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ORIGINAL ARTICLE

Studying of treatability of Gray Water Using Slow Sand Filter

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ABSTRACT
Using slow sand filter is one of the methods of water treatment which can remove organic compounds as well as solid particles. Biological layer that grows on the surface of the filter have a considerable role in the removal of soluble compounds. The water has averagely COD and BOD5 and turbidity of 117.34 and 27 mg and 18.56, respectively. In the research, the efficiency of slow filter was reviewed on removing organic compounds and consequently the removal of COD and BOD of 71.8% and 89% were obtained, respectively. The effluent has averagely the turbidity and suspended solids of approximately 5%, which shows the high efficiency of system.

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INTRODUCTION

Filtering or filtration is a physical method for removing the suspended particles in a liquid such as water. Aerosol can be mud, color, organic materials, plankton, bacteria, and particles resulting from the softening and so on. Filters can be divided into two categories. Depth filters in which the separation of suspended particles from liquid will be performed in the bottom of the bed like gravity filter or pressure filter and surface filter in which separation of suspended particles from liquid was only performed in very low depth, i.e. the surface of filter like filter paper.

Depth filters use for water filtration. Water containing suspended particles passes the bed of a material which can be sand or anthracite coal. Suspended materials were trapped due to passing through the pores between the particles and water that was virtually free from suspended solids obtained. Accumulation of suspended particles in the filter pores causes increased pressure drop (difference in water level on the surface of the filter and drain strainer). If the pressure drop exceeds a certain limit, the filter should be cleaned. First, the filters should be slowly filled up with the water flows from the bottom up to immerse the particles of bed in water. It is necessary to remove trapped air between the particles to prevent from blocking the water way by the air.

The water passing from bed contains suspended materials, colloidal material, different microorganism and soluble salts which leave them during the transition from the depth of 40 to 60 cm and the water contains small amounts of simple inorganic and relatively harmless salts after passing these depths. Bacterial activity extends usually to a depth of 60 cm of bed. Not only the most of harmful microorganisms are separated, but also soluble nutrients which cause the subsequent growth of bacteria in the sludge are removed in slow sand filter.

Gray water, wastewater produced by domestic activities such as cleaning, washing, bathing and laundry excluding toilet waste [1]. Grey water is generally less contaminated than toilet water; it has less pathogens and about 90% lesser nitrogen than toilet water [2].

MATERIALS AND METHOD

Laboratory Filter Dimensions

The slow sand filter made of a layer of fine sand with an effective size of 0.3 mm and a thickness of 400 mm. Cylinder containing filter particles has a diameter of 10 cm and a height of 2 meters. Uniformity coefficient, specific density and porosity of the sand are 1.82, 1.48 and 0.4, respectively. A layer of coarse sand has been located under sand bed to protect filter particles with the thickness of 300 mm. Gradation curve of filter particles can be seen in the figure below.

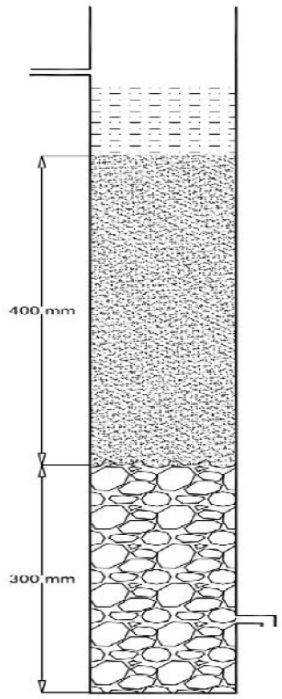

Figure1- Slow sand filters used for gray water

Wastewater characteristics

Discussed gray water of the output of the bathroom sink were sampled once a week in Azad University of Behbahan, and COD, BOD, N-NO3, Do experiments were measured based on the standard method book, the results were given in the table below.

Table 1- Characteristic of the studied gray water

average	unit	parameter
TSS	Mg/l	5-25
Turbidity	NTU	10-35
pH	Mg/l	8
Tem	c	16-20
p-po4	Mg/l	20
BOD	Mg/l	20-35
COD	Mg/l	60-160

Method

First, close the outlet valve and enter sewage into the filter and remain there for a week to form the biological layer on its surface. Then, open the outlet valve and enter the sewage from top with different organic materials loading from 0.1 to 0.3 m/h and measure the filter outlet. Filtration worked from 23 July 2011.

