Biological Treatment for Domestic Wastewater by SBR Combined With Coarse Filter

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Abstract- The biological treatment is an important part of any sewage treatment plant that treats wastewater from either of them municipality or industry. One of the most effective and economical wastewater treatment systems is the sequencing batch reactor system. The overall task of this study is to identify an appropriate control strategy for achieving the most efficient operation of Al Basra city SBR domestic wastewater treatment plant combined with the filter. The sequencing batch reactor (SBR) is a system that operates with the concept of activated sludge In this work, an experimental scale for an SBR unit was constructed in conjunction with a coarse filter. The most important components of this unit are: sedimentation tank for domestic wastewater (250 liters) and the SBR reactor (96 liters) as this reactor consists of a ventilation tube, a mixer, and a panel to control the operation and stopping of the aeration and mixing units. Coarse filter, which consists of a glass tank with a volume of (126 liters) consisting of two layers of gravel SBR system is shown that removal efficiency for (COD, BOD, PO4, SO4, and NO3) was (93%, 93%, 52%, 10%, and 65%) respectively and the removal efficiency of SBR with the filter for the same pollutants was (97%, 96%, 56%, 29%, and 70%) respectively.

Keywords – Biological treatment, domestic wastewater, SBR (Sequencing Batch Reactor), Filter, Pollutants removal.

I. INTRODUCTION

Wastewater is liquid wastes resulting from different human activates, such as domestic wastewater its wastewater coming from housing and commercial places such as banks, restaurants, and markets and institutional facilities such as schools and hospitals, and the amount of wastewater varies. Coming from homes with different hours of the day, days, and seasons, the new domestic wastewater is characterized by a smell similar to the smell of kerosene, while the old sewage water is characterized by a very bad smell, like the smell of rotten eggs similar to the Hydrogen Sulfide, and the wastewater has modern neighborhood gray color, while the old sewage owns a color black, ranging degree of drainage water temperatures healthy home between 10 degrees siliceous [1].

A wastewater treatment system that fixed on the activated sludge, work on a sequence of fall and draw cycle. These systems usually include the process of removing biological nutrients. The operation unit includes in SBR are equivalent to the conventional activated sludge systems. So that aeration and sedimentation clarification is completed. The differences between systems are in the conventional systems. These two operations are happening in different tanks, but in the SBR system, they happened sequentially in the same tank [2]. The physical or mechanical process is used to separate solids from liquids by overlapping a tray of media that only a liquid can pass through. Is known (Filtration) which is used to describe some biological processes, especially in the treatment of water and wastewater treatment in which unwanted components are adsorbed on a biofilm developed on or in the filter medium [3].

The work by Bernardes and Klapwijk (1996) [4] reflects how biodegradable substrates play an important role in the removal of biological nutrients. To assess the efficiency of SBR processing, including nitrification, denitrification, carbon oxidation, and phosphorus removal. Umble and Ketchum (1997) [5] treated urban wastewater by SBR technology with similar objectives. Their SBR was used to provide biological treatment of wastewater for the oxidation of organic matter, removal of suspended solids, and nitrification due to its operational versatility. Bernardes et al. (1999) [6] provided an important study on actions in terms of respiration rate and nitrate removal for an activated sludge sequencing batch reactor with domestic wastewater nitrification, denitrification, and carbon oxidation, among the various mathematical models that have been developed dealing with this form of treatment. Tiller and Cooper, 1960[7] Tiller and Shirato, 1962[8] Tiller and Shirato, 1964 [9] Shirato et al., 1969[10]. The development of filtration theory is based on differential equations involving local flow resistance and variable flow rates Cake filtration analysis to obtain these equations are often intended to provide a more detailed account of the movement of the liquid under the applied pressure gradient through the porous cake.

II. MATERIALS AND METHODS

A. Materials and Tools –

This study used a settling tank, SBR reactor which consists of the mixture, aeration system, pumps, control panel, and coarse filter that consists of two layers of gravel with the diameter (2/5-6/5)mm for the first layer and (6/5-9/5)mm .thickness for each layer was(7cm), figure (1).

