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Research paper

Performance of sequence batch moving bed biofilm reactor under different operation cycle modes for domestic wastewater treatment

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Abstract

Because of the rapid urbanization, the rate of surface water pollution is increasing daily due to the disposal of different wastewater in the water bodies leading to creating major impacts on humans and wildlife. Therefore, there is an urgent need to find a new treatment technology that can meet the challenges of increased sewage discharges and strictness in standard specifications for treated water and the lowest possible construction, maintenance, and operation costs while avoiding all the problems that arise from the use of the traditional technique of active sludge. Sequence Batch Moving Bed Biofilm Reactors (SBMBBR) technology has been developed to overcome these challenges, (SBMBBR) process is one of the most efficient and economical wastewater treatment systems. in our research. the Lab-scale of SBMBBR technology is constructed to treat domestic wastewater. The SBR unit is consist of; Primary clarifier of (150 L), an SBR reactor of (96 L) which were used to treated 80 L/d, at the MBB which used Kaldnes media, was utilized as a carrier in reactor at a media fill ratio equal to 50%. We Was optimize of five operations cyclic mode and choose The fourth cyclic mode is the best for the average efficiency of removal (COD, NH4+-N, TN, TP) was (98.132%), (97.642%), (82.255%), and (92.107%) respectively.

Keywords: *Sequence Batch Moving Bed Biofilm Reactor (SBMBBR); Domestic Wastewaters; COD; NH4+-N; TN; TP.*

1. Introduction

The surface water is affected in quality as a result of discharging untreated wastewaters which contain high concentrations of pollutants to the water surfaces [1]. In general, Iraq has suffered for over a decade because of the shortage of surface water supply. because of the high degradation of the Euphrates and Tigris rivers ,minimum rainfall and rise temperature As well as arise degree of pollution in the river water due to Clear contraction from rainwater networks with waste networks and the discharge of most of the sewage water to the main and secondary rivers because of lack of sewage treatment facilities. Then, necessary to consider seriously the proportionality of new technologies utilized in the treatment of wastewater in Iraq by setting up new sewage treatment plants utilization the latest international technologies To have a new source that can be a source of water supplies utilized for irrigation and drinking functions [2].

Abdul-Majeed, M. A., et all. (2012), presented of the experiment is a comparison between a low-cost moving bed biofilm reactor (MBBR) and an Activated Sludge system (AS). The BOD5 load is about (150-200) mg/l filling ratio of plastic elements in the MBBR reactor was 40%. Most biodegradable organic matter was consumed by Aerobic reactor. The BOD5 removal efficiencies were 78% and 90% for MBBR & AS respectively. And the Second part the BOD5 load about (900-1300) mg/l filling ratio is 67%. The removal efficiencies of BOD reached 73 %and 88% for AS & MBBR respectively [3].

Safwat, S.M.(2019), showed the advantages and disadvantages of the MBBR process, Some of the inherent advantages of MBBR is; Simple, flexible and compact design, Can be operated over a range of loadings (e.g. for Biochemical Oxygen Demand (BOD)/ Chemical Oxygen Demand (COD))removal, less than(5 mg BOD7/L to more than 20 g BOD7/L). High volumetric removal rates are achievable. And disadvantages of the MBBR process are; Aeration grids and propellers prone to excessive wear due to collisions with the biofilm carrier material. High BOD/COD loadings lead to poor settling conditions (e.g. use of coagulants/ flocculants in clarifier) [4].

2. Materials and methods

2.1. Description of the (SBMBBR) unit

The major parts of the SBMBBR plant which is used in this study are the Primary clarifier, SBR reactor, and Secondary clarifier, air compressor, mixer, airflow meter, Moving Bed Biofilm Reactor (MBBR), and others. A schematic diagram for the SBMBBR unit is depicted in figure (1).

