ISSN: 0975-766X
CODEN: IJPTFI
Research Article

Available Online through
www.ijptonline.com

SIMULATIONS REMOVAL OF COD AND AMMONIA FROM CARBONATED SOFT DRINK INDUSTRIES WASTEWATER USING A SEQUENCING BATCH REACTOR (SBR)

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Received on 04-03-2016 *Accepted on 25-03-2016*

Abstract

Over the years, the biological treatment processes is still the best option for treatment of municipal wastewater and many industries effluents. Sequencing batch reactor (SBR) is one of the reliable systems for treating the variety of wastewaters. Soft-drink industries wastewater is contains the considerable amounts of compounds including organic, inorganic matters, ammonia and etc. industrial wastes are great concerns for environment and public health. However, the aim of present study was an attempt to investigate the role of different effective parameters in a SBR reactor to treats the effluent of carbonated soft drink industries. To evaluate the SBR different conditions such as HRT (4, 6, and 8h), adjusting aerobic-anoxic sequential cycles, MLSS values (2000, 4000, 6000mg/L) were considered. The results showed that the higher SBR performance achieves when HRT and MLSS be set at 8 h and 6000mg/L, respectively. At this optimal condition, COD, NH3-N and turbidity were removed 94.45, 98.9 and 96.1%, respectively. Depending on the results it can be found with increase in HRT, a notable increase in removal performance will be achieved. Therefore, it can be concluded that the SBR systems can be successfully used to treatment of carbonated soft-drink industries wastewater.

Keywords: SBR, Soft-drink wastewater, industrial effluent.

Introduction

Population growth and development of industries caused that the water needs increased(1). However it can leads to water shortage in the world. So, water resource management should be considered as main strategy to solute the water crisis concerns (2). Water pollution control is one of element of the water resources management and also, it is known important method to reuse the wastewater Carbonated soft drink industrial discharges produced wastes with highly amounts of organic matter, TSS, BOD5, and COD (6). Sheldon et al. (2016), have been reported that the 50% of the carbonated soft drink industries is produced from the washing process and glass containers cleaning (7). Also, this industries is produced a moderate to high levels of organic compounds (sucrose, glucose, fructose, lactose, synthetic flavors, synthetic colors through biological treatment processes. The COD content in the carbonated soft drink wastewater are relatively variable and can vary from the range of 1to10gO2/L depending on the type of process and products(7).

Biological treatment is a reliable and suitable method for treatment of variety of industrial effluents with high ratio biologically degradable organic contents (BOD5/COD $\geq$ 0.5)(8-9). SBR process is the popular treatment methods which it has been successfully used in researches(10-11). This process has been suggested to removing the nitrogen and phosphorous from food industries (12-13). This process is comprised of five stages with highly biological mass. Desirable advantage of SBR are including easy to operation, high flexibility, no need to secondary settlement tank and sludge recycle system, lower volume due to integration, higher effective for organic materials and nutrients removal, small space needed for the installation, and economic in comparing to active sludge (16-18). Other desirable characteristics of SBR are comprised the adjustability of reaction and settlement time that makes it more flexible to changes biomass loads. However, it is suitable for industrial wastewater with variety of organic and hydraulic shocks (14). Sathianet al. (2014) reported the new design of SBR namely CFIDAB was able to treat the carbonated soft drinks industries waste water with COD, nitrogen, and phosphorous removal efficiencies about98, 72, and 65%, respectively (8). The SBR operating factors such as HRT, organic and inorganic loads and available biomaterial in reaction tank play as important performance keys(21). Accordingly, at present work the SBR reactor was set for wastewater treating from carbonated soft drink industries regard to changes in HRT, MLSS and inlet COD and ammonia.

Material and methods

Wastewater characteristic

Influent wastewater was collected form Kermanshah carbonated soft drink industries, Kermanshah, Iran. Table 1, shows the carbonated soft drink wastewater characteristics. .

Table 1. Carbonated soft drink waste water characteristics.