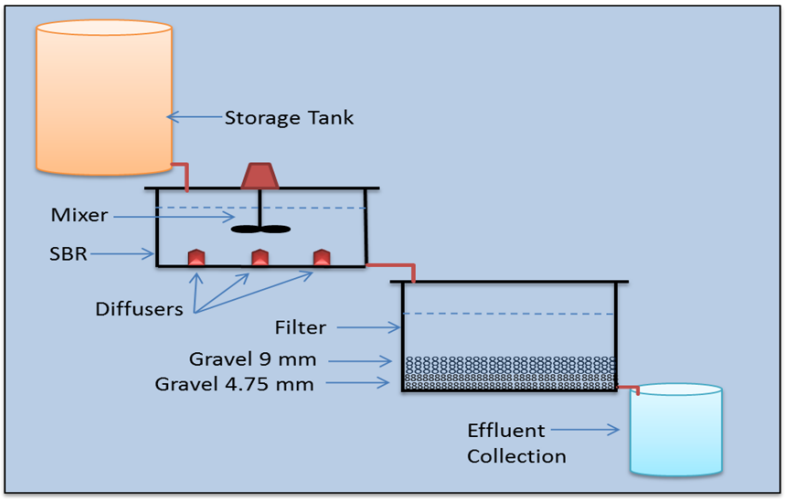

Figure 1. Schematic Diagram of Constructed Unit

B. Experimental Work procedure –

Raw wastewater was from the main manhole of AL-Junaina region. That collected in the settling tank and transport to SBR with volume 96L and after five stages of SBR (fill, aeration, mixer, sedimentation and draw). The effluent wastewater from SBR transport to the filter and the effluent collection. All tests were done in a sanitary laboratory in the civil engineering department of Basrah university. In the work, we used spectrometer Dr5000 for COD, PO4, NO3, and SO4[11]. BOD checked by oxidized instrument manual[12].

III. RESULTS AND DISCUSSION

The experimental period for different operational cycle modes occurred in each sequence batch reactor and filter as shown in figure (1). Operational optimization is performed to select the best cycle mode that gives good results in the reactor. This operation was performed in cycle modes (1 to 4). Each with its own set of treatment parameters. The paragraph explains the specification for each cycle. The experiment was launched in 2020 between February and September. The temperature (21 - 30) co in this condition is suitable for living sludge organisms, operated as four-cycle modes as shown in figure (2).

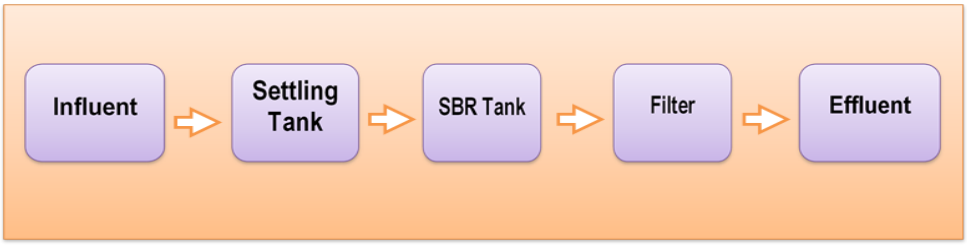

Figure 2. Experimental Process.

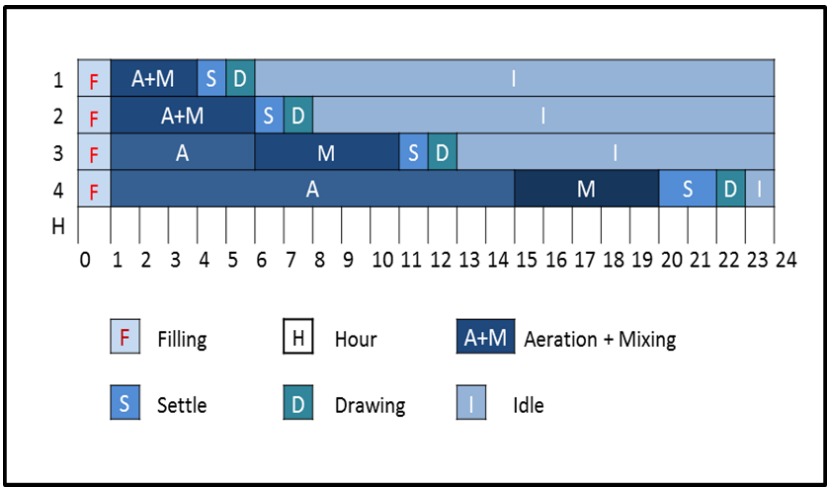

Figure 3. SBR operation cycle modes.

A. Microscopic Examination for Sludge.–

The SBR found different types of microorganisms such as Alga which provide oxygen to bacteria that oxidize the organic matter in that wastewater. The main section of the algae is the division Cyanophyta section which is classified within the group of bacteria with the name cyanobacteria and there are many kinds of algae such as chlorophyte, euglenaphyta, etc there are autotrophic algae.