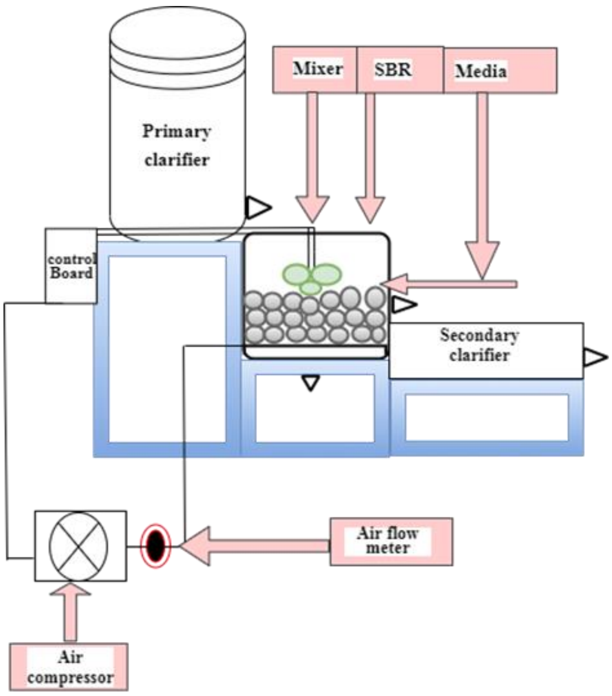

Fig. 1: Schematic Diagram for the SBMBBR Unit Is Depicted.

2.2. Domestic wastewater

Raw wastewater is decanted from the manhole in Al Samawa City (AL Samawa sewage) and collected in the collection tank which represents the source of the influent raw wastewater in the SBMBBR reactor.

2.3. Analytical methods

We are studying parameters that were Chemical Oxygen Demand (COD) by DR5000 Pursuant to the standard process [5]. Ammonium (NH_4^+ -N) method (LCK 303) by DR 1900 [6], Total Nitrogen (TN) It was measured according to this method (LCK 338) by DR 1900 [7], and Total Phosphor (TP) It was measured according to this method (LCK 348 Phosphorus total) by DR 1900 [8].

3. Results and discussion

We studied the effect of the time of aeration and anoxic on the performance of the treatment system and find the optimum values of the time of aeration and the time of anoxic by operating the treatment system after several different cycles and choosing the cycle that gives the best of removal efficiency. The experimental period involved five different operational cyclic modes that occurred in the (SBMBBR) under the optimal value of gas/water ratio which equal to 7/1 as shown in table (1).

Table 1: Characteristics of Operation Cyclic Modes Parameters in the Steady-State Process

Cyclic Mode	Cycle time (hr)	Fill (hr)	Aeration (hr)	Anoxic (hr)	Settle (hr)	Discharge (hr)
1st	24	1	13	8	1	1
2nd	24	1	12	9	1	1
3rd	24	1	11	10	1	1
4th	24	1	10	11	1	1
5th	24	1	9	12	1	1

3.1. COD removal at different operating cycle modes

The results of COD Concentration and removal efficiency under five operation cycle modes are depicted in figure (2), (3) respectively
In the first cycle mode, the average concentration influent of COD was (478.33 mg/l), The average concentration effluent of COD (16.78 mg/l), and the removal efficiency was (96.491%). in the second cycle mode, The average concentration influent of COD (403.33 mg/l), The average concentration effluent of COD (18.333 mg/l), and the removal efficiency was (95.405%). In the third cycle mode, The average concentration influent of COD (237.67 mg/l), The average concentration effluent of COD (13.3 mg/l) and the Removal efficiency was (94.295%). In the fourth cycle mode, The average concentration influent of COD (391.33mg/l), the average concentration effluent of COD (7.066 mg/l), and the removal efficiency was (98.132%). In the fifth cycle mode, the average influent COD concentration was (285 mg/l), the average effluent concentration of COD (12.766 mg/l), and the removal efficiency was (95.487%).We can present the fourth cycle mode as a better mode for COD removal by comparing the average Removal efficiency of the COD through the process cycle mode.

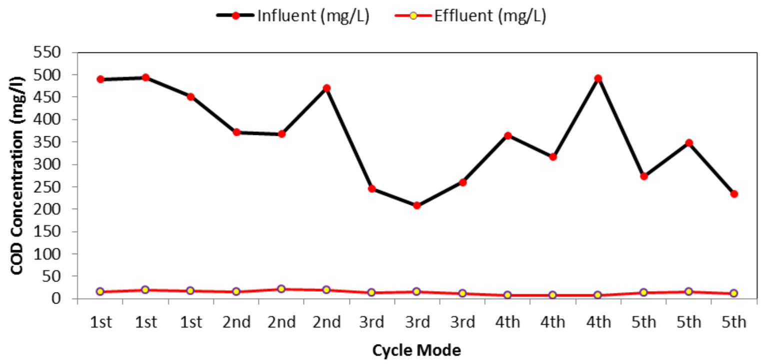

Fig. 2: Profile of COD Concentration Under Different Operation Cycle Modes.