Parameter	Concentration
sCOD	2400±80 mg/L
BOD_5	1050±95 mg/L

TSS	320±37mg/L
NH_3-N	85±9mg/L
TP	26±7
Turbidity	128.6±4.3NTU
pH	6.4

Reactor Setup

The present study was carried out as an experimental with actual wastewater. A cylindrical pyrex glass reactor was used as SBR with an effective volume about 2L. the reactor was equipped by aquarium pump and air-stone in order to mixing, aeration and supplying required oxygen to provide the constant temperature for biological process, an aquarium thermometer was used and it was adjusted at 20±2ºC. Fig. 1 illustrates the schematic plan of SBR reactor that used in this study.

Start up

The start-up phase took place in order to adapt the wastewater microorganisms. The primary microbial seeds were prepared from the waste water treatment plant (returning activated sludge). First, the reactor was filled by raw wastewater sludge with a final MLSS about 4000 mg/L. Then, reactor was aerated and fed carbonated soft drink wastewater at HRT 8h. To ensure from the optimum growth of microorganisms, micronutrients was added to influent consisted of (g/L) 1.5 $FeCl_3 \cdot 6H_2O$, 0.15 H_3BO_3, 0.03 $CuSO_4 \cdot 5H_2O$, 0.18 KI, 0.12 $MnCl_2 \cdot 4H_2O$, 0.06 $Na_2MoO_4 \cdot 2H_2O$, 0.12 $ZnSO_4 \cdot 7H_2O$, 0.15 $CoCl_2 \cdot 6H_2O$ and 10 mM acetate. The final adaptation of microorganisms took place with different concentrations of industrial wastewater regularly. This phase were continues operated at constant condition for more than two month until the reactor were reached steady state.

In operation phase, the system was fed with real wastewater taking by considered effective parameters. At this time, inlet air flow rate was set on 19.5L/h and the various amount of HRT, cellular retention time and MLSS (2000, 4000, and 6000 mg/L) were checked.

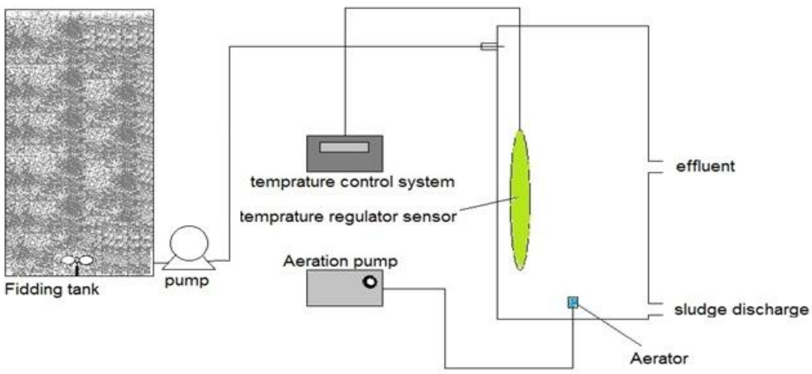

Fig. 1. Schematic plan of the SBR reactor.

Analysis

According to standard methods for water and wastewater, ammonia and COD were analyzed. To determine the content ammonia, the Phenate method (λ_{max} 640 nm, spectrophotometry, 4500-NH_3 F) was used. Also, the COD value was measured spectrophotometry at λ_{max} 600 nm.

Results and Discussion

COD removal

High performance of the SBR system to remove COD was concluded from three different ways consist of ; i) High degradable level of wastewater contents (BOD/COD $\geq$ 0.46), ii) provided a relative long HRT taking by establishment the aerobic and anoxic regime and iii) presence of adequate amounts of biomaterial (high value of MLSS) values to preserve the endogenous condition. To evaluate the performance of SBR for removing organic matters, changes of COD was considered. Inlet and outlet concentration of COD in the SBR reactor during 10 days were investigated. This tracing are illustrated in Fig. 2. According to Fig.2a, b and c, variations of COD at different HRT values (2, 4, 6, 8h) with different MLSS 2000, 4000 and 6000mg/L. with regard increase in HRT has improved the removal of COD and turbidity. It is clear that the ten reactors performance was shown better condition under 4000 mg/L of MLSS and higher HRT. At this time, SBR efficiency increased from 69.95% at HRT 2h to 91.45% at HRT8h. In addition, effluent turbidity decreased significantly from 15.6 to 8.36 NTU after two primary hours of aeration, and it more reduced to 2.89 NTU at upper HRT 8 h.

