A Review on Utilization of Sequence Batch Reactor Technology (SBR) For Waste Water Treatment Plant

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***Abstract**: This review paper intends to provide an overall vision of SBR technology as an alternative method for treating wastewater. This technology has been gaining popularity through the years, mainly because of its single-tank design and ease of automation. The bibliographic review carried out here shows the efficiency and flexibility of this technology, as it is able to treat different kinds of effluents such as municipal, domestic, hyper saline, tannery, brewery, and dairy wastewater; landfill leachates; etc.*

***Keywords**: Sequence Batch Reactor, nutrient removal, Biological, etc.*

INTRODUCTION:

During the past hundred years, the conventional suspended growth activated sludge processes have been widely used for the wastewater treatment. A typical activated sludge treatment is characterized by relatively high energy consumption and biomass production, leading to high operation costs and problems with the disposal of large amount of sludge. The technological development, improvement of operation conditions and enforcement of strict legislations in the recent years have led to the replacement of conventional suspended-growth activated sludge system by robust cost-effective and high-efficiency sequencing batch reactor (SBR), particularly in areas characterized by low or varying flow conditions. The sequencing batch reactor (SBR) is activated-sludge technology commenced with the investigation of fill-and-draw reactors. Wherein the sewage was introduced batch wise into the reactor for a specified period of time later, SBRs are basically suspended growth biological wastewater treatment reactors, in which all metabolic reactions, solid–liquid separation takes place in one tank and in a well-defined and continuously repeated time sequence. It assume that periodic exposure of microorganisms to defined process conditions is effectively achieved in a fed batch system This processes known as to save more than 60% of the expenses required in operating cost and achieve high effluent quality in a very short aeration time. Whereas, the conventional activated sludge systems require about 3–8 h of aeration. It suspend biomass configuration perform relatively better in terms of carbon removal over conventional suspended growth systems. More than 90% biochemical oxygen demand (BOD) removal has been reported while the conventional processes are capable of removing 60–95% of BOD. Also, significant reduction in suspended solids (SS) concentration (<10 mg/L) have been investigated.

SBR Process:

SBRs are a variation of the activated-sludge process. They differ from activated-sludge plants because they combine all of the treatment steps and processes into a single basin, or tank, whereas conventional facilities rely on multiple basins. According to a 1999 U.S. EPA report (Wastewater Technology Fact Sheet, 1999), an SBR is no more than an activated sludge plant that operates in time rather than space. A basic Cycle comprises of the following phases which take place independently in sequence to constitute a Cycle and then gets repeated:

- Fill
- React
- Settling
- Decanting
- Idle

Fill:

The influent to the tank may be either raw wastewater (screened and DE gritted) or primary effluent. It may be either pumped in or allowed to flow in by gravity. It kept either aerated or non-aerated depending upon the wastewater characteristics. The feed volume is determined based on a number of factors including desired loading and detention time and expected settling characteristics of the organisms. The Fill time depends upon the volume of each tank, number of parallel tanks in operation, and the extent of diurnal variations in the wastewater flow rate. The period lasts for 25% of the full cycle time. Change in the length of fill could alter productivity of the SBR process during optimization. Virtually any aeration system (e.g., diffused, floating mechanical, or jet) can be used. The ideal aeration system, however, must be able to provide both a range of mixing intensities, from zero to complete agitation, and the flexibility of mixing without aeration. Level sensing devices, or timers, or in-tank probes (e.g., for the measurement of either dissolved oxygen or ammonia nitrogen) can be used to switch the aerators and/or mixers on and off as desired.

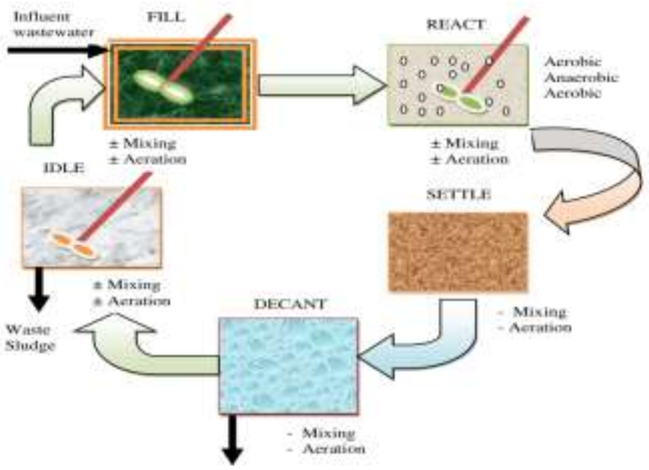

Fig.1

React:

