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# A Review on Wastewater Treatment Using Sequential Batchreactor

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***Abstract:*** ***This paper intends to provide an overall vision of SBR technology as an alternative method for treating waste water.SBR technology differs in various ways from conventional technologies used in biological treatment of wastewater. The most obvious difference is that in SBR technology, the reactor volume varies with time, whereas it remains constant in the traditional continuous flow system. The advantages of SBR technology include the flexibility of operation (change of phase), feasibility of operation at low retention time, control over microbial population and various reactor configurations. SBR process consists of several time oriented periodic steps, characterized by a series of process phases viz. fill, react, settle, decant and idle, each lasting for a defined period during which wastewater is treated. The success of SBR technology depends on the great potential provided by the possibilities of influencing the microbial system in the reactor. SBR processes are comparatively easy to operate and cost efficient and this process saves more than 60% of the expenses when compared to conventional activated sludge process.***

**Keywords: Sequencing Batch Reactor, Operational parameters, Biologicalprocess, Aeration,nitrification,denitrification,anoxic,anaerobic, reaction time, operating cycle.**

## Introduction

Water reuse is an attractive strategy that can significantly contribute to water conservation in areas suffering from water scarcity or overconsumption. This allows the use of reclaimed water for specific purposes, which depending upon the application, requires different levels of treatment.Sewage Treatment is employed to reuse the treated water.

To prevent/reduce pollution of the natural environment, biological treatment, using Activated sludge process has been the common treatment process for sewage. (Bashir et al., 2008; Aziz et al., 2011; Souza S. Bruno et al., 2013 ;)

## Characteristics of Sequencing Batch Reactor

Activated Sludge has become the most extensively employed secondary unit process for the treatment of wastewater. Arden & Lockett's original investigations in 1913 involved aerating sewage for several weeks before the treated liquor was permitted to settle & the supernatant water was decanted. Thus, the very original activated sludge process was operated as a batch reactor & became identified as the fill & draw method. SBR's treatment process is characterized by a repeated treatment cycle consisting of a series of sequential process phases; fill, react, settle, decant& idle (Mahvi et al., 2008; Aziz et al., 2011 ;)

### Basic treatment processes

**a) Fill**

The fill process is where the reactor is filled with wastewater between a low water level & a high water level. Fill could occur under mixed, unmixed, aerated or unaerated conditions. The time of fill depends on the capacity of each reactor, the number of parallel reactors in operation, & the variations in the wastewater flow rate (Aziz et al.,2011;)

**b) React**

The react phase begins once fill is complete. It includes mixing & aeration (dissolved oxygen (DO)>2 mg/l). In this phase, no influent flow into SBR aeration & sludge could be wasted (Surampalli et al., 1997 ;) Aeration process serves to nitrify ammonia, oxidize organic carbon, & promote uptake of phosphorus in the sludge, while unaerated conditions support denitrification of nitrite & nitrate.

**c) Settle**

In this phase, neither influent flows to SBR nor waste of sludge is permitted. Clear supernatant appears in the upper part of the reactor. The duration of settle can be adjusted for sludge settle ability.

**d) Decant**

In this phase, no influent flows to SBR as well as no aeration is conducted. The supernatant is decanted from the upper part of the reactor via automatic valves.

**e) Idle**

The period between draw phase & the fill phase is termed as idle. The idle time could be employed effectively to waste settled sludge. It is optional phase & no influent is fed to the reactor in addition to the absence of aeration.

## ADVANTAGES & DISADVANTAGES OF SBR

### Advantages

1. Equalization, primaryclarification, biological treatment & secondary clarification can be achieved in a single reactor vessel.
2. Operating flexibility & control.
3. Minimal foot print
4. Potential saving cost by eliminating clarifiers & other equipment.

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**Disadvantages**

1. A higher level of sophistication is required especially for larger systems, of timing units & controls.
2. Potential of discharging floating or settled sludge during the DRAW or decant phase with some SBR configurations.
3. Potential requirement for equalization after the SBR, depending on the downstream processes.

**OPERATIONAL PARAMETERS FOR SBR PROCESS**

The performance of SBR depends on a no. of parameters such as characteristics of waste water, sequential process phases for the repeated cycles, cycletime, ratio of treated waste water to working volume of the reactor, aerationtime, contacttime, DO concentration inside the reactor, MLSS concentration, MLVSS, Solids Retention time,(HRT) Hydraulic Retention Time, Organic Loading Rate(OLR) & F/M ratio.

