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Preface

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1625** 011001

PREFACE

On behalf of the Editors, it is our great pleasure to accept many research papers on the latest development in infrastructure studies during International Conference on Sustainable Infrastructure 2019 (ICSI 2019). The major goal of the conference, which was organized by Department of Civil Engineering and Planning, Yogyakarta State University is to bring academic scientists, engineers, industry researchers together to exchange and share their experiences and research results about most aspects of sustainable infrastructures, and discuss the practical challenges encountered and the solutions adopted. In this Conference, there were many opportunities for the delegates to exchange new ideas and application experiences face to face, to establish business or research relations and to find global partners for future collaboration.

We would like to thank the organization staff, the members of the program committees and reviewers. They have worked very hard in reviewing papers and making valuable suggestions for the authors to improve their work. We also would like to express our gratitude to the external reviewers, for providing extra help in the review process, and the authors for contributing their research result to the conference. Special thanks go to Atlantis Press.

Lastly, we would like to warmly thank all the authors who, with their presentations and papers, generously contributed to the lively exchange of scientific information that is so vital to the endurance of scientific conferences of this kind.

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Peer review declaration

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1625** 011002

Journal of Physics: Conference Series **1625** (2020) 011002 doi:10.1088/1742-6596/1625/1/011002

Peer review declaration

All papers published in this volume of Journal of Physics: Conference Series have been peer reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

- **Type of peer review: Single-blind / Double-blind / Triple-blind / Open / Other (please describe) Double-blind**
- **Conference submission management system: @**icsi.uny.ac.id self developed by Yogyakarta State University
- **Number of submissions received: 121**
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Biosand Filter for Removal of Organic Pollutant from Laboratory Wastewater

To cite this article: B Primasari *et al* 2020 *J. Phys.: Conf. Ser.* **1625** 012057

Biosand Filter for Removal of Organic Pollutant from Laboratory Wastewater

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Abstract. This research aims to investigate the ability of biosand filter to remove organic pollutants from laboratory wastewater. Biosand filter is a simple treatment using fine sand, coarse sand and gravel media. In the biosand filter, the biofilm growth occurs on the top surface of the media. The observed parameter for organic content was BOD and COD. The media in the biosand filter reactor were fine sand: coarse sand: gravel with a depth ratio of 50: 5: 5 cm. The biofilm growing process was carried out for 15 days by immersing the media with samples. The substrate was added to the reactor in the 10th day to accelerate biofilm growth. During the growth of the biofilm, the dissolved oxygen (DO), pH and temperature were also observed. After the biofilm growth, the biosand filter was operated intermittently for 14 days, which is an hour operation and a pause period of 47 hours, repeatedly until 29 days. The applied flow rate was 0.6 L / min. The results showed that BOD removal efficiency was 76.9%, and COD removal efficiency was 73.5%. The biosand filter reduced BOD concentration from 161.5 mg/L to 36.1 mg/L and reduced COD concentration from 202.4 mg/L to 52.8 mg/L.
Keywords: biosand filter, BOD, COD, laboratory wastewater

1. Introduction

Biosand filter is one of the development of slow sand filters that are specifically designed for water treatment[1] . Biosand filter is a water filtering equipment which the water is treated by passing water to a process media in low speed. The treatment is affected by the diameter of the fine sand and the media has carried out the planting of seeds (seeding) so that biological processes occur in it. The Biosand filter uses the media of fine sand, coarse sand and gravel. Fine sand acts as a filter media, while coarse sand and gravel act as a buffer layer [2]. In the biosand filter, biofilm growth occurs on the top surface of the media that is able to degrade contaminants in the water [6]. Besides sand, the media used in biosand filters can also be combined with other media such as wood charcoal, coconut shell charcoal, mangrove charcoal [7]. Biosand filter can reduce bacterial content by 98.5%, viruses 70-99%, protozoa 99.9%, turbidity 95%, metals 90% -95% and organic compounds 90% [3].

