DESIGN OF A SLOW SAND BED FILTRATION SYSTEM FOR PURIFICATION OF CANAL WATER

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ABSTRACT

The purpose of the present study is to present the design of a filtration system for removal of canal water impurities. The canal water characteristics were examined before and after the treatment with a slow sand bed filtration system. The gravel and sand were used as media for the proposed filtration method. The canal water was introduced in batch wise from the top of the system. The water then passed through the layers of media and purified. The filtered and purified water was collected at the bottom of the system through riser pipe. The pH, turbidity, total dissolved solids (TDS) and electrical conductivity (EC) of canal and filtered water was examined. It is found from the study that the maximum efficiency of the proposed system was 99% in reducing turbidity level and 6% in reducing TDS and EC level. The proposed system was found to be more effective for reducing turbidity from the canal waters among examined parameters.

Keywords: *Canal water, characteristics of water, impurities, media filtration*

1. INTRODUCTION

Water is one of the most important substances and essential natural resource for sustaining the life on earth [1-2]. It can be used for variety of purposes like drinking, cooking, washing, cleaning, agriculture, and industrial development, and growth of plants. The water used for drinking purpose should be safe and clean [3-5]. The majority of population is consuming ground water and surface water for drinking purpose in Pakistan [6]. Since, the quality of surface water is being affected by anthropogenic activities such as urban development, municipal and industrial wastewater discharges, agricultural practices and by natural processes like weathering, sediment transport and soil erosion [7-10]. The anthropogenic activities are the major cause of water quality degradation, however, these activities can be controlled by means of applying better management system and through the usage of different techniques namely physical (settling), chemical (disinfection or coagulation) or biological (slow sand filtration or activated sludge techniques) [11-12]. Besides, it is reported that almost 80 % of ailments and more than 33 % of death are due to the consumption of polluted water in developing countries [13]. Pakistan ranks at number 80 among 122 nations regarding drinking water quality [14-15]. Moreover, the major part of the rural population of Pakistan survives only on the groundwater sources due to unavailability of water treatment systems. It is reported that around 40% deaths are attributed to direct or indirect effect of waterborne diseases in Pakistan [16]. It is because 2000 million gallons per day of sewage is being discharged to the surface water bodies in Pakistan [17-18]. It is further reported that only 6 persons out of 10 have access to safe drinking water in Pakistan [19]. The government has set a target to provide safe drinking water up to 93% of the population by 2015 and to the entire population by 2025 [20-21]. However, it is a very challenging task to achieve the target because of many problems including technical, economic and political barriers.

In this regard, the contribution of research organizations and involvement of every citizen is of prime importance. Therefore, it is our duty to give practical and economical solutions to the government for implementation of projects to achieve the above mentioned goals. Therefore, this study was conducted to develop a cheap and clean filtration technique to remove suspended particulates from the canal waters.

2. MATERIAL AND METHODS

2.1 Study Area

The Gajra wah canal water was selected for this study. The canal is passes through the centre of Nawabshah city and receives the sewage waste from the various locations of the city as well as effluents from Habib Sugar Mills [16, 22]. The maximum quantity of this canal water is being utilized for the irrigation purpose of the area and drinking purpose for the surrounding people. Gajra wah canal is the main source to provide water for drinking and irrigation purpose in the city and surrounding "taluka" Nawabshah. Therefore the quality of Gajra wah canal waters was investigated. The main surface water quality parameters viz. pH, turbidity, total dissolved solids and electrical conductivity were studied. The pH refers to the measurement of hydrogen ion activity in the solution. It is measured on a scale of 0 to 14. A pH of 7 is considered as neutral, above 7 basic and below 7 acidic. Turbidity is a

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measure of water clarity. The material suspended in water decreases the passage of light through the water hence it become opaque. Total dissolved solids (TDS) are a measure of the combined content of all inorganic and organic substances contained in a water sample. Electrical conductivity measures a material's ability to conduct an electric current. The above parameters can indicate the either the water is suitable or not for drinking purpose [23].

