A Study of Sequencing Batch Reactor Efficiency to Treat Centralized Kitchen Wastewater

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Abstract: ***Demand of fresh water for various urban and industrial purposes increasing day by day. The wastewater generated from kitchens is about 60% of total water used in various kitchen activities. The lack of awareness about adverse effects may force human beings to dispose kitchen wastewater with high concentration of biodegradable pollutants directly on receiving water body or land. On one had thousands of liter water has wasted in the form of kitchen wastewater and on other hand fresh water has consumed for urban applications like flushing, car washing, gardening and urban irrigation. This study investigates the performance of SBR on treating Kitchen Wastewater with Hydraulic Retention Time (HRT) 2 hrs and F/m ration 0.2. Laboratory analysis were carried out in influent and effluent in order to achieve maximum efficiency reduction in effluent, Parameters tested for both influent and effluent are pH, COD, BOD, Phosphorous, Nitrogen, MLSS and SVI. Total percentage removal obtained for COD - 90%, BOD – 97%, and pH is around 7.***

Keywords: Sequencing Batch Reactor, Waste Water, Centralized Kitchens, Reuse.

1. Introduction

Industrial development is primarily responsible for migration of human groups towards metro cities in search of job. This may cause crowded urban areas with insufficient infrastructural facilities. Food is one of the basic requirements of human beings and to fulfill this Centralized Kitchens, Hotels, Restaurants etc were developed rapidly in urban areas. The wastewater generated from the Centralized Kitchens, Hotels, Restaurants, and Societies contains high concentration of BOD, COD and Oil with varying pH value. Negligence of human beings is towards treatment of kitchen wastewater and intentionally going for disposing off into natural water bodies and on Land. This practice leads towards environmental pollution along with risk to environmental health.

Grey water is defined as urban wastewater which includes waste water generated from dishwashers, kitchen sinks, hand basins, baths, showers and washing machines and excluding wastewater generated from toilets [05]. Two separate septic tanks are used to treat grey water from the kitchen and bathroom and black water from the toilet separately for same house. The results of this study shows the quality of the effluent depends on the contents of organic matter in the wastewater [03]. The characteristics of grey wastewater and factors affecting on characteristics of gray water are discussed. The factors affecting on characteristics of gray water are: (a) the quality of the water supply, (b) the type of distribution net for both drinking water and the grey wastewater and (c) the activities in the household [06]. Ghunmi et al. assessed the potentials and requirements for grey water reuse in Jordan. Also the study concentrates on quantitative and qualitative characteristics of grey water. The grey water generated around 64 to 85% of the total water flow in the rural and urban areas in Jordan. The study suggest about storing of the grey water, which may be reused as per requirements in terms of volume and timing. To improve the quality of grey water, need treatment, in terms of solids, BOD5, COD and pathogens, before storage and reuse [07]. The focus the work is to illustrate the modern techniques to the reuse of grey water at building level. Also described the grey water reuse is toilet/urinal flushing, can be reduce water demand by up to 30% within building. The gray water application is not only limited for flushing but also grey water has been used for many other purposes, including irrigation (often contains valuable nutrients) of lawns at cemeteries, golf courses and college campuses; vehicle washing; fire protection; boiler feed water; concrete production; and preservation of wetlands [04]. Grey water treatment systems used for gray water treatment were discussed. Detailed study on comparison of advanced grey water treatment processes for single households were carried out in this study. Also through the study evaluated efficiency of membrane bioreactor (MBR) systems to treat gray water for single households. The study concludes the use of treatment methods for grey water depends on the quality and quantity of the grey water and its reuse application [09]. The feasibility study on constructed wetland for treatment of kitchen waste water generated from hostel mess was carried out. The wetland Phragmites australis plant species were grown in the constructed wetland. The campus wastewater has a major variation in quantity; the effect of this variation is not looked into in this pilot study [02]. The efficiency of SBR technique to treat wastewater was studied. The major factors like organic loading rate, HRT, SRT, dissolved oxygen, and influent characteristics such as COD, solids content, C/N ratio etc. affecting on SBR's performance. The study shows on controlling of these factors, the SBR process can be used for carbon oxidation, nitrification and denitrification, and phosphorus removal [08]. USEPA, reported advantage as control in process and flexibility of the SBR technique in treatment. As the "react" time is not flow dependent; it can be adjusted to as per process objectives [12]. Reuse or recycling of treated kitchen wastewater for different applications were studied. The study shows reduction in quantity of effluent discharges into receiving water body and proposed a reliable option for supply of water in various applications. These applications are such that they do not require high quality water. The aerobic SBR treatment process is used to treatment of kitchen wastewater before depositing into body of water and for reuse for irrigation purposes [01]. The treatment of sewage has a challenge due to varying raw water characteristics & strict effluent regulations. Finding of the study is SBR system has oxygen dissolving capacity higher than ASP and provides Higher Fecal coliform removal efficiencies with less cost and space. The effluent quality through SBR is better than ASP system, which helps in maintaining acceptable quality of water [10].