Biosand filter is usually used for water treatment, but also has the ability to remove organic compounds. Most application of biosand filter is for water treatment, but recent study shows that application for wastewater is also possible [4]. A study shows that biosand filter could be applied to remove BOD from wastewater significantly [5]. From previous studies it was proven that biosand filter with andesite sand media was able to set aside BOD content in ground water by 74-87% and COD by 65-70% [9]. Biosand filters can also be used to eliminate parameters of domestic (artificial) pollutants with COD removal reaching 76.93% and TSS 81.32% [10]. Biosand filters with a combination of sand and wood charcoal media were able to remove organic matter ($KMnO_4$) from well water in peat areas with an efficiency of 91.92% [11].

The advantage of biosand filters is not require large amounts of land and chemicals, as well as easy and inexpensive operation for waste treatment [8]. In the operation of biosand filters, the term pause period is known as the rest time for the biosand filter reactor. In the pause period microorganisms on biofilms degrade contaminants in the water, and bring into famine condition. After pause period it is expected that the microorganism will react more effectively to degrade organic compound. Pause period is carried out after reactor operation with a minimum time of 1 hour and a maximum time of 48 hours [3].

The high organic content in laboratory wastewater has the potential to reduce dissolved oxygen in the water. It may cause disturbance to the ecosystem in the receiving water bodies. Therefore, a treatment is needed for the laboratory wastewater so that the adverse effects of laboratory wastewater to the environment can be minimized. This research aimed to investigate the ability of biosand filters to remove oranic pollutant, in terms of BOD and COD, from laboratory wastewater.

2. Material and Method

2.1. Reactor

Biosand filter is made of a fibre glass reactor with the length of 30 cm long, the width of 30 cm, and the height of 90 cm. The height of the media, i.e. fine sand: coarse sand: gravel is 50: 5: 5 cm respectively. The height of water during the pause period is 5 cm above the surface of fine sand. The water level must be kept 5 cm above the top surface of the media. The schematic diagram of the biosand filter scheme can be seen in Figure 1 below. The layers consisted of the fine sand, coarse sand and gravel. The biofilm was formed in the upper surface (approximately 5 cm) of fine sand layer.

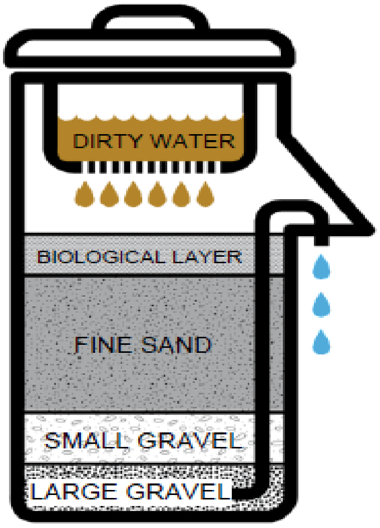

Figure 1. Biosand filter reactor.

The design criteria of the biosand filter the selected size can be seen in Table 1. All fine sand, coarse sand and gravel are from andesite rock. Andesite rock is easily found in the Sumatera. This rock is crushed to the size of fine sand, coarse and gravel.

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Table 1. Criteria design for biosand filter.

Desain Criteria	Range	Selected
Fine sand	≤1 mm	1 mm
Coarse sand	1 mm-6 mm	6 mm
Gravel	6 mm-15 mm	12 mm
Flow Rate	0,4-1 L/min	0,6 L/menit
Biosand Filter Dimension	30 cm x 30cm x 90 cm	30 cm x 30 cm x 90 cm
Media (height)	Gravel 5 cm Coarse sand 5 cm Fine sand 50 cm	Gravel 5 cm Coarse sand 5 cm Fine sand 50 cm

2.2. Laboratory Wastewater

Laboratory wastewater was collected from wasted chemical wastewater from laboratory activities, such as practical works. The volume of wastewater collected for a semester was 20 liters. The laboratory wastewater was diluted 50% before treatment in the biosand filter.

