EFFECT OF FIXED MEDIA ON BIOLOGICAL WASTEWATER TREATMENT

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ABSTRACT: Adequate treatment of wastewater is important for the protection of the environment. In many countries, the existing conventional biological wastewater treatment systems are unable to meet the required standards. Therefore, the present research focused on the improvement of aerobic wastewater treatment plants by adding readily available cheap media. Plastic net-like media was used due to its non-biodegradable property. The media length was 5 meters, but it was rolled into a spiral shape. The average removal of TDS and COD, without the media, was about 35% and 70%. After the media has been added, the removal efficiency improved to 55% and 95%. The experimental results demonstrated that the use of media is capable of improving the quality of effluents in wastewater treatment towards a better quality of effluent to be discharged to nature. Such improvements in pollutant removal can be attributed to the retainment of a high amount of microbes in the fixed media, which provided a high surface area compared to a system without any media.

KEY WORDS: *Effluent standard, Media, Pollutants, Pollution loading, and Wastewater treatment.*

1. INTRODUCTION

Sewage sludge is the biggest volume of all the residues produced by wastewater treatment processes [1]. Malaysia produces around 7 million cubic meters of sewage sludge annually, which needs to be treated before being discharged into rivers, lakes, and the ocean [2,3]. High levels of organic matters especially phosphate and nitrate found in untreated wastewater can trigger algae blooms that can affect water turbidity and reduce the recreational value of a local waterway [4]. Human waste products such as discharges from industrialized operations, agricultural uses such as inorganic fertilizers, compost, and wastewater treatment effluents are common sources of nitrate and phosphate pollutants in water bodies [5].

Phosphates and nitrates are non-renewable micronutrients that are necessary for human survival [6]. Phosphate is a compound made up of the element phosphorous that degrades water quality by causing algae to grow in unnaturally large amounts. Phosphate ions in the water feed algae, which destroy other kinds of life and produce dangerous toxins [5]. Nitrogen is another important molecule, and it has a crucial role in the production of amino acids, proteins, nucleic acids, and other metabolites in living organisms [7]. Similarly, excess nitrogen is regarded as the most toxic waste for ground and surface waters, posing a serious threat to humans, animals, and plant life [7]. Thus, with increased human populations and trends toward the centralization of modern societies, most regions now require that wastewater be treated before being discharged into a local water system, and most importantly to treat the wastewater up to the required standard.

The biological wastewater treatment process uses the ability of some living organisms to remove pollutants from wastewater, allowing it to be used for surface irrigation and other industrial purposes. The main part of biological wastewater treatment is the transformation of dissolved and suspended organic pollutants into evolved gases and biomass [8]. Attached growth and suspended growth are two types of biological wastewater treatment methods. Microorganisms are immobilized on a support surface, generating biofilms, in the attached-growth process [9]. Biological filtration is a waste treatment technique in which organic contaminants in any fluid stream come into contact with microorganisms adhered to the filter media's surface. These microbes use the ingested organic molecules for growth and cell development and eventually starts the biodegradation process, which can be aerobic or anaerobic [10].

The incorporation of media biofiltration consists of a reactor filled with solid material over which a biolayer of appropriate microbial populations forms [11]. The artificial compounds that can be packed inside of a reactor are textiles, plastics, or ground glass [12]. Systems packed with compact units such as plastic media as a filter that have wide surface area can reduce the waste load entering the sewer [10,13]. In addition, filter as media can serve as a surface for bacteria to colonize and for biochemical and physical treatment processes to occur which would help achieve a better level of purity at low operational cost and environmental damage [9–11,14].

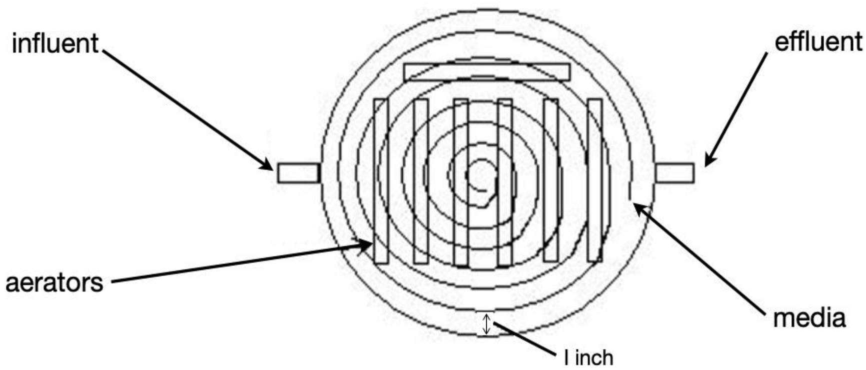
Although numerous investigations were carried out using synthetic materials as filters in wastewater treatment, no efforts have been made using polymeric plastic materials such as nylon mosquito nets. A commercially available mosquito net is very cheap, non-biodegradable, highly resistant to moisture, and above all has a high specific surface area which can be considered a better choice for increased microbial support and treatment efficiency. In addition, such material has the additional ability to withstand sudden shock for any wastewater treatment operations [10,11]. Previously, polymer fibre geotextiles have been established to support biofilm development and also augment the biodegradation rate [15]. Therefore, in the present study emphasis has been given to a reliable and cost-effective technology by introducing commercially available nylon net for sewage treatment.