**Boundaries for operational parameters in SBR process**

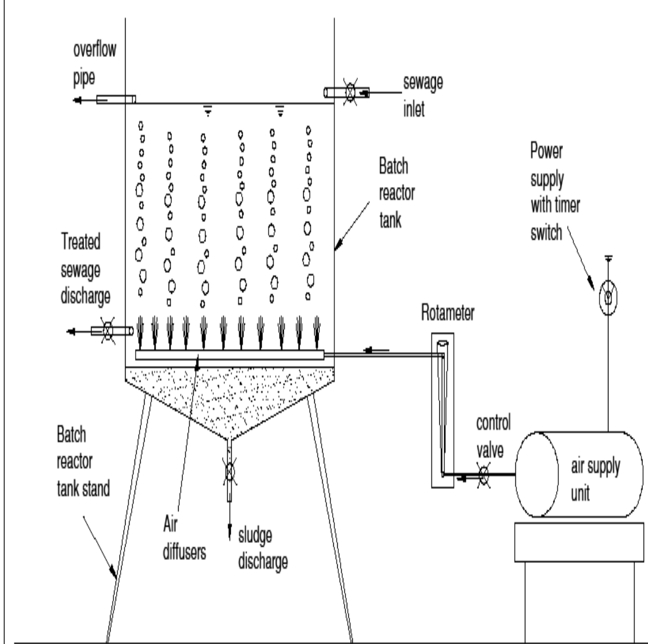
| Serial no. | Parameters | Values | |
|---|---|---|---|
| | | Minimum | Maximum |
| 1. | Cycle time (hours) | 3.53 | 24 |
| 2. | Typical cycle time | 6 | 8 |
| 3. | Treated volume/working volume(hours) | 8.3 | 90 |
| 4. | Aeration time(l/min) | 0.2 | 11.9 |
| 5. | DO concentration during react (mg/l) | >2 | |
| 6. | MLSS(mg/l) | 500 | 24650 |
| 7. | HRT(days) | 0.44 | 12 |
| 8. | SRT(days) | 9 | 52 |
| 9. | OLR(kg COD/$m^3$.day) | 0.15 | |

**Common Modifications in SBR**

SBRs can be modified to provide secondary, advanced secondary treatment, nitrification, denitrification & biological nutrient removal.SBRs were originally configured in pairs so that one reactor was filling during half of each cycle (while the waste water in the other reactor was reacting, settling& being decanted).The modified configurations available include 1 SBR with an influent surge/holding tank; a three SBR system in which the fill time is one third of the total cycle time;& a continuous inflow SBR.(USEPA,1992).

In recent years, some modifications of SBR has been used by researchers, such as continuous flow SBR (Mahvi et al.,2004),Sequencing Batch Biofilm Reactor(SBBR)(Speital& Leonard,1992),anaerobic Sequencing Batch Reactor (ASBR)(Dague et al.,1992) & anaerobic aerobic Sequencing Batch Reactor (Bernet et al.,2000). An experimental lab model of SBR is illustrated in the figure:

**Experimental setup of Lab model of SBR**




Schematic Diagram of Proposed Pilot study model for SBR

**Applications**

SBR technology is applicable for any municipal or industrial waste where conventional or extended aeration activated sludge treatment is appropriate. This technology is applicable for BOD & TSS removal, nitrification, denitrification & biological phosphorus removal. The technology finds its applicability for industrial pretreatment of smaller flow as well as where the waste is generated for less than 12 hours per day (USEPA, 1992). SBRs are also cost effective if treatment beyond biological treatment is required, such as filtration.

**Performance**

The performance of SBRs is typically comparable to conventional Activated sludge systems & depends on system design & site specific criteria. The avg. performance data values are as follows:

| Parameters | % removal efficiency |
|---|---|
| BOD | 89-98% |
| TSS | 85-97% |
| Nitrification | 91-97% |
| Total Nitrogen Removal | >75% |
| Biological Phosphorus removal | 57-69% |

**Chemicals Required**

Chlorination & dechlorination chemicals are required for applications which involve the direct discharge of domestic waste. Alum or ferric chloride is also added sometimes to meet stringent effluent phosphorus limits.

**Residuals generated**

Secondary sludge is generated at quantities similar to the activated sludge process depending on the system operating conditions.

**Environmental Impact**

Solid waste, odor& air pollution impacts are similar to those encountered with standard activated sludge processes.

**Toxics management**

The same potential for sludge contamination upsets & pass-through of toxic pollutants exists for SBR systems as with standard activated sludge processes.

**Limitations**

SBR process discharges in batches with flow rates several times higher than average flow rates, the impact on downstream unit processes (such as disinfection & outfall hydraulics) must be considered, or a post-SBR flow equalization tank should be considered. Also the SBR process decants from a common tank, the drop in water surface elevation can be significant. The impact on overall process hydraulics should be considered in the design.

**Conclusion**

Waste water treatment has been a challenge throughout the years due to varying influent chemical & physical characteristics & stringent effluent regulations. Treatment system using activated sludge has been able to handle many of such difficulties. The advent of SBR systems have resulted in providing better control to variable flows, option for anoxic & anaerobic condition in the same tank,good oxygen contact with micro-organisms &substrate,good removal efficiency. The many advantages offered by the SBR process justifies the recent increase in the implementation of this process in industrial & municipal waste water treatment.

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