2.3. Operation of Reactor

Biosand filter was operated intermittently for 1 hour in 48 hours (2 days) with gravity flow. The pause period was 47 hours, considering that the available sample volume and to study the effect of a longer pause period range from previous studies. The operation of the biosand filter reactor lasted for 14 days. The samples were taken from the inlet and outlet of the reactor. The COD and BOD concentrations were analysed. The operation steps of the biosand filter reactor are as follows: laboratory waste was poured into a sample container (20 L bucket) which located above the reactor; sample was flowed into the reactor, the valve was opened, at a flow rate of 0.6 L / min. The height of the sample in the reactor was kept ± 5 cm above the diffuser plate, by providing a hole in the reactor wall for overflow; Overflow flowed into the container, which would later be put back into the sample container; outlets at the reactor are opened during operation. When the reactor was operating, inlet and outlet sampling was taken. The sampling of the outlet was carried out after 35 minutes operation, by considering the detention time in the reactor.

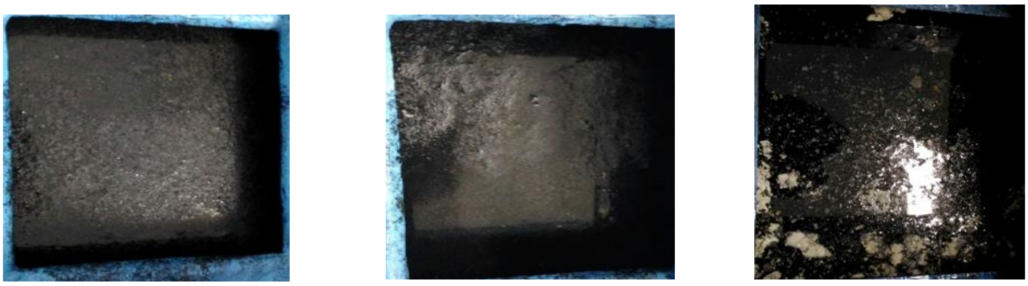
2.4. Analyses of BOD and COD

Analysis of BOD and COD parameters in this sample was carried out before the sample was processed and after being processed in the biosand filter. The BOD analysis is the Wrinkler in accordance with Standard Method APHA AWWA No.5210B. The COD measurement method applied the open reflux method in accordance with Standard Method APHA AWWA No.5220B. COD reactor was used in the COD test to heat the mixture of the digestion solution, Ag_2SO_4 and the sample at 150°C for 2 hours. After heating, a titration with 0.05 N FAS solution is formed until a brownish red colour is formed.

3. Result and Discussion

3.1. Biofilm Growth

The biofilm growth process was carried out for 15 days by immersing the media inside the biosand filter reactor with samples where the water level was kept 5 cm above the top media. On the 10th day an additional 1 mg / L glucose solution was added to each reactor [12]. This is done because after visual inspection biofilm is still little formed which is marked by the least amount of bubbles. The addition of this glucose solution can be done to accelerate the formation of biofilms [13]. The development of biofilm formation can be seen in Figure 4.2. Bubbles on the surface of the water until the 7th day are still small (Figure 2 (a)). On the 10th day, glucose solution was added as an additional nutrient for microorganisms so it was hoped that the growth of microorganisms in the biofilm layer would be better (Figure 2 (b)). On the 15th day, changes have been seen, marked by the formation of mucus on the top surface of the media, and bubbles that appear in greater numbers on the surface of the water (Figure 2 (c)).



(a) (b) (c)

Figure 2. Water surface during biofilm growth.
(a) day-7, (b) day-10, after addition of glucose, (c) day-15.

3.2. DO (Dissolved oxygen) concentration

The results of DO measurements on inlet and outlet samples in reactor can be seen in Figure 3. DO inlet content ranges from 3.5 to 6.6. The DO outlet content ranges from 4.9-7.3. On the 1st to the 8th day DO values at the outlet decreased. This is probably due to the adaptation of the organic compound removal process, so it requires oxygen. There was an increase in DO concentration in the outlet until attained the DO outlet concentration of 7.3 mg/L on the 14th day.