Depends on results, when increasing in MLSS from 2000 to 4000 mg/L was performed at COD and turbidity removal rate were improved directly. In addition, MLSS change from 4000 to 6000mg/L leads to loss in COD removal. Gohary et al. (2009) reported using an integrated SBR reactor(combination of chemically pretreated and SBR) they were able to remove the COD, BOD_5 and TSS at HRT 5 h from dyes wastewater with a removal efficiency about 68.2, 76.3 and 61.4%, respectively) (23).

In other study that have been presented by Kapdan et al. (2005), they reported SBR process removed the color and COD from dyestuff effluent about 95% and 70% at 15 days sludge retention time [24]. In other study Kapdan et al. (2006), they investigated an anaerobic–aerobic sequencing batch reactor, to treatment of textile dyestuff at different anaerobic–aerobic residence times ($\theta_{Hanaerobic}$ = 2–19 h) and initial COD concentrations (COD_0 = 400–1800 mg /l)[25]. They demonstrated that the color and COD eliminated in SBR with removal efficiency about 90% and more than 85%, respectively.

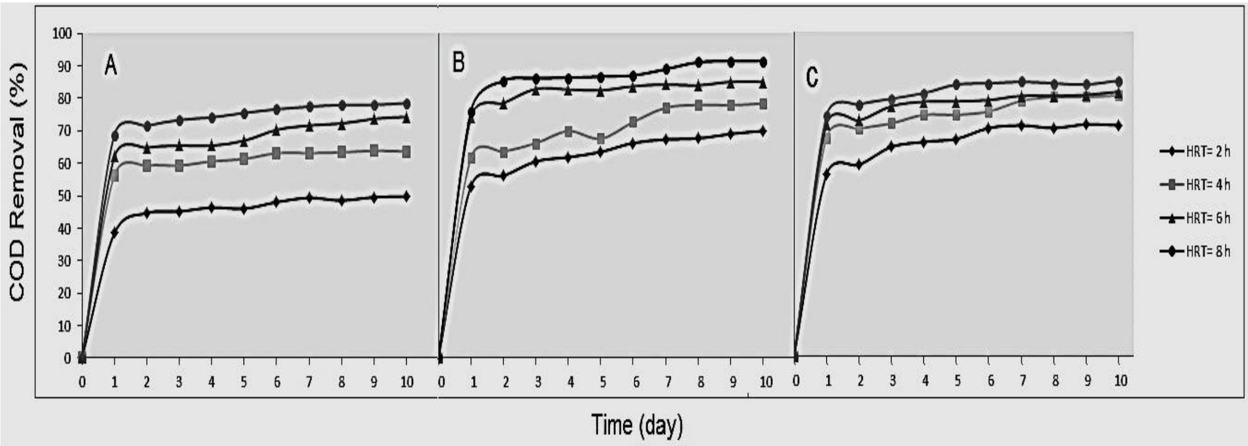

Fig. 2. COD variations removal performance at different HRT values (2, 4, 6, 8h) with different MLSS values (a= 2000mg/L, b=4000mg/L, and c=6000mg/L).

Ammonical nitrogen and variations of TSS and turbidity

From the main strategy to remove the nitrogenous compounds from wastewater is to use sequential aerobic, anoxic, and anaerobic cycles. This can provide continuous nitrification/denitrification. Considering, the SBR reactor can create this different conditions and can be an alternative to remove the nitrogenous compounds. As seen in Fig. 3, ammoniacl nitrogen removal is represented. According to this plot, can be found when the HRT is shifted from 2 to 8h, considerably decreasing in concentration of ammonia nitrogen occurs. It happens due to presence of high biomaterial mass and a high amount of nitrifying and denitrifying bacteria. However, it is expected when increasing in MLSS from 2000 to 6000mg/Lis occurred available ammonia was decrease. To demonstrate this fact, the residual concentration of NH3-N was determined and revealed that the ammonia concentration declined from 13.4 to 0.9mg/L. In addition, with increase in operation time, ammonia nitrogen removal capability of the system was increased. Jung et al. (2004) using a modified zeo-SBR were able to remove the ammonia reduction rate about 68.5–70.9% [26].Yalmaz et al. (2001) have been recommended that the use of the SBR technology for biological ammonia removal from landfill leachate (27).