The research studies shows SBR process is an excellent tool to treat a variety of wastewaters; this could be applied to treat domestic wastewater, landfill leachate, industrial wastewater, biological phosphorus and nitrogen removal etc. There are too literature mentioning the applicability of this promising process. As SBR method has around 95% BOD, TSS and COD removal efficiency, this technique is effective to treat centralized kitchen wastewater which is having high concentration of BOD and COD.

In this research study an attempt has been made to carryout experimental study on laboratory scale aerobic sequence batch reactor to treat kitchen wastewater. The centralized kitchen wastewater was used as feed for the experiment to investigate the capability of wastewater reuse after treatment. This approach will be contributing to the sustainability of the environment by conserving fresh water resources. The objective of this research is to understand quality of treated Centralized Kitchen Wastewater and reuse/recycle/irrigation in the interest of environmental protection.

2. Methodology

2.1 Research Approach

The research approach followed in this study has been explained through a flow diagram as shown in Figure No. 1.

2.2 Design and development of Pilot plant SBR model

SBR model was designed for discharge of with following standard parameters and procedure as per Wastewater Engineering Treatment and Reuse [11]. The designed dimensions of SBR model are as shown in Table No. 1.

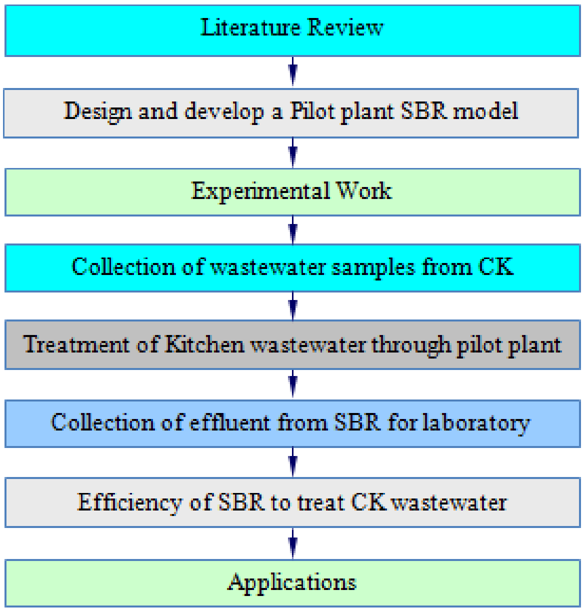

Figure 1: A Flow diagram for Research Approach

Table 1: The Dimensions of SBR model

Sr. No.	*Tank*	*Capacity in liters*	*Dimensions in mm*		
			Length	*Width*	*Depth*
1	Holding	20	300	250	300
2	Reactor	20	300	250	300
3	Collection	20	300	250	300

The Sequencing Batch Reactor SBR model was developed with the acrylic sheet and Silicon adhesive material. The reactor unit tanks were formed with 4 no's of rectangular glass pieces for sides and one piece for bottom. The capacity of tank is 20 liters'.