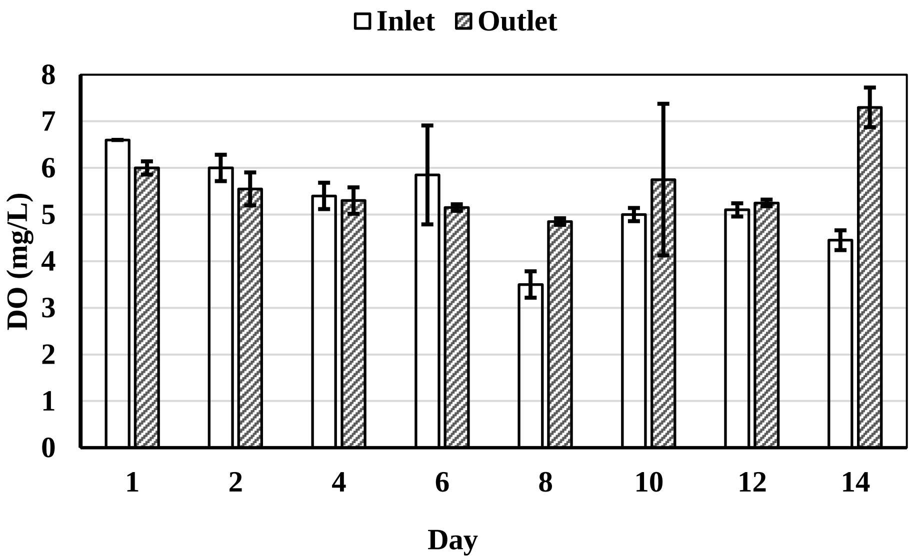


Figure 3. DO concentration.

3.3. pH change

The results of pH measurements in the inlet and outlet can be seen in Figure 4. The pH of the sample in the inlet was 2.29 to 3.35, while the pH of the outlet increases to 6.04 to 6.49. It showed that the pH of the outlet, the wastewater after passing the media was close to neutral [14].

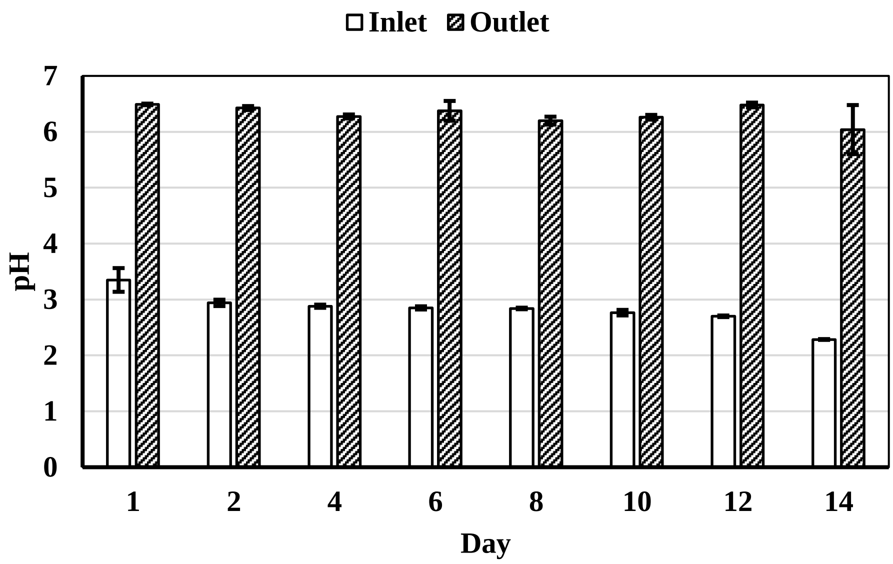


Figure 4. pH change.

3.4. Temperature Change

Temperature at the inlet ranges between 26.4-27.3ºC, while at the outlet ranges from 26.5-27.4ºC. The temperature change is not too significant between the inlet and outlet because the sample temperature close to the ambient air temperature. This is consistent to result from Lestari [15] and Alda [9] where there is no large temperature change between samples before and after treatment by biosand filters.