2. MATERIALS AND METHOD

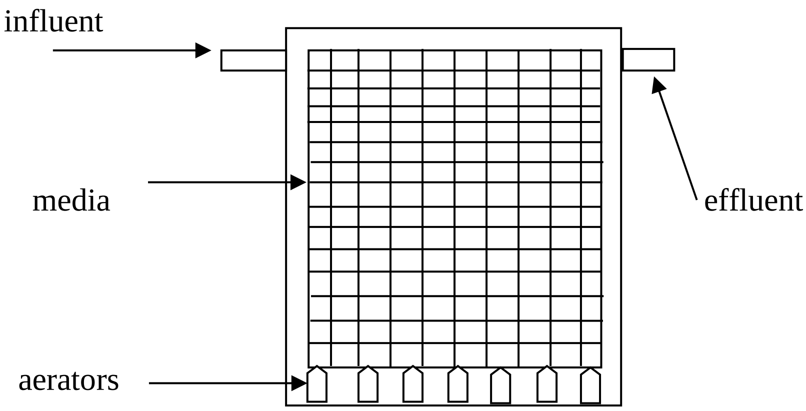
2.1. Reactor and Media

An aerobic digester was used in the present study and the media (net) made from nylon was placed inside. The net media was made of plastic, which is commonly available at most hardware shops. The net was constructed in the shape of a spiral with a 25 mm (1-inch) space. Aerators placed at the bottom of the aerobic reactor produced bubbles to homogenize and control the Dissolved Oxygen (DO) of the wastewater in the reactor tank. The plant was fabricated by Dosiertechnik Sdn. Bhd. (Fig. 1). Schematic diagrams of the top view (plan) and the section of the main reactor are shown in Fig. 2 and 3.

Fig. 1. Aerobic digester plant used in the study.



a) Top view or plan of the main reactor with media



b) Vertical section of the reactor with media (schematic)

Fig. 2. Cross section of the aerobic reactor.

2.2. Laboratory tests

Wastewater collected from the cafeteria located at the International Islamic University of Malaysia, Gombak Campus was used in this study. The characteristics of the wastewater were analyzed using established and standard methods [16]. The chemical oxygen demand (COD) was determined following the HACH DR-5000 Spectrophotometer [17].

2.3. Process startup and monitoring

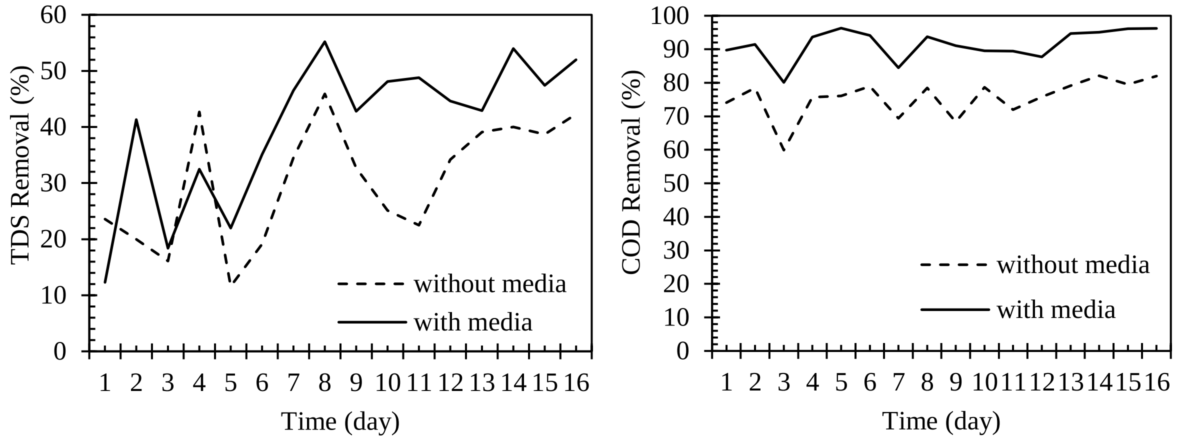
The main drawback of aerobic treatment is the production of a high amount of biosolids (sludge). All aerobic wastewater treatment systems produce various amounts of sludge. Untreated sludge is a significant environmental and public health hazard. In the present study, the use of media in the reactor resulted in a substantial decrease in the amount of sludge in the effluent. Fig. 3 shows the condition of the media used at the beginning and the end of the experiments.

a) Before the experiment b) After the experiment

Fig. 3. Arrangement of the fixed media used in the experiments.