A air blower with control knob and three numbers of air diffusers are provided through sub-mains in order to supply air evenly throughout the total volume of aeration tank. An agitator provided to agitate the mix so that all suspensions should not settle at the bottom. To remove the supernatant from tank a tap is provided such a way that sludge retained in the tank is up to 6 liters (see Figure 2)

Figure 2: Pilot plant SBR Model

2.3 Experimental Work

Treatment of Centralized kitchen wastewater

The collected kitchen wastewater sample cans were kept stable to allow oil may float at the top surface of can. Genteelly layer of oil was removed manually from the opening of can in the first step. In the next step suspended solids and grit has been removed by screening operation. The suspended matter along with grit collected separately and precautions were taken while disposing off as wet solid waste.

After screening wastewater sample was feed to holding tank. From holding tank wastewater was taken into aeration tank. With the diffused aerator with an air blower was used to supply designed quantity of oxygen to treat wastewater by microbial metabolism. The reactor was filled with 10 Litres of Kitchen wastewater and it was aerated for 24 hours. Then 2 litres of activated sludge placed in the reactor.

The experimental loading of reactor was started when MLSS concentration was 1800 mg/L. To maintain mixed aeration SBR treatment process an agitator was provided in reactor tank. Agitator may agitate wastewater thoroughly so that stabilized bio solids will remain in suspension. On completion of 120 min. aeration phase in aerator wastewater was allowed to settle for 60 minutes.

During settling phase stable bio solids were separated from treated effluent. Then the treated wastewater as supernatant has collected in collection tank from a tap provided in the tank.

Laboratory analysis of SBR effluent

Figure 3: Calibration of pH of treated kitchen wastewater

The analysis of effluent from SBR model used to treat centralized kitchen wastewater periodically. The parameters pH, MLSS, SVI and COD of treated and untreated wastewater samples analyzed daily. The parameter BOD of treated and untreated wastewater simple analyzed at the interval of three days (see Figure 3).

3. Results and Discussions

The summery of average parametric values for laboratory analysis results has as shown in Table 2.

Table 2: The average parametric values summery of treated centralized kitchen wastewater through SBR with F/M=0.2

Sr. No.	*Month*	*Reactor Characteristics*		*Influent Characteristics*			*Effluent Characteristics*			*Percentage Reduction*	
		MLSS mg/l	*SVI ml/gm*	*COD mg/l*	*BOD mg/l*	*PH*	*COD mg/l*	*BOD mg/l*	*PH*	*COD*	*BOD*
1	Jan. 17	2999.03	63.84	1831.35	826.39	6.96	182.54	17.79	6.52	90.03	97.84
2	Feb. 17	2999.57	63.94	1820.81	816.68	6.89	185.60	18.92	6.32	89.80	97.70
3	Mar. 17	3000.65	63.76	1829.92	822.84	6.91	179.42	18.95	6.48	90.19	97.70
4	Apr. 17	2999.36	63.85	1809.85	809.72	6.85	178.84	17.95	6.46	90.12	97.78
Average		2999.65	63.85	1822.98	818.91	6.90	181.60	18.40	6.45	90.04	97.76

From Table No. 3; it is observed that

1. The average parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: MLSS = 2999.03 mg/l; SVI = 63.84 ml/gm; COD = 182.54 mg/l; BOD = 17.79 mg/l and pH = 6.52. (During Jan. 2017)
   a. The % reduction in parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: COD = 90.03 % and BOD = 97.84 %.
   b. The average COD, BOD and pH values of treated wastewater are within the permissible limits to dispose treated wastewater in inland water body.
   c. The MLSS and SVI values for F/M = 0.20 shows good quality of sludge generated through SBR treatment.