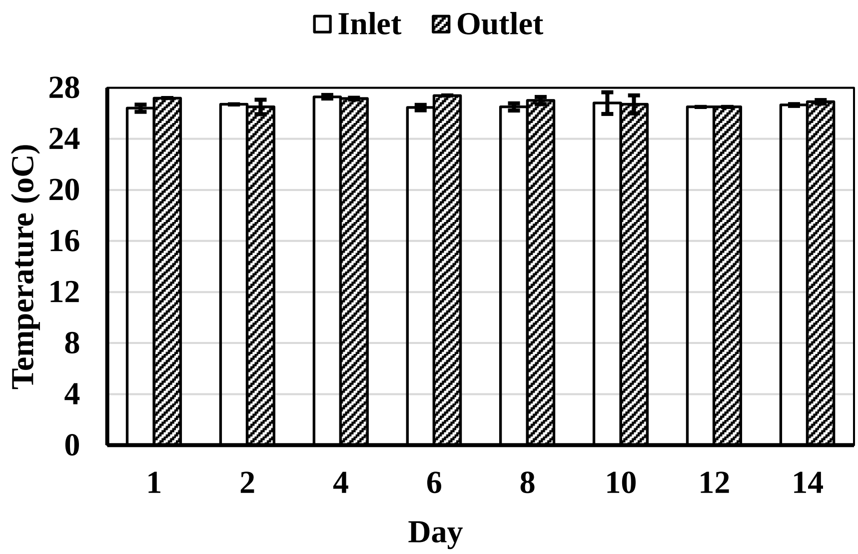


Figure 5. Temperature change.

3.5. BOD removal

Figure 6 shows the inlet and outlet BOD concentrations. The inlet BOD concentrations ranged from 109.06 mg / L to 164.27 mg / L. While the BOD outlet concentrations ranged from 31.17 mg / L to 60.35 mg / L. The decrease in the BOD concentration at the outlet is due to the presence of biofilms, to decompose organic compounds in the sample. Decomposition of organic compounds produces energy for the synthesis of new microorganism cell or biomass. The population of microorganisms increased and can remove organic compounds better. This is in accordance to research on the removal of BOD and COD in groundwater with andesite rock media in the biosand filter [9], the BOD of the outlets have decreased due to the microorganisms on biofilms that degraded organic compounds. The BOD concentration measurement can be seen in Figure 6.

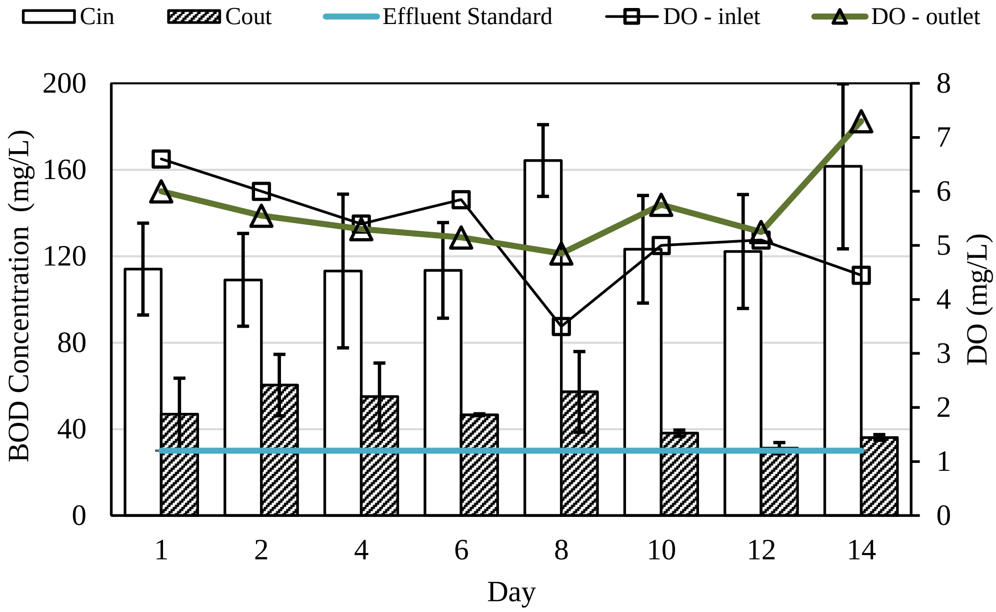


Figure 6. BOD concentration and DO concentration.

Figure 6 also showed relation of BOD concentration to DO. DO concentration confirmed to the BOD concentration in the outlet. The higher BOD concentration , more DO was utilized by microorganism [14]. Even though BOD had been removed, BOD concentration in the outlet still did not fulfil effluent Standard of 30 mg/L.

Figure 7 showed the BOD removal efficiency from 1st day to the 14th day. It showed that removal efficiency increased with time. The increasing indicated that the wastewater had adapted well to the biofilm, therefore more decomposition of biodegradable organic took place [16].