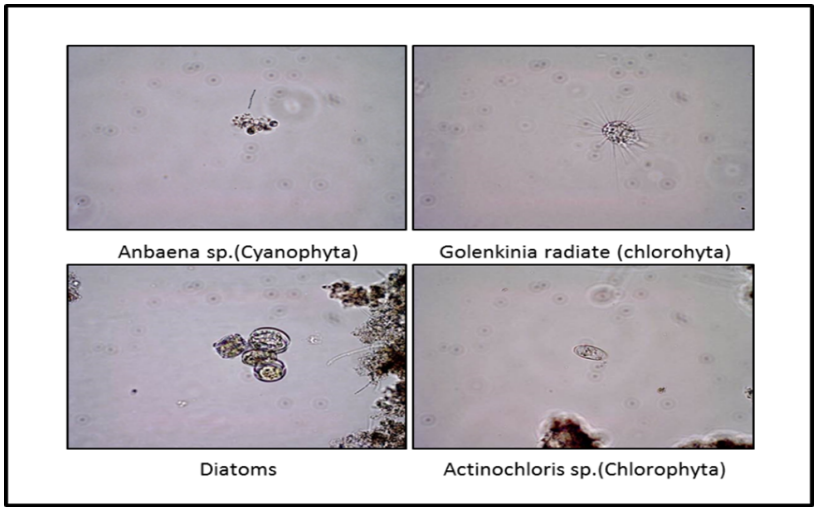

Figure 4. Type of Algae

They use sunlight as their source of energy, and carbon dioxide or bicarbonate as their source of carbon. The oxygen which is produced during photosynthesis replenishes the water's dissolved oxygen content. In aerobic oxidation ponds, they are mostly used as they can provide the oxygen required for aerobic bacteria. In the aquatic food chain, algae are the major primary producers. As shown in figure (4). By the method of spread plate Technique we have got types of bacteria, the most important of them was Escherichia Coli (E. coli) as shown in figure (5).

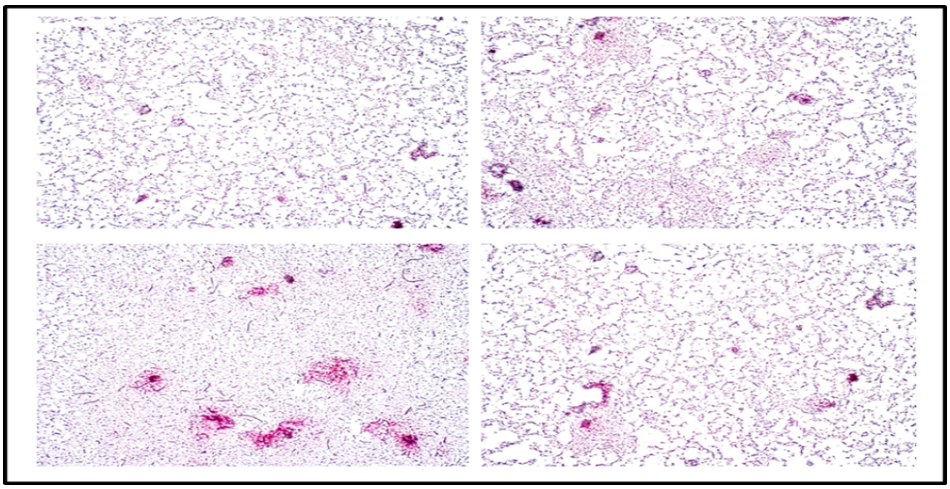

Figure 5. E-Coli

By Spread plate Technique method. In this method, 0.1ml of the solution that contains microbes are spread, and after this part is transferred by sterile pipette and spread on solidified culture medium nutrient agar as shown in figure (6).