2.2 Sample Collection

Ten different locations on Gajra wah canal were selected for investigation of canal water. The samples were taken during the months of July, August and September 2014. Following the grab water sampling method, water samples were collected at varying depths from the surface of the canal and stowed in fresh polythene plastic bottles with a capacity of 1.0 litter each. Three different samples were taken from the same spot for consideration of average values. The samples were stored in thermoset container at 25°C and then analyzed [24].

2.3 Development of Slow Sand Bed Filtration System

Different filtration systems such as rapid sand filtration, slow sand filtration and continuous sand filtration techniques are exist for treatment of canal waters. In rapid sand filtration, there is chance of materials erosion and continuous systems require pressure to push the water through the pores of the media. Since, the slow bed system does not require any force to drive the water through the media and there is also no chance of sand erosion. Therefore, a slow sand bed filtration System (SSBFS) was designed and fabricated in the Department of Energy and Environment Engineering, Quaid-e-Awam University of Engineering Science & Technology (QUEST), Nawabshah, Sindh, Pakistan.

The different components of the designed system are illustrated in Fig. 1. The designed slow sand bed filtration system (SSBFS) comprises of a steel container (763.5 mm in height, 458.1 mm in width & length), screen, lid plate, diffuser plate and a riser pipe. The steel container was used to hold the sand and gravel. A diffuser plate was employed to sprinkle the poured water in a proper way. Small holes were arranged (3 mm in diameter at 25 mm x 25 mm) in a grid pattern. It was fitted at the inlet point of treatment unit. A riser pipe (drain pipe) with small holes was fitted above 50.9 mm from bottom of unit to receive clean water and drain in the clean tub or bottle. Initially riser pipe was wrapped with filtering cloth then fitted in the filter container. The top side of SSBFS was covered with a lid (top cover), which was made from the metallic sheet.

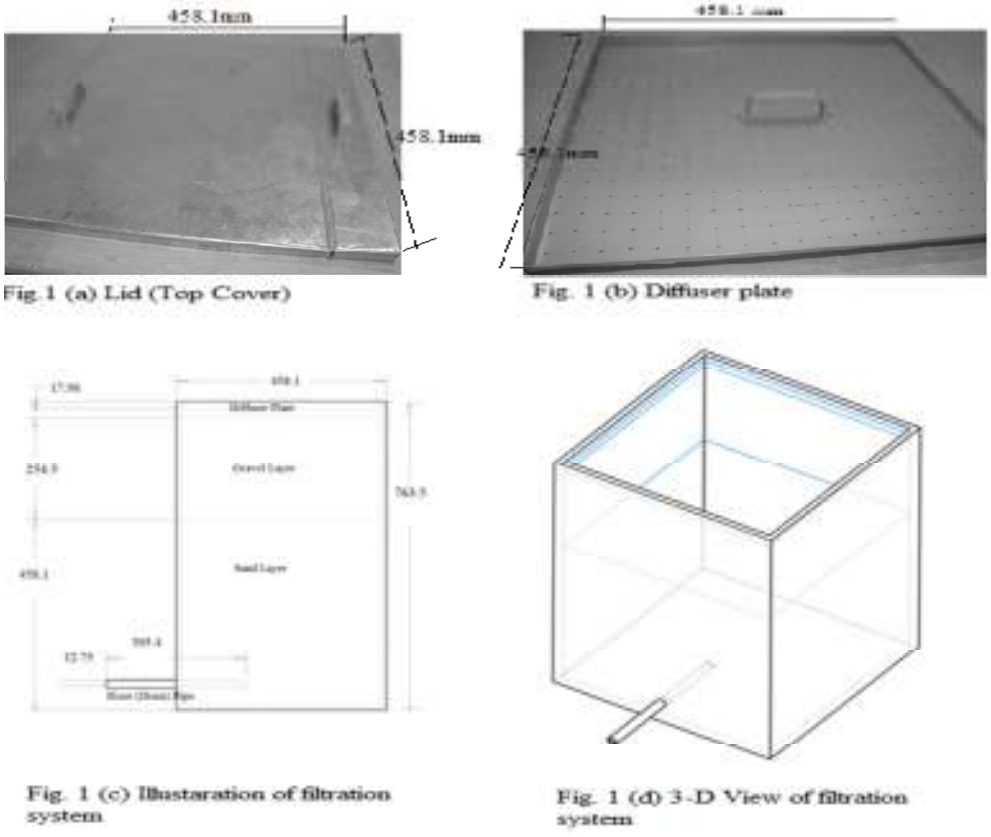

Fig. 1 (a) Lid (Top Cover)