2. The average parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: MLSS = 2999.57 mg/l; SVI = 63.85 ml/gm; COD = 185.60 mg/l; BOD = 18.92 mg/l and pH = 6.32. (During Feb. 2017)
   a. The % reduction in parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: COD = 89.80 % and BOD = 97.70 %.
   b. The average COD, BOD and pH values of treated wastewater are within the permissible limits to dispose treated wastewater in inland water body.
   c. The MLSS and SVI values for F/M = 0.20 shows good quality of sludge generated through SBR treatment.
3. The average parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: MLSS = 3000.65 mg/l; SVI = 63.76 ml/gm; COD = 179.42 mg/l; BOD = 18.95 mg/l and pH = 6.48. (During Mar. 2017)
   a. The % reduction in parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: COD = 90.19 % and BOD = 97.70 %.
   b. The average COD, BOD and pH values of treated wastewater are within the permissible limits to dispose treated wastewater in inland water body.

c. The MLSS and SVI values for F/M = 0.20 shows good quality of sludge generated through SBR treatment.

4. The average parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: MLSS = 2999.36 mg/l; SVI = 63.85 ml/gm; COD = 178.84 mg/l; BOD = 17.95 mg/l and pH = 6.46. (During Apr. 2017)
   a. The % reduction in parametric values of treated kitchen wastewater through SBR using F/M = 0.20 are: COD = 90.12 % and BOD = 97.78 %.
   b. The average COD, BOD and pH values of treated wastewater are within the permissible limits to dispose treated wastewater in inland water body.
   c. The MLSS and SVI values for F/M = 0.20 shows good quality of sludge generated through SBR treatment.

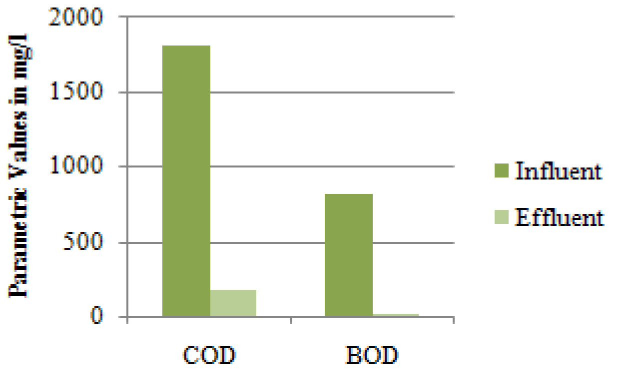

Figure 6: A graphical representation of average parametric values of influent and Effluent

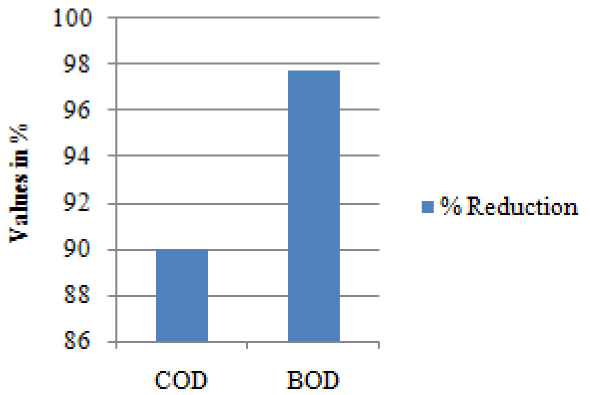

Figure 7: A graphical representation of % reduction in average parametric values

4. Conclusions

The focus of work under this research was determination of efficiency of the SBR model to treat centralized kitchen wastewater.

The conclusions of this study are

- The compact SBR model developed to treat kitchen wastewater is effective to treat centralized kitchen wastewater at source.
- The treatment of kitchen wastewater may recycle water for different uses like terrace gardening, urban farming, society gardening, flushing and landscaping.
- The available recycled water from kitchen wastewater by SBR may reduce fresh water consumption for irrigation around urban areas.
- The SBR treatment process may be economical way to treat kitchen wastewater at the source.

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