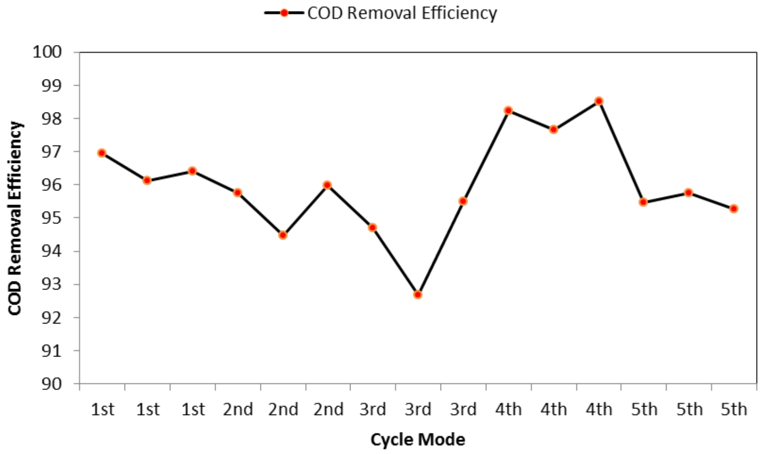

Fig. 3: Profile of COD Removal Efficiency Under Different Operation Cycle Modes.

3.2. NH4+-N removal at different operating cycle modes

The results of NH_4+-N Concentration and removal efficiency under five operation cycle modes are depicted in Figure (4), (5) respectively. In the first cycle mode, the average influent NH_4+-N concentration was (37.28mg/l), the average effluent concentration of NH_4+-N (1.426 mg/l), and the removal efficiency was (96.151%). In the second cycle mode, the average concentration NH_4+-N influent was (39.24 mg/l), the average concentration effluent of NH_4+-N (2.276 mg/l), and the removal efficiency was (94.161%). In the third cycle mode, the average influent NH_4+-N concentration was (38.14 mg/l), the average concentration effluent of NH_4+-N (2.41 mg/l) and the removal efficiency was (93.635%). In the fourth cycle mode, the average influent NH_4+-N concentration was (36.87 mg/l), the average concentration effluent of NH_4+-N (0.86 mg/l) and Removal efficiency was (97.642%). In the fifth cycle mode, the average influent NH_4+-N concentration was (39.43 mg/l), the average effluent concentration of NH_4+-N (2.41 mg/l), and the removal efficiency was (93.863%).

We can present the fourth cycle mode as a better mode for NH4+-N removal by comparing the average removal efficiency of the NH_4+-N through the process cycle mode.

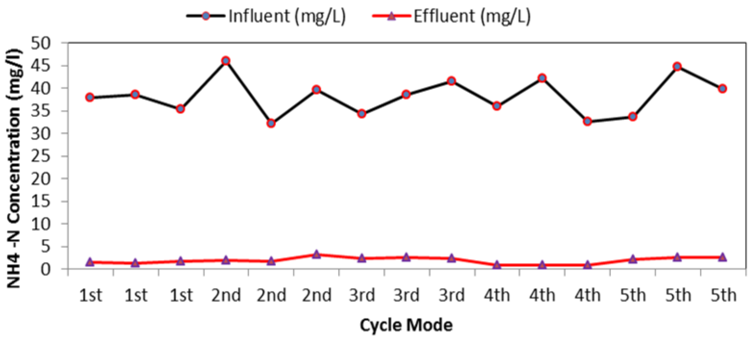

Fig. 4: Profile of NH_4+-N Concentration Under Different Operation Cycle Modes.