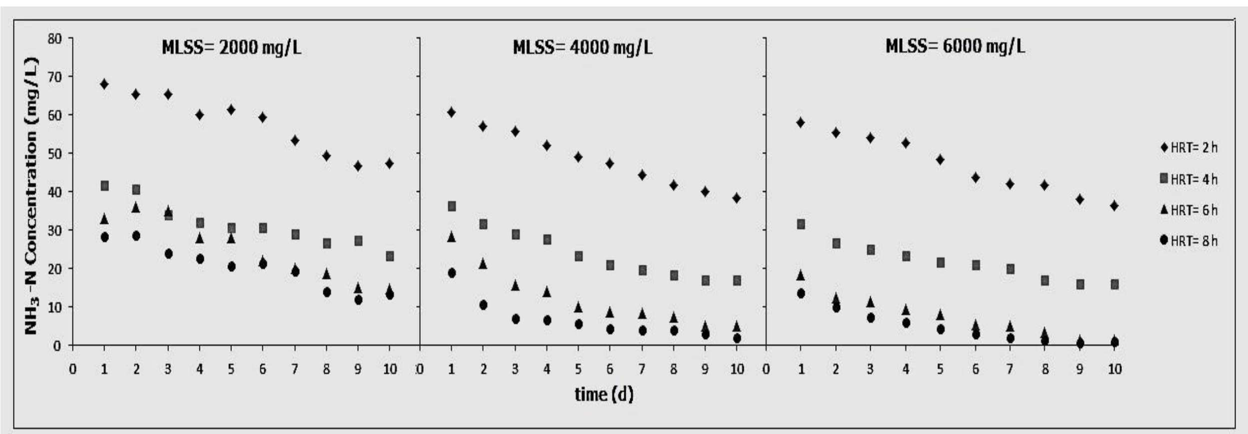

Fig. 3.Variation of NH3-N at different HRT values (2, 4, 6, 8hr) and different MLSS values.

To tracking the TSS and turbidity from treated waste water this step was conducted. The trend of TSS and turbidity was investigated under optimal HRT (8 h) condition and three MLSS 2000, 4000 and 6000 mg/L. Fig. 4, shows the turbidity change during operation runs. It can be clear the higher performance of turbidity elimination is obtained at primary startup. This is parallel with nitrogenous removal. Since the main part of turbidity is created by nitrification and denitrification byproducts and with depletion of these compounds the turbidity is lost. On the other hand, TSS was removed in coordinately with turbidity (data not shown).

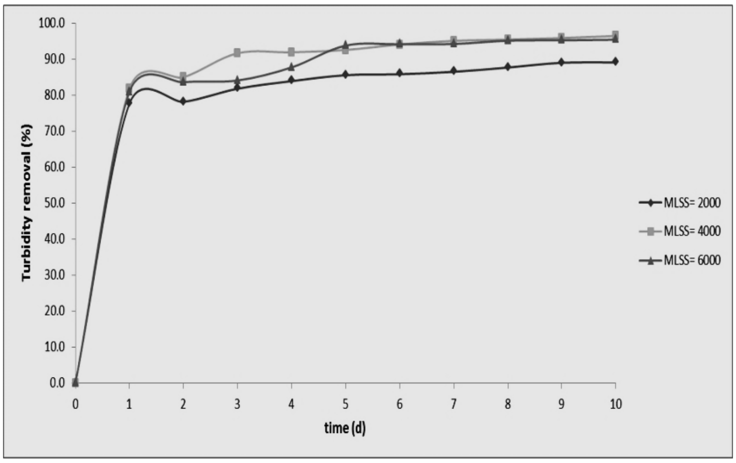

Fig. 4. **Removal of Turbidity during operation time.**

Conclusion

Efficiency of SBR and the effective factors on removal of organic and ammonia nitrogen compounds from the carbonated soft drink wastewater were examined. The results demonstrate a notable effect of main parameters such as HRT, MLSS, and operation time in SBR performance is existed. Increase the available MLSS from 2000 to 6000mg/L increased capacity biological mass to oxide the organic, ammonia TSS and turbidity. Depending on the results it can be found with increase in HRT, a notable increase in removal performance will be achieved. However, it can be concluded that the SBR systems can be successfully used to treatment of carbonated soft-drink industries wastewater.

Acknowledgement

The authors acknowledge all non-financial supports provided by Kermanshah University of Medical Sciences. The authors declare that there is no conflict of interest.

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