RESULTS

Removal of suspended solids in filter

The amount of suspended solids and turbidity entering the filter is averagely 9.65 and 18.57 mg/l, respectively. In maximum mode, 72.8% suspended solids and 67% turbidity were removed from filter. The removal of 70-75% in horizontal filter and 37-86% in vertical filter were observed in 1992. Santos et al (2012) reported the removal of 16-39% for suspended solids after filtration [3]. Guy Ramon (2003) reported the removal of 45-70% and 92-97%, respectively, for COD and turbidity in ultra-filter [4]. Bhausaheb obtained the removal of 83%, 70%, 83%, 50%, 97%, 46% and 49% for organic compounds, TDS, TSS, total hardness, oil and fat, anion and cation, respectively, with a system included primary sedimentation cascading water, aeration, agitation and filtration in 2010[5].

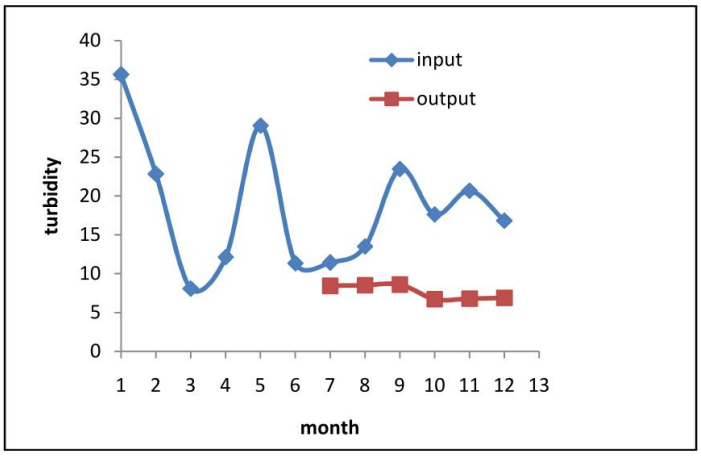

Figure 2- turbidity changes during different months from July 2011

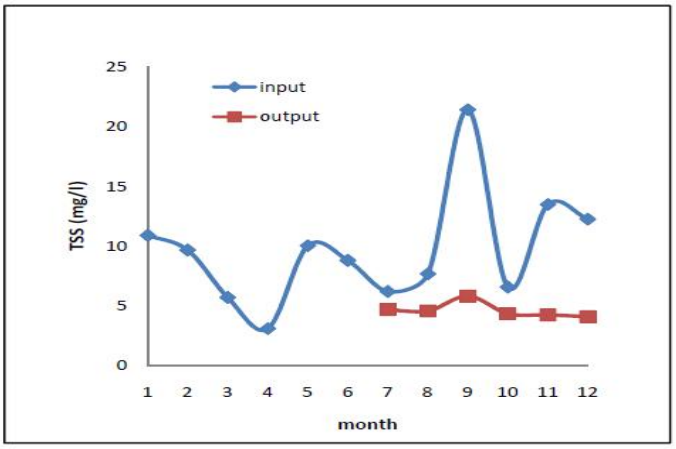

Figure 3- removal and changes of suspended solids during different months of the year from July 2011

Temperature and soluble oxygen

Biological activity in filter increases water temperature. Raw water and water temperature in filter were averagely measured to be 13.5-38.1 and 17.29, respectively, and it was approximately 15.4-19 ^{o}C. Soluble oxygen was observed to be averagely 8.4 in raw water and the minimum and maximum were 5.4 and 7.7, respectively. Active bacteria and organisms in the filter bed were the reasons of oxygen depletion.

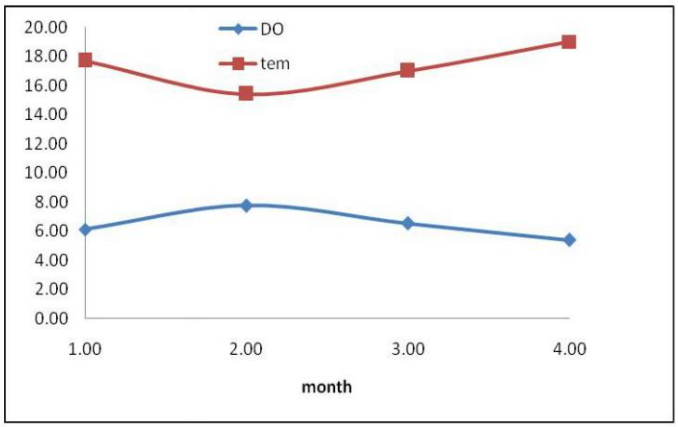

Figure4- changes in the temperature during different months of the year from July 2011

Removal of COD and BOD

COD outlet is 19.15-71.45 Mg/l which obtains averagely 45.86**.** The maximum removal efficiency of 71.85% was observed for COD in filter. The removal of 89% was observed for BOD. BOD5 of 6.76 was measured for filter outlet.