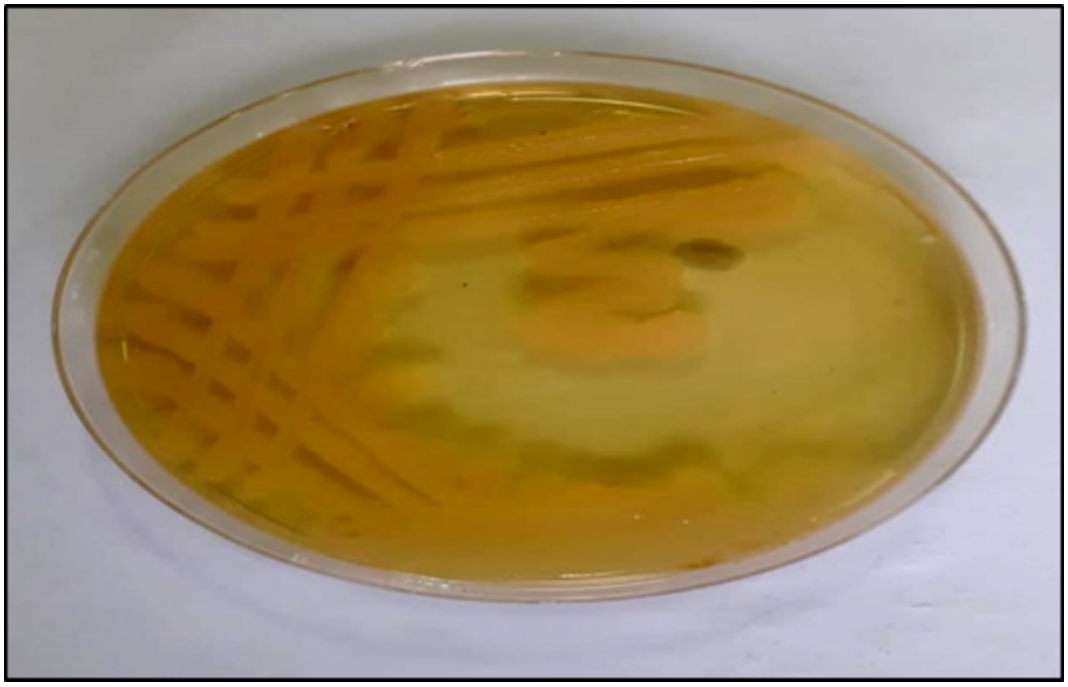

Figure 6. E. Coli bacteria that grow on a medium nutrient agar

And by MacConkey agar the color of the colonies appears as a reddish-pink color due to the fermentation of the bacteria and their interaction with the MacConkey agar medium as shown in figure 7.

Figure 7. E.Coli bacteria that grow on a medium MacConkey agar

B. Best cycle mode operation–

It can be concluded according to the findings that SBR and filter are a good method for the treatment of domestic wastewater where the system has high efficiency of removal in the third cycle operation mode as shown below in figure (8). Two bases were introduced to test the efficiency of SBR as a biological treatment tool. The first is based on the calculations of the personage of removal and the second on the comparison of an effluent content with the criteria for the discharge of natural wastewater . The practical results showed that the efficiency of SBR to remove the pollutants (COD, BOD, PO4, SO4, NO3) were (93%, 93%, 52%, 10%, 65) respectively, and the removal efficiency of SBR with filter for the same pollutant were (97%, 96%, 56%, 20%, 70%). Comparison of wastewater from Al-Basra city with the characteristics of treated domestic wastewater shows that it contains the average concentration of (COD, BOD, PO4, SO4, NO3and TSS) were (23.10, 13.90, 2.27, 55.14, 4.87 and 172.42) mg/l and for the same pollutant of SBR with filter (9.07, 9.04, 2.08, 48.86, 4.08 and 67.8) mg/l. as shown in figure (9) within the range of Iraqi specifications.

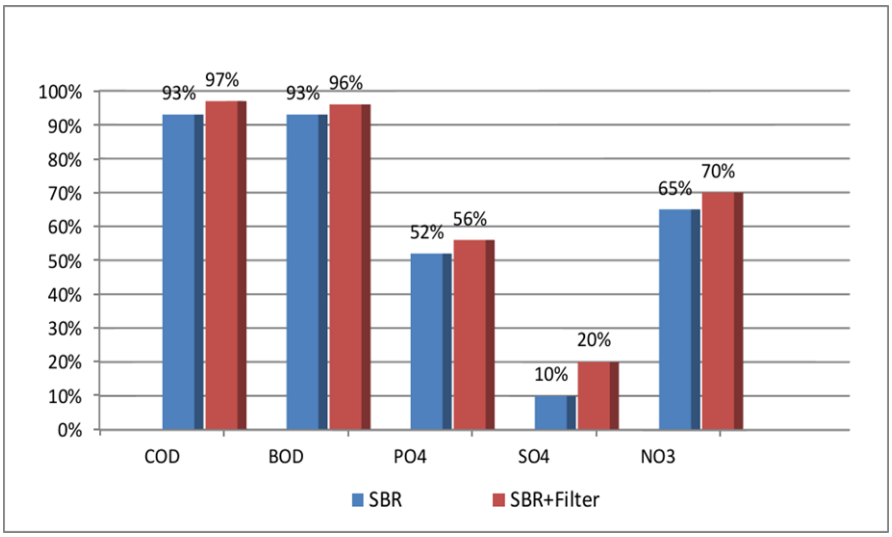

Figure 8. COD, BOD, PO_4, SO_4, and NO_3 removal efficiency under SBR and SBR with filter.