3. RESULTS AND DISCUSSION

Total suspended solids (TSS) are one of the common pollutants in the surface water resources in Malaysia and many other countries. A high total suspended solid can block light from reaching submerged vegetation because the amount of light passing through is reduced. As such, the removal of TSS is one of the main targets of wastewater treatment facilities. The TSS values have been reduced roughly from 2000 mg/l to as low as 50 mg/l when media was incorporated in the reactor. However, without media, the lowest TSS in the effluent was found to be 100 mg/l. Due to the attachment of the bacteria and solids to the media, the value of TSS in the effluent has decreased more in the system with media. The TDS values were reduced to around 150 mg/l in the effluent in the experiment when no media were used. However, the incorporation of the media resulted in much lower TDS values, around 85 mg/l. An additional of 20% TDS removal efficiency was observed with the addition of the media in the reactor. This proves that the media helps in reducing the TDS values and that the process can be more effective (Fig. 4).



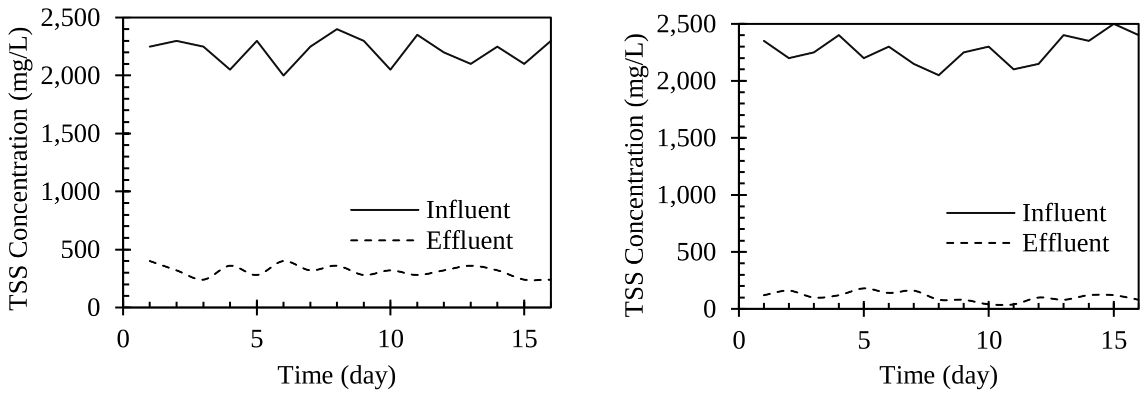
a) Total dissolved solids (TDS) b) Chemical oxygen demand (COD)

Fig. 4. Comparative removal efficiency of TDS and COD in the reactor.

Wastewater has been treated using a variety of media. Both organic and inorganic synthetic media have been utilized in the small community sector [12]. Artificial media include open cell foam such as open cell polyurethane foam (OCPUF) [18,19], textiles such as non-woven fabrics [20,21], and plastics such as biofilm [22] and floating plastic media [23]. The use of net-like media is also reported in various publications such as net-like 3D plastic mesh disks [24] and spider-net [25].

The experimental results helped to calculate the reduction in COD values in the effluent with and without media in the reactor. However, media helped to remove extra 25% COD from the effluent as compared to the reactor without media. The values met both Standard A and Standard B of Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979. This once again proved the effectiveness of the media in the reactor for the treatment of sewage.

In order to study the TSS removal from the reactor, influent TSS concentrations were varied between 2000 and 2500 mg/l. It was impossible to feed influent with the same value of TSS, due to natural variation in the wastewater. Although the performance of the aerobic process was already good (reduction from 2000+ mg/l to less than 500 mg/l), further improvement in TSS reduction could be seen from the results shown in Fig. 5.



a) Without media b) with media

Fig. 5. Performance of the reactor on TSS removal.

4. CONCLUSIONS

Based on the results observed during the experiments, it can be concluded that the percentage removal has increased by more than 20% when a net-like media is incorporated into the reactor. The use of media is effective in increasing the surface area of the support media. System reliability is somewhat better than suspended package plants because of the more effective capture and control of suspended solids. In conclusion, it can be said that the introduction of media in the activated sludge system can increase the effluent quality.

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