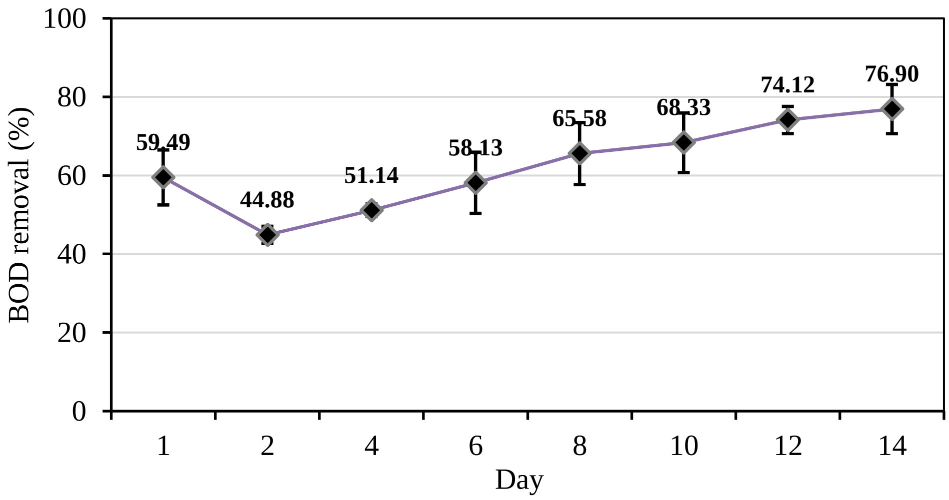


Figure 7. BOD removal.

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3.6. COD removal

Figure 8 showed COD concentration int the inlet and outlet of the reactor. COD concentration in the inlet of the reactor ranged from 176 mg/L to 220 mg/L while the COD in the outlet ranged from 2.8 mg/L to 88 mg/L. The decrease in COD was caused by the decomposition process by biofilms and the media in the reactor, where biological and physical mechanism occurred [5]. Biological mechanism occurred because microorganisms in biofilms were capable to remove organic compounds by consumed the organic material foe their metabolism. Physical mechanism took place by filtration and sedimentation process [17]. Organic pollutants that passed through andesite sand can be filtered and settled in the form of suspended particles and retained in the media. This elimination caused organic compounds in the outlet to be reduced so that the DO in the outlet increased. This can be seen in Figure 7 where the DO concentration of the 14th day increased.

Figure 8 also showed that DO concentration in the outlet confirmed to the COD removal in the reactor. The higher removal of COD caused a lower concentration of DO. It indicated that the DO was consumed by the microorganism to decompose organic material. The COD in the outlet had fulfilled effluent standards for domestic wastewater, i.e. 100 mg/L of COD.

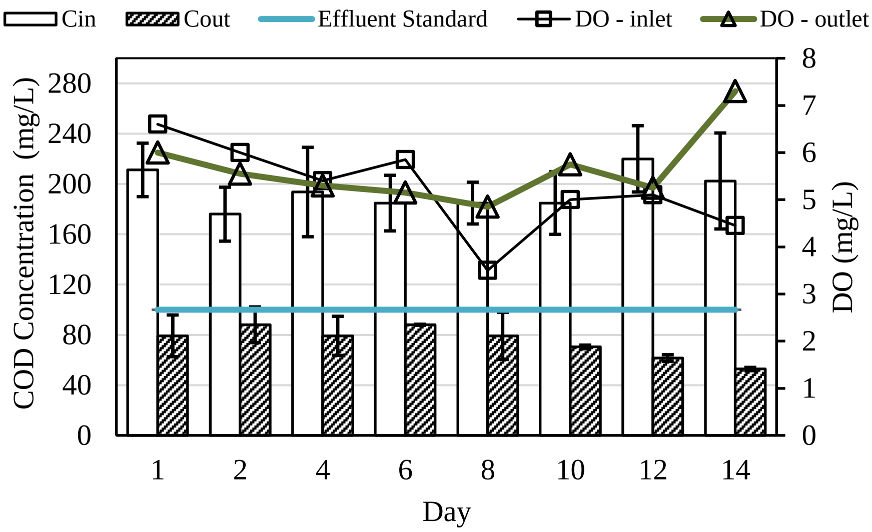

Figure 8. COD concentration and DO concentration.