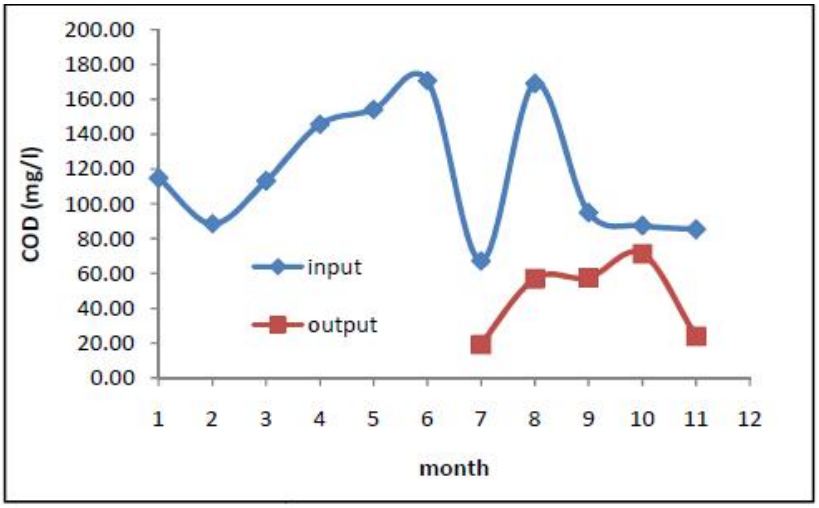

Figure 5- removal of COD during different months of the year from July 2011

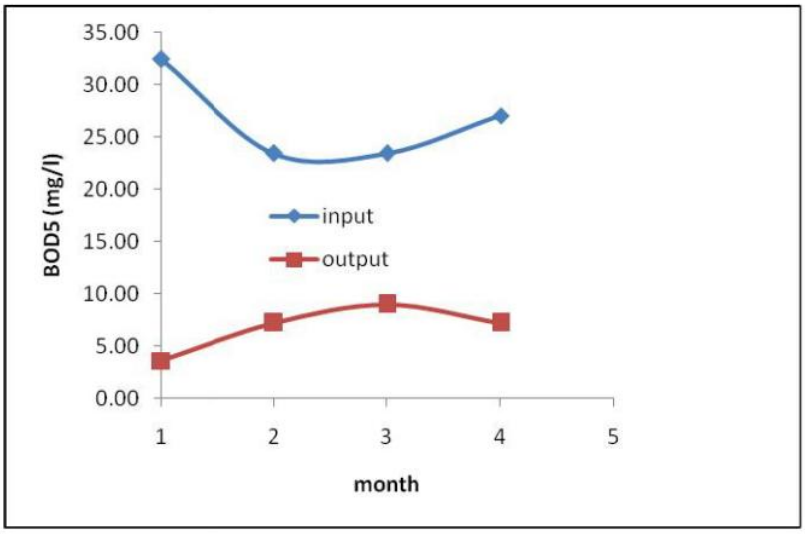

Figure6- changes in BOD during different months of the year from July 2011

Sorja Ghosh et al (2010) used ceramic micro filter and physical pretreatment and adsorption for sink and kitchen gray water treatment. BOD and COD of 98% and 99% were observed, respectively, and it was reported that the treated water was suitable for irrigation of green spaces and agricultural use.
The removal of BOD obtained in this project compared well with the other studies used slow sand filter with the height of 0.6-1.2. Elston (2003) obtained the removal of 90% for SCT system and slow sand filter [6]. Whereas, Jensen (2001) obtained the removal of 70% for BOD 5 in a system included only a slow sand filter [7]. that proposed a depth of 600 mm to 1 m. A filter with a depth of 35 cm works well to maintain dissolved oxygen stability in the filter. In depth filter may observe the lack of dissolved oxygen and nutrients in high depth.

RECOMMENDATION

Authorized COD and BOD are 120 and 30 mg/l, respectively, for agriculture. Thus, it can be concluded that the output of the filter is suitable for agricultural use in terms of BOD and COD.
4.2. Parameters such as heavy metals, sodium and microorganisms are very important in agricultural uses because they are the source of heavy metals of industrial wastewater. Although the discussed sewage is domestic and residential gray water, it is necessary to complete the research on the removal of such metals by such a system in future. More comprehensive research and experiments are necessary for the removal of sodium.
4.3. the amount of oil and fat is likely to be high in gray water, it is recommended to pass the gray water from a layer of vegetable soil before entering sewage or use wetland system.

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