

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1 Introduction

Disposal of wastewater is a vital issue for many countries in the world including Iraq. Untreated wastewater and industrial effluent discharge caused serious deterioration of the surrounding living environment and aquatic ecosystem [16]. High-strength wastewaters like slaughterhouse wastewater contains significant concentrations and wide variations of pollutants such as biological oxygen demand (BOD), chemical oxygen demand (COD), total soluble solid (TSS), abnormal pH, organic compounds and hazardous heavy metals [1]; [8].

Slaughterhouse wastewater contents high concentrations of organic pollutant loading like BOD5, COD nutrients due to a large amount of blood and residual waste which is easily biodegradable [17]. A potentially variation of contaminated in natural sources like soil, water surface and ground water will occurs if such wastewater is not treated properly [15].

Conventional wastewater treatments, treated wastewater generates a complex compound effluents, in addition to a high contamination and sludge. The most common method of biological treatment activates sludge process. With stringent regulations of effluent discharge criteria of environmental quality, conventional activated sludge alone do not meet desirable limits and unable to get rid of the pollutants of wastewater [1].

To take away or reduce pollutants from slaughterhouse wastewater, biological process shows a removal of non-settleable colloidal solids and reducing the concentration of organic compounds. Therefore, such process is one of the most important parts of the slaughterhouse wastewater treatment [15].

Attached growth process offered a significant impact on the stability of the traditional suspended growth process. Therefore, this technology has been tested with a different materials in order to choose the best material. However, biofilm wastewater treatment mechanism is well established through removal potentiality on some pollutant constituents from organic rich wastewater. The biofilm systems provide several advantages compared with traditional systems through bacteria growth, due to the better process stability in terms of short-term inhibitory effects, suitable sludge retention time, and biomass washout from the system [6].

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2. Methodology

2.1 Slaughterhouse Wastewater Sampling and

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Characterization

Slaughterhouse wastewater samples were collected from the secondary settling tank and filled in 25 L plastic container. Prior to use in experiments, samples were stored at 4C° in the cooling laboratory place to minimize biological and chemical reactions [2]. After storing the sample, get out from the refrigerator for analysis and experimentation purpose, it was kept in a room temperature at (24 – 26) C° around 2 hours for conditioning before analysis was carried out. The samples were disturbed for re–suspended of possible settling solid before any test was conducted.

2.2 Activated Sludge (AS) Sampling and Characterization

The activated sludge (AS) was collected from wastewater treatment plant. AS was sampled before entering the aeration tank from clarified. Before using the sample was aerated. And then analysed for pH, COD and mixed liquor suspended solid (MLSS), and obtained pH range between 7.02-7.27, COD=7820 mg/L and mixed liquor suspended solid (MLSS)=34794 mg/L.

2.3 The Experimental Setup

Figure 1 shows the experimental setup of AS+BF and only AS reactors, this system contains two reactors was made from Plexiglas material of size 0.17m x 0.1m x 0.7m and the capacity was 10 L liquid volume.

In this study principle of sequencing batch reactor (SBR) was used. The SBR was seeded with activated sludge, and then the fed with the collected sample to maintain MLSS in the range of 1000-1200 mg/L and pH adjusts between 6.5-7.5. The design experiment was showed below:

The feeding volume was calculated:

$$\frac{F}{M} = \frac{\text{BOD X Feeding Volume}}{\text{MLSS X V}}$$

$$0.21 = \frac{\text{610 X Feeding Volume}}{\text{1200 X 10}}$$

$$\text{Feeding volume} = 3.95 \text{ L} \approx 4 \text{ L}$$

2.4 Analytical Methods

Analyses of slaughterhouse wastewater were carried out according to the Standard Method for the Examination of the Water and Wastewater referred by American Public Health Association [2]. The pH was mesured by pH meter (Milwaukee SM101). By using a HACH DR/2500 spectrometer COD were determined. However, BOD_5 were determined by Method 5210B and reactor digestion method (Method 8000). The removal efficiency was calculated by using the following equation:

TABLE 1

EXPERIMENT DESIGN FOR TREATED SLAUGHTERHOUSE WASTEWATER

Parameters	Dimension / unit
pH	6.5-7.5
Aerator process	21 hours
Pumping rate	20 L/min
MLSS	1200mg/L
F/M	0.21
BOD_5	610 mg/L
Feeding volume	4 L

$$\text{Removal Percentage (\%)} = \frac{(C_i - C_e)}{C_i} \times 100\ \%$$

Where: Ci is the influent concentration of pollutant wastewater,

Ce is the effluent concentration of the pollutant wastewater.