Figure 9 showed the removal efficiency of COD from 1st day to 14th day. It can be seen that removal efficiency increased with time [18]. Adaptation and physical mechanism improved from time to time, therefore more removal efficiency had been achieved.

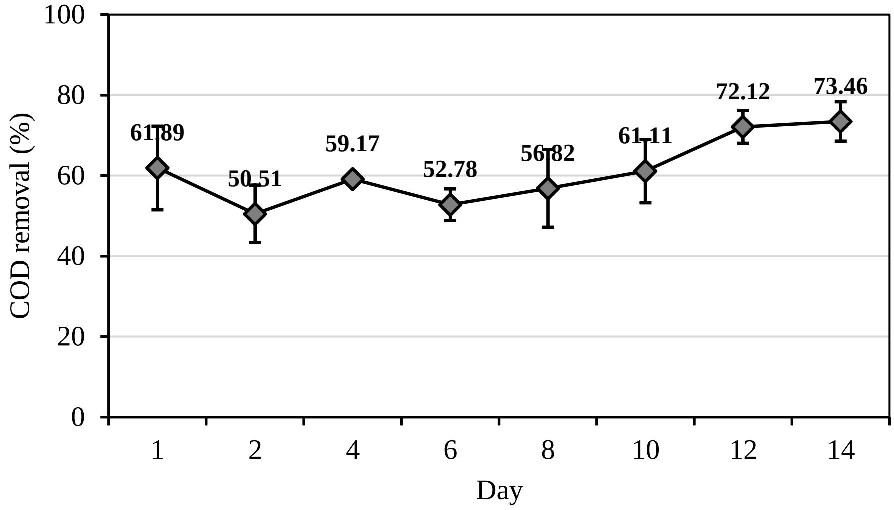

Figure 9. COD removal.

4. Conclusion

Biosand filter has a potential for organic removal from laboratory wastewater. Biosand filter could remove 76,9% of BOD (from an initial concentration of 161.58 mg/L) and could remove 73.46% of COD (from an initial concentration of 202.4 mg/L) from laboratory wastewater.

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Acknowledgments
Authors would like to express the gratitude and sincere appreciation to the Universitas Andalas for funding this research by Scheme Riset Dasar BOPTN 2019, Contract No. T/48/UN.16.17/PT.01.03/RD-Inovasi-Sains/2019.

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Publication type Conferences and Proceedings

ISSN 17426588, 17426596

Coverage 2005-2020

Scope The open access Journal of Physics: Conference Series (JPCS) provides a fast, versatile and cost-effective proceedings publication service.

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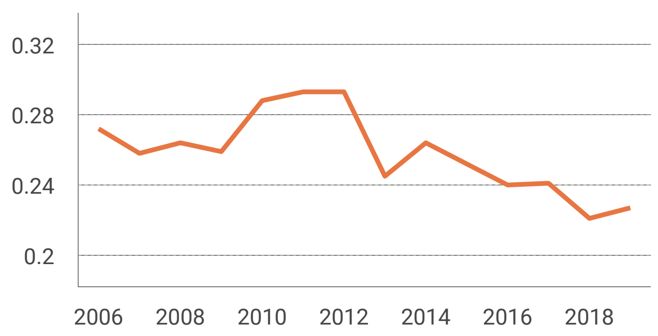

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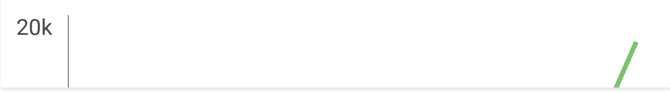