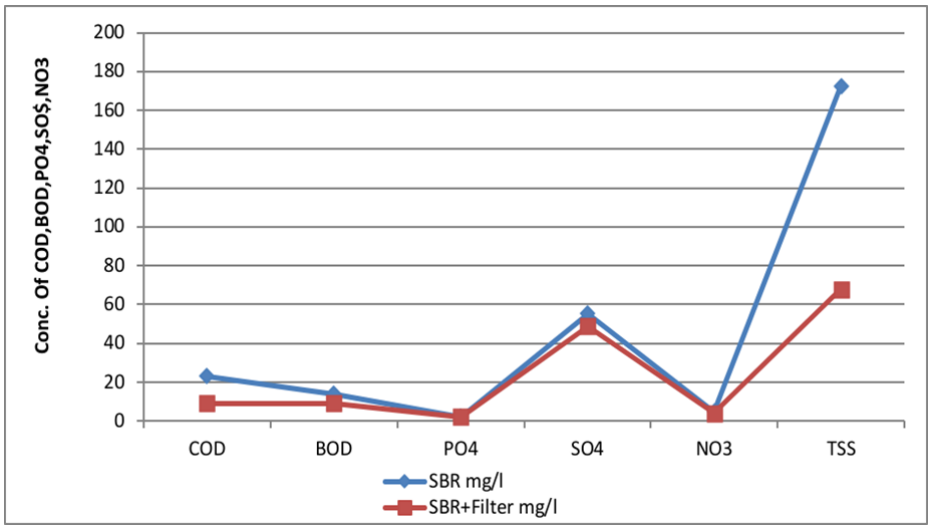

Figure 9. COD, BOD, PO_4, SO_4, and NO_3 removal efficiency under SBR and SBR with filter.

IV.CONCLUSION

Domestic wastewater was treated by sequencing batch reactor combined with the filter in four operating cycle modes (first, second, third, and fourth).

From the tests and results of the present stage, the following conclusions are obtained

1. The sequences batch reactor system can be used successfully to treat municipal wastewater from Al-Basra and achieve a high pollutant removal rate.

2. The results showed that the efficiency of SBR with the filter to remove the pollutants (COD, BOD, PO4, SO4, and TSS) is higher than that of SBR alone.

V. REFERENCE

[1] Mackenzie Davis, (2010) "Water and Waste Water Engineering", New York; McGraw-Hill, page 18-2, Edited.

[2] Nicholas P. Chermision off, (2012) "Hand Book of Water and Waste Water Treatment Technologies", Butter Worth-Heine Mann, page 62.

[3] Kameran M. Salih, (2012)"Role of Different Filter Media in Water Purification and Water Treatment", Kurdistan Engineers union, 33, 5046.

[4] Bernardes, R. S.; Klapwijk, A. (1996) "Biological nutrient removal in a sequencing batch reactor treating domestic wastewater". Water Sci. Technol, 33 (3), 29.

[5] Umble, A. K.; Ketchum, L. H., Jr. (1997) "A strategy for coupling municipal wastewater treatment using the sequencing batch reactor with effluent nutrient recovery through aquaculture". Water Sci. Technol, 35 (1), 177.

[6] Bernardes, R. S.; Spanjers, H.; Klapwijk, A.(1999) "Modelling respiration rate and nitrate removal in a nitrifying-denitrifying SBR treating domestic wastewater". Bioresour. Technol., 67 (2), 177.

[7] Tiller, F.M. and H. R.Cooper. The Role of Porosity in Filtration, Part IV. Constant Pressure Filtration, AIChE J., 6, No. 4, pp. 595-601, 1960.

[8] Tiller, F.M. and H. R. Cooper. The Role of porosity in filtration, Part V. Porosity Variation in Filter Cakes, AIChE J., 8, No. 4, pp. 445-449, (1962).

[9] Tiller, F. M. and Shirato M., (1964) "The Role of Porosity in Filtration: VI. New Definition of Filtration Resistance," AIChE Journal, 10, 61.

[10] Shirato, M., M. Sambuichi, H. Kato and T. Aragaki. Internal Flow Mechanismn Filter Cake. AIChE J., 15, No. 3, pp. 405-409. (1969).

[11] DR5000 Spectrophotometer Procedures Manual November 05 Edition 2. Germany.

[12] BOD System OxiDirect Instrument Manual, 2.3 page 6.