Fig. 1 (b) Diffuser plate

Fig. 1 (c) Illustaration of filtration system

Fig. 1 (d) 3-D View of filtration system

Fig. 1. 3 D view showing different components of proposed filtration system

The purpose of lid was to control the debris, insects and biological reaction inside of treatment system. The cleaned and washed fine sand (0.063- 0.2 mm) and gravel (4.75–12.0 mm) were charged in SSBF system. During the charging of different filtration media's, the 254.5 mm of gravel bed and 458.1 mm of sand layer were provided in the steel container [12, 25-29]. After fabrication of whole system, the water samples were poured from the top of the system through sprinkling technique. The water then passed through the media, where the dissolved solids and turbid materials of the samples were trapped. The filtered water is collected in a clean bottle at the bottom of the designed system.

The selected properties of canal water and filtered water samples namely pH, turbidity, total dissolved solids and electrical conductivity was examined in the Laboratory. The temperature of water samples was measured with the help of thermometers, pH through Lovibond, Sensodirect pH 110 meter and total dissolved solids with ELE International TDS meter Model HI98302 by HANNA. Whereas, Milliampere meter was used to assess the electrical conductivity and Nephelometer (Turbidimeter) for turbidity of canal water samples [30].

3. RESULTS AND DISCUSSION

A total of four parameters, namely pH, turbidity, total dissolved solids and electrical conductivity of Gajra wah water samples were examined as per American Society for Testing and Materials (ASTM). The pH of water samples were tested by ASTM D1293-12, turbidity ASTM D7315-12, total dissolved solids ASTM D5907-13 and electrical conductivity ASTM D1125-14 methods [31].

The average pH value of untreated canal water samples was 8.43, and the maximum and minimum values were 8.77 and 8.11 respectively as shown in Fig. 2. Likewise, the average pH value of treated canal water samples was 7.9, and the maximum and minimum values were 8.17 and 7.69 respectively. It was observed that the pH values of treated water samples were slightly decreased and become closer to the neutral value.

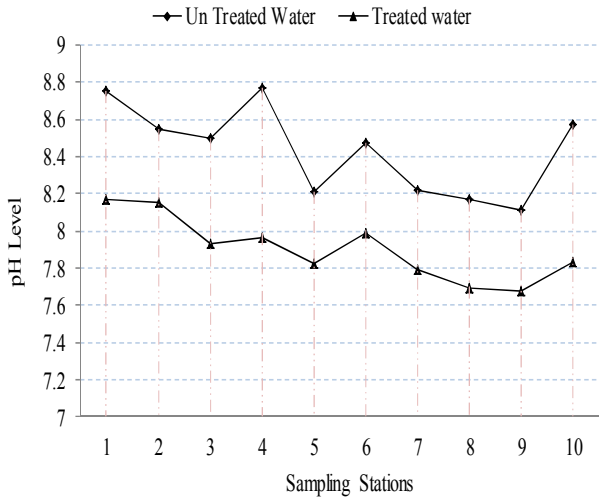

Fig. 2. Results of pH (canal water and treated water samples)

As shown in Fig. 3, the average level of turbidity of untreated canal water samples was 627 FTU with a maximum value of 714 FTU and minimum 557 FTU. Similarly, the average level of turbidity of treated canal water samples was 5.72 FTU with maximum and minimum values of 6.55 FTU and 4.94 FTU respectively. The improvement of turbidity was around 99 %. It is observed from the analysis that turbidity level was successfully improved as compared to other parameters.