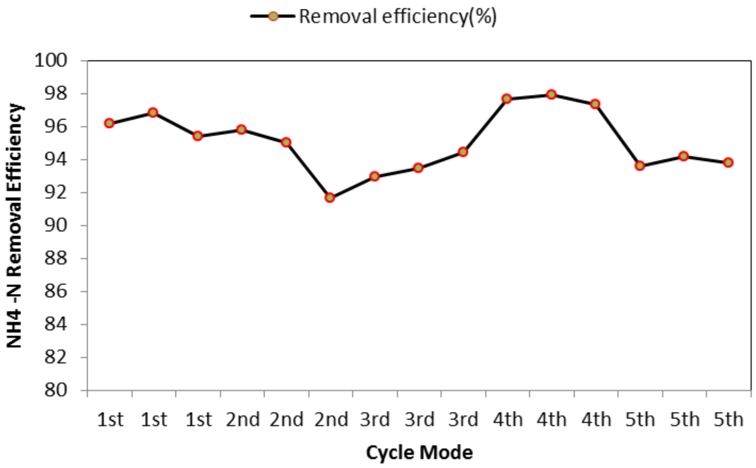

Fig. 5: Profile of NH_4+-N Removal Efficiency Under Different Operation Cycle Modes.

3.3. TN removal at different operating cycle modes

The results of TN Concentration and removal efficiency under five operation cycle modes are depicted in Figure (6), (7) respectively. In the first cycle mode, the average concentration influent of TN was (65.23 mg/l), the average concentration effluent of TN (22.133 mg/l), and Removal efficiency was (66.034%). In the second cycle mode, the average influent TN concentration was (66.17 mg/l), the average effluent concentration of TN (20.1 mg/l), the Removal efficiency was (68.948%). In the third cycle mode, the average concentration influent of TN was (69.07 mg/l), the average concentration effluent of TN (16.733 mg/l) and Removal efficiency was (75.704%). In the fourth cycle mode, the average influent TN concentration was (66.94 mg/l), the average effluent concentration of TN (11.666 mg/l), and the removal efficiency was (82.255%). In the fifth cycle mode, the average influent TN concentration was (64.23mg/l), the average effluent concentration of TN (18.3mg/l) and the removal efficiency was (71.501%).
We can present the fourth cycle mode as a better mode for TN removal by comparing the average removal efficiency of the TN through the process cycle mode.

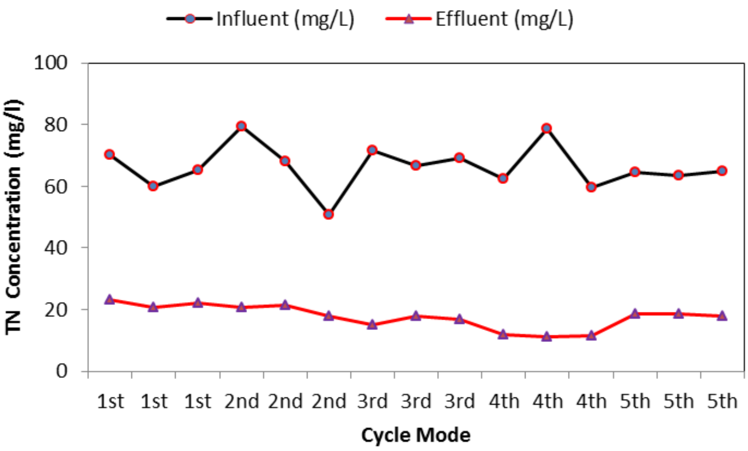

Fig. 6: Profile of TN Concentration Under Different Operation Cycle Modes.

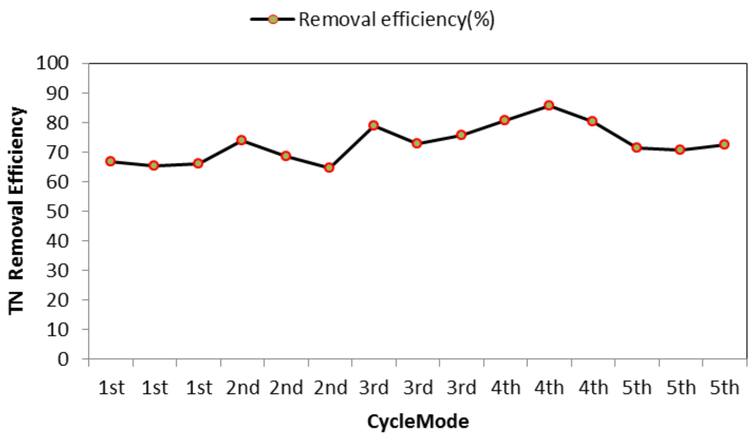

Fig. 7: Profile of TN Removal Efficiency Under Different Operation Cycle Modes.

