A Review on Sequential Batch Reactor to Treat Domestic Waste Water

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***Abstract*: As we know that about 70% of earth surface is covered with water but with rapid increase in human population and pollution caused by the human activities like unscientific release of industrial wastes poses serious threat to ecological system. Thus there is a need of technology which minimizes the pollution. The review aims the analysis of treatment of domestic waste water using Sequential Batch Reactor. Sequential batch reactor is a fill-and draw system for the treatment of aerobic and anaerobic wastewater. Domestic wastewater comprises both organic as well as inorganic pollutants such as phenols, oils, soaps, greases and grey water which is produced from the wash basins, kitchen sinks, showers, laundry sources, bathrooms and toilets. The working of sequential batch reactor mainly includes five steps i.e., fill, react, settle, decant, and idle. The main advantage of SBR is its flexibility nature which allows the modification of processes. The cycles, hydraulic retention time (HRT), and sludge retention time (SRT) can all be modified, giving it a wide range of treatment options, all in a single reactor, which is a huge plus. According to the results of many authors' experiments, the removal effectiveness of SBR for Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Nitrogen (TN), Total Phosphorus (TP), total suspended solids (TSS), etc. is superior to conventional approaches.**

Keywords*: *Sequencing batch reactor, domestic wastewater, hydraulic retention time, sludge retention time.

I. INTRODUCTION

Water quality is a major concern for humanity because it is closely linked to human well-being. Pollution of surface and ground water is a major concern. Domestic wastewater, industrial wastewater, and agricultural discharges are the main causes of pollution. Disposing of home and industrial wastewater indiscriminately into surface and groundwater degrades the ecosystem. As a result, any type of wastewater must be treated in order to create effluent of acceptable disposal quality. However, it is vital to select an acceptable and successful treatment system. Domestic wastewater, in particular, necessitates adequate management due to its unique characteristics.

Filling-and-draw batch processes similar to SBR are not a recent development as is commonly thought. Between 1914 and 1920, numerous full-scale filling and drawing systems were in operation. SBRs were made a viable option over the standard activated-sludge system during the late fifties and early sixties, and improved equipment and technology, especially in aeration devices and computer systems. SBR systems have been used extensively to manage water from both urban and industrial scrapes. They are also best designed for wastewater treatment applications typified by bad or intermittent operating conditions. [1]

A sequencing batch reactor is a fill-and-draw reactor type system, consisting of a single complete mix reactor, in which all the activated-sludge steps occur. SBR and standard activated sludge systems are similarly integrated with them in unit systems. In both processes, aeration and sedimentation/ clarification are achieved. However, there is one significant difference in conventional plants; the processes are carried out simultaneously in different tanks, while the processes are carried out sequentially in the same tank in SBR process. [2]

The SBR systems contain either two or more parallel reactor tanks, or one equalization tank and one reactor tank. The tank type used depends on the properties of the waste water flow (e.g. high or low volume). These units are installed mainly in conditions where no public sewer is available and a septic tank is not environmentally acceptable. Basically SBR is an Activated Sludge system which runs on Fill and Draw principle. The main advantage of using SBR is both aeration process and sedimentation process are carried out sequentially in the same reservoir. The usage of SBR usually involves five phases as shown in the fig. (1.1).

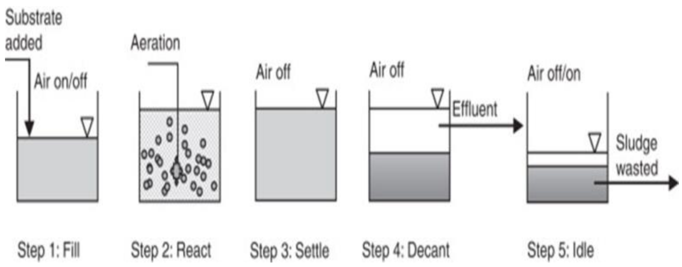

Fig.1.1: Process cycle of SBR

Fill: In this phase, volume and substrate like raw waste water are added to the react. This allows the liquid level to rise from 75% of capacity to 100%. When dual tanks are employed, the fill process may last about 50% of full cycle time. In this phase, reactor may be allowed to mix only or mixed as well as aerated to trigger biological reaction with influent waste water.

React: In this phase, Biomass starts to consume the substrate under controlled environmental conditions.