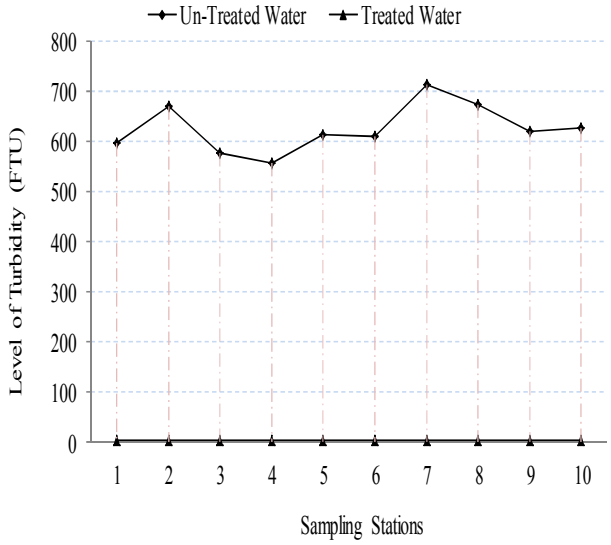

Fig. 3. Results of turbidity (canal water and treated water samples)

The measured results of total dissolved solids (TDS) and electrical conductivity (EC) are shown in Fig. 4. The average level of TDS of untreated canal water samples was 435 mg/l with a maximum and minimum values of 447 mg/l and 415 mg/l respectively. The average TDS value of treated canal water samples was 415 mg/l, and the maximum and minimum values were 427 mg/l and 391 mg/l respectively. The average EC of untreated canal water was 654 µS/cm, and the maximum and minimum values were 672 µS/cm and 625 µS/cm respectively. Likewise, the average EC of treated canal water samples was 621 µS/cm, and the maximum and minimum values were 638 µS/cm and 591 µS/cm respectively. The TDS and EC showed similar behaviour with only 6 % improvement in the examined samples. These both parameters are interrelated with each other, as the increase of TDS results the increase of EC and vice versa.

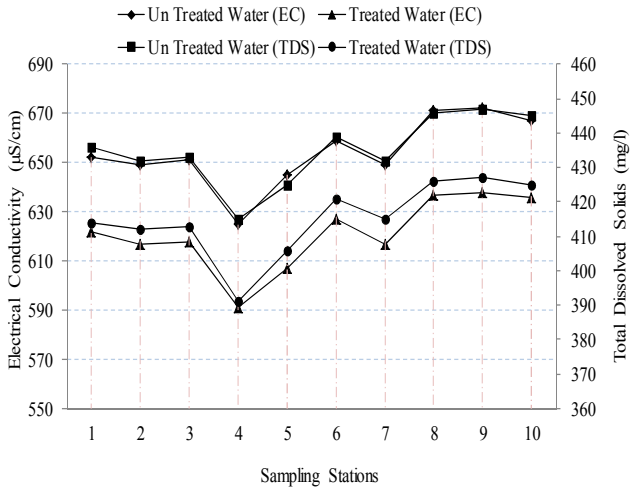

Fig. 4. Results of Electrical conductivity and Total Dissolved Solids (canal water and treated water samples)

4. CONCLUSION AND SUGGESTION

A slow sand bed filtration system is designed and fabricated in the Department of Energy and Environment, Quaid-e-Awam University of Engineering, Science and Technology Nawabshah. The sand and gravel were used as media for the filtration of canal water. The water samples were poured batch wise through sprinkling technique. The pH, turbidity, total dissolved solids and electrical conductivity of canal water and filtered water was analysed. The maximum efficiency of slow sand bed filtration system was found to be 99 % for turbidity and minimum efficiency was 6.28 % for pH. It is observed that the designed system was more effective for removal of turbidity from the canal waters among examined parameters. It is suggested that Sindh Environmental Protection Agency (SEPA) may organize awareness programs for people to prevent the quality of surface and canal waters. SEPA should assure that industries could not throw their effluent directly into the surface water bodies. The random checking of water samples may be carried out in regular intervals (weekly or monthly) to make the quality of drinking waters as per standards.

5. ACKNOWLEDGEMENT

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