3.4. TP removal at different operating cycle modes

The results of TP Concentration and removal efficiency under five operation cycle modes are depicted in figure (8), (9) respectively. In the first cycle mode, the average concentration influent of TP was (2.7 mg/l), the average concentration effluent of TP was (0.5 mg/l), and the Removal efficiency was (81.270%). in the second cycle mode, the average concentration influent of TP was (2.83 mg/l), the average concentration effluent of TP was (0.42 mg/l), and the Removal efficiency was (84.895%). In the third cycle mode, the average concentration influent was (3.25 mg/l), the average concentration effluent of TP was (0.43mg/l) and the removal efficiency was (86.496%). In the fourth cycle mode, the average concentration influent was (3.53 mg/l), the average concentration effluent of TP (0.256 mg/l), and the Removal efficiency was (92.107%). In the fifth cycle mode, the average influent concentration of TP was (2.9mg/l), the average concentration effluent of TP (0.46mg/l) and Removal efficiency was (83.804%).
We can present the fourth cycle mode as a better mode for TP removal by comparing the average removal efficiency of the TP through the process cycle mode.

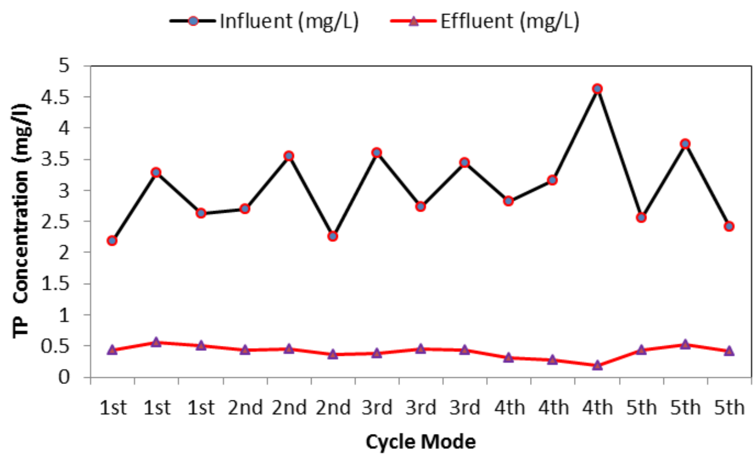

Fig. 8: Profile of TP Concentration Under Different Operation Cycle Modes.

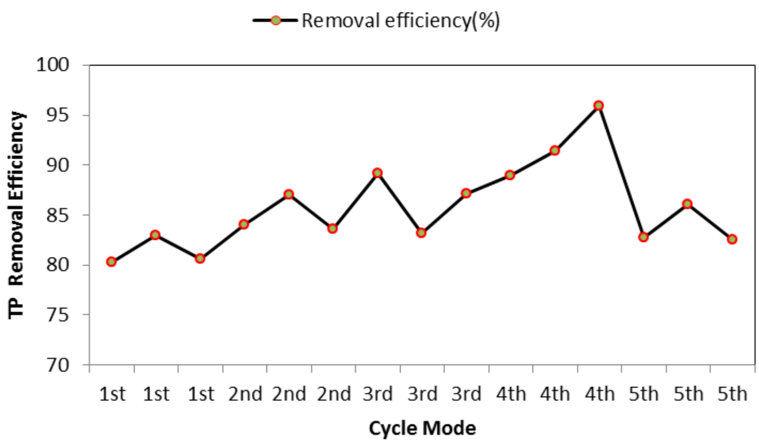

Fig. 9: Profile of TP Removal Efficiency Under Different Operation Cycle Modes.

4. Conclusions

According to the results of the experiment, The Fourth cyclic mode is considered the best one Comparison with the other cycles, gave higher removal rates for COD= (98.132%), NH_4+-N= (97.642%), TN=(82.255%), TP=(92.107%) for the SBMBBR. the Fourth cyclic mode characterized by follow: 1 hour (fill), 10 hours (aeration), 11 hours (anoxic), 1 (settle), 1 hour (discharge) and treatment for 80 L/day, HRT is 24 hours.

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