Settle: “In this phase, solids separate out from the liquid under quiescent condition which results into clarified sediment that can be discharged as effluent.”

Decant: In this phase, Effluent is removed. Commonly used decanting mechanism is Floating or Adjustable weirs.

Idle: The interval between drawing and filling is referred to as idle time. This phase is critical when using SBR with a continuous supply of waste water. This time can be better spent disposing of sludge.

Generally, SBR systems have a relatively small footprint; they are useful in areas where the available land is limited. In addition, device cycles can be easily changed, making SBRs highly versatile for public authorities to adjust to more restrictive effluent quality requirements. In order to determine the SBR activity sequence, it is crucial to determine the influential characteristics and effluent specifications, site-specific parameters such as temperature and main design parameters such as nutrient-to-biomass ratio, length of the treatment cycle, suspended solids and hydraulic retention time. It enables the number of cycles per day, number of basins (lots), amount of decanting, scale of the reactor, and detention times to be measured.

II. OBJECTIVES

The main objective of this project is to study the treatment of domestic wastewater using SBR methodology by obtaining the parameters such as BOD, COD, TKN, TSS, pH.

III. REVIEW WORK

Amir hosseinmahvi etal.,(2004) they carried out there study on "Domestic waste water treatment by continuous flow sequential batch reactor" the experiment was done in 3 runs by varying influent rate and HRT and they found the average removal efficiency for 3runs for COD,BOD,N,TSS,TP was 94.9%, 97.7%, 71%,99%,55.9% respectively and from this result the study revealed that continuous flow sequential batch reactor has high removal efficiency and used for small and medium size community waste water treatment plant. [3]

Arnolds sarthi etal.,(2007) carried out study on "Domestic sewage treatment by anaerobic sequential batch reactor" the main objective of study was to evaluate the performance of the ASBR (ASBR1,ASBR2,ASBR3) with a different geometric characteristic and mixing type (Mechanical and liquor Recirculation) containing inoculated with anaerobic granular sludge. From the result they observed that 2 ASBR (ASBR1, ASBR3) with liquid recirculation showed lower removal efficiency of COD and TSS about 40% and 60% respectively. The weak performance is mainly due to the low retention of solid. ASBR2 with mechanical mixing showed better removal efficiency of 60% and 80% for COD and TSS. From the result study revealed "ASBR is a promising technology for the treatment domestic sewage." [4]

Lin jeang yuan etal.,(2011) carried out study on "Decentralized domestic sewage treatment by the SBR"The main aim of the study was to treat sewage from university as decentralized waste water and make reuse of it and from the result observed the average removal efficiency of SBR for COD,Ammonium nitrogen, total nitrogen, phosphate, are90%,92%, 67%,89% hence effluent coming out from the system meet water quality for reuse. And result sagest the SBR system is best method for treating sewage of low carbon to nitrogen ratio with varying water quality from result study revealed "SBR is a best method for treating decentralized domestic waste water and to reuse of treated waste. [5]

Jamile Wagner etal.,(2013) studied "The aerobic granulation in SBR using real domestic waste water specially with an low organic loading rate of 2 Kg COD/ m3d." Here, SBR operated in three different stages namely Stage I, Stage IIand Stage III. After prolonged operation of 140 days in stage II reactor, a mature granules having average diameter of 0.7 mm appeared. Further when OLR was increased, partial separation of mature granules was noticed in the initial period of Stage III reactor. In this, Reactor was sufficiently able in removing Carbon and Nitrogen compounds. Result found was about 92% of COD reduction, 96% of NH4+ -N reduction. Also aerobic granules formed with real domestic waste water. [6]

B.K.Bindu etal.,(2013) carried out study on "waste water treatment by aerobic granulation technology in SBR"they conducted 3 trial with different OLR 3.6 and 9Kg COD/(m3 /day) with different COD concentration 1000,2000 and 3000 mg/lit and they found that there was development aerobic granulation in all 3 case and also observed that trial 2 with OLR 6 and influent COD concentration 2000mg/lit show higher COD removal efficiency of 97.9 and sludge settling with good (SVI of 25 ml/g compared to trial 1 and trial 3 with COD removal efficiency of 96% and 95%.The study revealed the aerobic granulation is best technology for treating high strength organic waste water and also revealed that apart from the synthetic water dairy waste water also treated by this technology and observed COD removal efficiency was about 90%. [7]