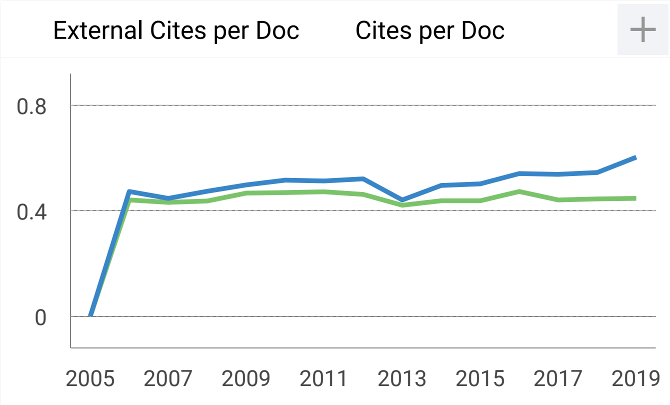

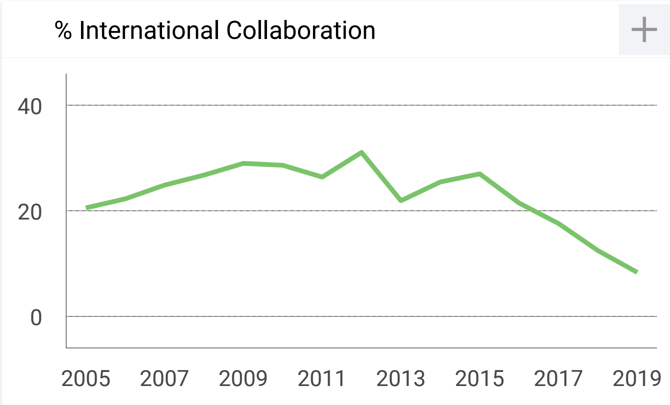

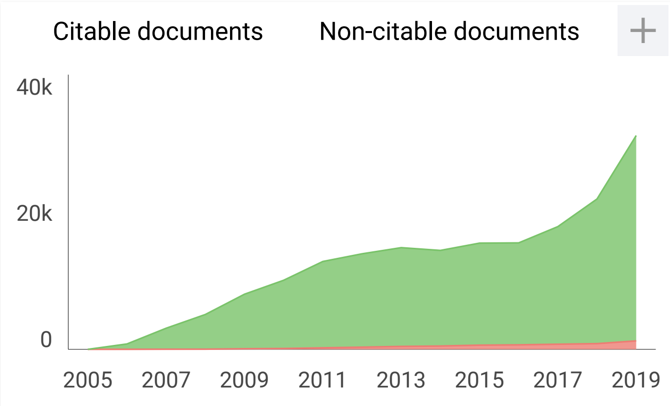

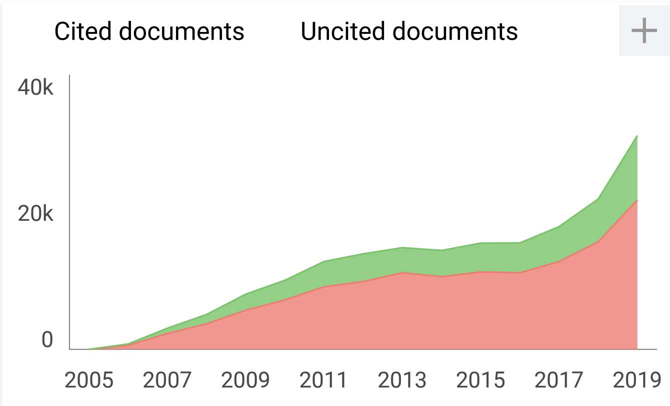

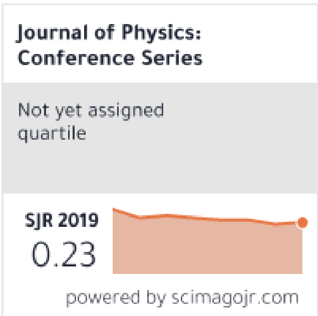

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S **Sheetal Jagdale** 2 months ago

This "Journal of Physics: Conference Series" is classified as Journal in SCOPUS october 2020 list.
Even in https://www.scopus.com/sources it is listed in Journal
But the SCImago has mentioned conference.
Kindly guide

reply

Source details

Journal of Physics: Conference Series

Scopus coverage years: from 2005 to 2020
Publisher: Institute of Physics Publishing
ISSN: 1742-6588 E-ISSN: 1742-6596
Subject area: Physics and Astronomy: General Physics and Astronomy

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