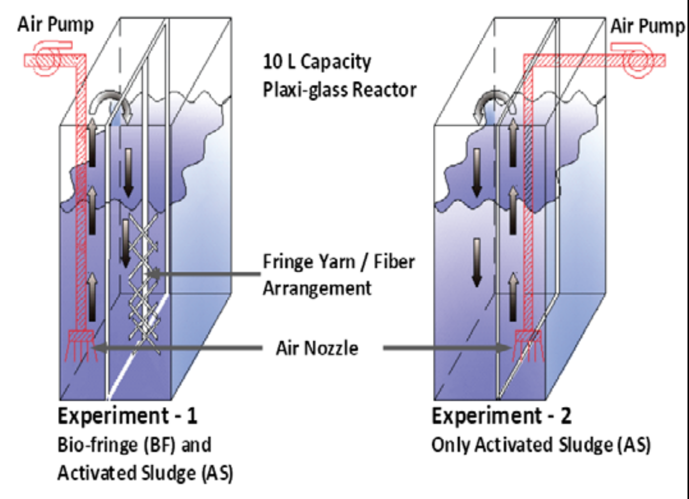

Fig. 1. Schematic Diagram of Experiments Setup

3.1 Statistical Analysis

Statistical data analyses were conducted by using Mini Tab 14 software for selected pollutant constituents.

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TABLE 2
SLAUGHTERHOUSE WASTEWATER PARAMETERS

Parameter	Unit	Range (Max - Min)	Mean ± St.Dev[1]	Standard [2]
pH	N/A	7.10 - 6.82	6.93±0.054	5.5 – 9.0
COD	mg/L	963 - 833	914.3±43.8	100
BOD_5	mg/L	653 - 486.1	609.4±56.8	50

[1] Mean ± Standard Deviation. [2] Source: Department of Environment, Ministry of Science, Technology and Environment, Environmental Quality Report, 1997, Malaysia.

Descriptive statistics and significant test were done using F-test with 95% confidence level. Graphics were created using SigmaPlot 11.0.

3.2 Slaughterhouse Wastewater Characterization

The pH level is ranging between 7.10 and 6.82, which indicated slightly acidic to neutral. A colloidal material and small amount of total suspended solid (TSS) resulted of this pH value [8]; [12]. The high BOD_5 / COD ratio was indicated a high degree of biodegradation from wastewater. A BOD_5 / COD ratio of slaughterhouse wastewater between 15% and 82% depend on the amount of dissolved materials [11].

Due to the high BOD_5/COD ratioio (66%) many problems in water body will causes, like eutrophication and oxygen depletion [11]. Furthermore, it is a very important indicator for applied technology in this research, though the rising of performance of the reactor [15]. By nitrifying bacteria a biologic oxidation process transformation NH_3 into NO_3, which results ammonia nitrogen has affected on BOD_5, which might have a significant dissolved oxygen requirement [2]. Such results have agreed with Aizz, 2011 and Roye et al. ,1980.

3.2 Activated Sludge (AS) Reactor Performance

During the AS reactor experiment, The percentage removal from an initial concentration of COD and BOD_5 are 84.3%, 98.8 % respectively (Fig 2).

Due to long aeration time in the reactor BOD_5 has shown the highest percentage of removal followed by, COD. The COD concentration has reduced from 610mg/L to 6.4mg/L [10].

3.3 Activated Sludge Including Biofringe (BF+AS) Reactor Performance

During the BF+AS reactor experiment the percentage removal from initial concentration of COD, BOD_5, were 97.5%, 99.1% respectively (Fig 3).

As shown in Figure 3 the highest removal efficiency for BOD_5 is 99% followed by COD. Through oxidation process and the biosynthesis of new microorganisms the organic matter was utilized, at the same time, COD has decreased [6]. Slaughterhouse wastewater was containing high amounts of organic compounds [6]. Due to biologic oxidation process nitrification and denitrification process affected on BOD_5. Since this process occurred in a good condition due to the aerobic and anaerobic zone in the same system. Therefore, the react his shown a higher removal for BOD [9].