Arnaldo Sarti etal.,(2007) aimed to the comparative performance of three pilot-scale anaerobic sequencing batch reactors treating domestic sewage from the University of Sao Paulo (Sao Carlos City, Brazil) was evaluated. The three ASBR reactor with 1.2 m3 each had different geometric characteristics and mixing type (mechanical mixer or liquor recirculation) and were designed for the treatment of 1.95 m3 .d!1 of domestic sewage. The two ASBR reactors (ASBR1 and ASBR3) that were operated with mixed liquor recirculation had unsatisfactory results, with mean COD and TSS removal efficiencies of 40% and 65%, respectively. The mean effluent values were of 320 mg COD l^-1. And 85 mg TSS l^-1. The ASBR2 operated under mechanical mixing showed better results with average removal efficiencies of 60% and 80% for COD and TSS, respectively. The mean values of effluent COD and TSS were 215 mg l ^-1 and 50 mg l^-1 respectively. In the comparison of the ASBR1 and ASBR2 reactors with different mixing type and equal ratio L/D relation and of ASBR1 and ASBR3 with different ratios (L/D) and same mixing type, similar performances in the units with liquor recirculation were perceived. Mechanical impeller mixing resulted in improved organic matter efficiency and operating stability. The ASBR with mechanical mixing achieved mean efficiency removal values of 60% (COD Total) and 78 percent (COD Filtered), as well as a mean efficiency of 79 percent for suspended solid removal. [8]

G. Kassab etal.,(2010) compared with the conventional aerobic technologies based on activated sludge processes, lower energy consumption and lower excess sludge production can be achieved with a high-rate anaerobic pre-treatment step. The energy savings from using anaerobic pre-treatment, especially with concentrated sewage, will be significant. The literature results collected thus far clearly demonstrate the efficacy of sequential anaerobic–aerobic systems in the treatment of domestic wastewater and solidify their advantage over conventional aerobic systems. The large contributions of anaerobic treatment to the overall performance of sequential systems highlight the distinct reduction in energy consumption and extra sludge production when conventional aerobic systems are replaced with sequential anaerobic–aerobic systems. His Investigations on a pilot scale system resulted in achieving removal efficiencies of 90% for the total COD, 90% for the total suspended solids (TSS) and 81% for the total nitrogen (TN). Produced excess sludge was limited to 0.2 kgTSS kgCOD1 removed. [9]

Jamile Wagner, Rejane Helena Ribeiro da Costa etal.,(2013) studied the aerobic granulation in a sequencing batch reactor (SBR) using real domestic wastewater with an organic loading rate at or lower than 2 kg COD · m−3 · d−1. According to the applicable OLR (1.4, 1.0, and 2.0 kg COD • m3 • d1, respectively), the reactor was operated in three phases (Stage I, II, and III). After 140 days of operation (Stage II), the reactor biomass consisted mainly of compact mature granules (average diameter of 0.7 mm) with a good settling ability. The reactor proved effective in removing carbon and nitrogen compounds, especially when run with an OLR of 2 kg COD • m3 • d1, with an average COD removal efficiency of 92 percent and an NH 4 –N removal efficiency of 96 percent. The findings showed that aerobic granules may be made with genuine home wastewater and can effectively remove carbon and nitrogen. This study was conducted over 241 days to form aerobic granules using domestic wastewater The reactor was effective at removing carbon and nitrogen compounds, especially when operated with an OLR of 2 kg COD · m−3 · d−1. The results prove that aerobic granular sludge presents a promising technology for real domestic waste water treatment. [10]

IV. CONCLUSION

According to statistical data from the review of research papers on the treatment of domestic waste water, reasonably high removal of BOD, COD, TSS, and N from the influent has been observed. The increase in HRT led to the higher removal efficiencies in case of BOD, COD, TSS, and TKN, TN. But in case of TP removal efficiency decreased with increase in HRT. As aeration period increases removal efficiency also increases with optimum flow rate and setting time. From above study it is revealed that SBR shown better result in removing the organic matter and suitable for the treatment of low strength wastewater and is best suitable for testing domestic wastewater. The study also revealed that continuous flow sequential batch reactor has high removal efficiency and used for small and medium size community waste water treatment plant.

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