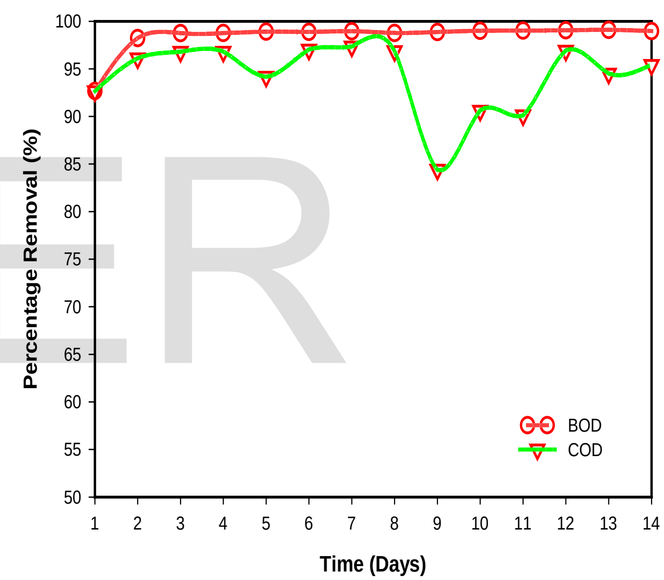

Fig. 2.Removal Percentage of COD, BOD_5 for AS Treatment

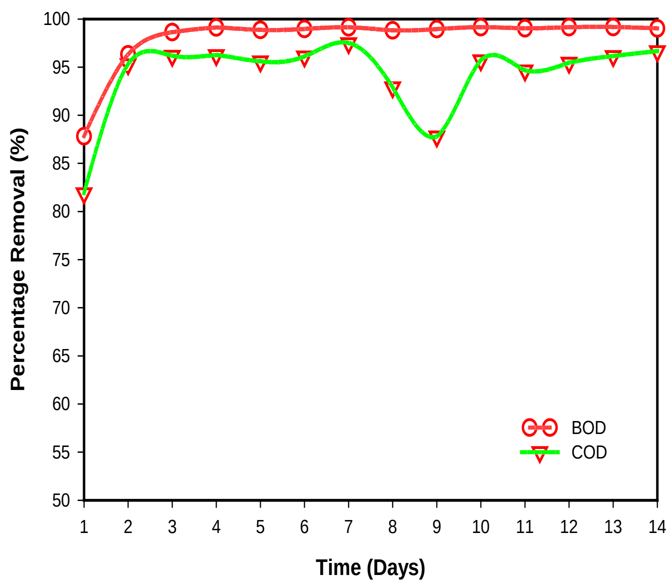

Fig. 3. Removal Percentage of COD, BOD_5 for AS+BF Treatment

TABLE 3
SUMMARY OF COMPARISON BETWEEN AS WITH BF AND ONLY AS TREATMENT

Par. (mg/L)	Mix. % (AS+BF)	Day On achievement	Mix. % (AS)	Day On achievement
COD	97.5 %	7 th day	97 %	7 th day
BOD	99.1 %	4 th day	98 %	12 th day

3.4 Performance Comparison of Two Treatment Systems

Usually, slaughterhouse wastewater has a high contained concentrations of dissolved organic matter easy to biological treatment due to their biodegradable nature. The comparison between removing selected pollutants from slaughterhouse wastewater presented in table 3. Besides, The AS + BF reactor show higher performance in less time compare to the AS reactor for the percentage removal of BOD and COD.

4. CONCLUSION

The contamination level of slaughterhouse wastewater depended on many parameters, such as type of operations (like cleaning and butchering) and amount of slaughterhouse wastewater. Slaughterhouse wastewater is consisting of high pollutant loading, high organic nitrogen as well as a large part contains of food waste which is easily biodegradable. The influence of acryl-fiber biomass carrier with activated sludge was compared with conventional activated sludge systems by using suspended growth bioreactors. Due to supply the AS + BF system, both attach and suspended growth, which support aerobic and anaerobic conditions. The performance of AS + BF reactor efficiently removed BOD, COD removal.

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