During react, wastewater flow to the tank is restricted while aeration and mixing continues. Biological reactions, which were initiated during Fill, are completed during React. As in Fill, alternating conditions of low dissolved oxygen concentrations (e.g., Mixed React) and high dissolved oxygen concentrations (e.g. Aerated React) may be required. While Fig. 1 suggests that the liquid level remains at the maximum throughout react, sludge wasting can take place during this period as a simple means for controlling the sludge age. By wasting during React, sludge is removed from the reactor as a means of maintaining or decreasing the volume of sludge in the reactor and decreases the solids volume. Time dedicated to react can be as high as 50% or more of total cycle time. The end of React may be dictated by a time specification (e.g. the time in React shall always be 1.5 h) or a level controller in an adjacent tank controlling the time of mixing and/or aeration produces the degree of treatment required. The on/off cycling of air and mixers provides nitrification, denitrification and phosphorus removal.

Settle:

In the SBR, solids separation takes place under quiescent conditions (i.e., without inflow or outflow) in a tank, which may have a volume more than ten times that of the secondary clarifier used for conventional continuous-flow activated sludge plant. Quiescent conditions developed give rise to the better solid separation than that of conventional clarifiers. The major advantage in the clarification process results is entire aeration tank serves as clarifier when no flow enters in tank. Because all biomass remains in tank until some fraction must be wasted no need for underflow hardware .by way of contrast, mixed liquor is continuously removed from a continuous-flow activated-sludge aeration tank and passed through the clarifiers only to have a major portion of the sludge returned to the aeration tank. The settle period last between 0.5 and 1.5 h and prevent the solid blanket from floating due to gas buildup.

Decanting:

After the settle phase, the clarified supernatant is discharged from the reactor as effluent. The withdrawal mechanism should be designed and operated in a manner that prevent floating material to be discharged. The time dedicated to draw can range from 5 to more than 30% of the total cycle time. The time in Draw, however, should not be overly extended because of possible problems with rising sludge.

Idle:

The period between draw and fill is termed as idle. Despite its name, this “idle” time can be used effectively to waste settled sludge while sludge wasting can be as infrequent as once every 2 to 3 months, more frequent sludge wasting programs are recommended to maintain process efficiency and sludge settling. This phase is generally required when several SBRs are in operation. In a multi tank system, its purpose is to complete the fill cycle before switching to another unit.

Biological Nutrient Removal

In recent years, considerable emphasis has been placed on reducing the quantities of nutrients discharged, mainly Nitrogen (N) and phosphorus (P) because they lead to problems of eutrophication and undesirable changes in aquatic population. Many studies therefore have been stimulated on understanding, developing and improving the biological nutrient removal process. Essentially, it encompasses an intricate array of biochemical processes to be sustained in an appropriate sequence of aerobic, anoxic and anaerobic conditions.

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LITERATURE REVIEW:

Li and Zang (2002) studied the SBR performance for treating dairy wastewaters with various organic loads and HRTs. At 1 day HRT and 10000mg/l COD, the removal efficiency of COD, Total solids, Volatile solids, Total Kjeldal Nitrogen (TKN) and nitrogen was reported to be 80.2,63.4,66.3,75 and 38.3% respectively.

Uygur and Kargi (2004) experimented with four step SBR (anaerobic, oxic, anoxic, and oxic phases with HRT of (1 h/3 h/1 h /1 h) for investigation of nutrient removal from synthetic wastewater at different phenol concentrations ranging from 0 to 600 mg/l. It was observed that the nutrient removal efficiency was almost 90% and 65% for nitrogen and phosphorus respectively and above 95% for COD removal for phenol concentration up to 400 mg/l. The performance of SBR was drastically affected above 400 mg/l concentration of phenol. There was similar observation in case of SVI as there was drastic increase from 45 ml/g to 90 ml/g.

Catalina *et al.* (2011) carried evaluation of nitrogen removal in wastewater from a meat products processing company, using a SBR at pilot scale. The complete cycle of the SBR (filling, reaction, settling and draw) was 8 h, with three cycles performed per day. It was concluded that the SBR was an appropriate treatment system to perform the joint removal of organic matter and ammonia nitrogen in wastewater from a meat processing company products, demonstrating the SBR system to operate with discharges that present strong variations in composition.

Kim et al. (2008) researched the treatment of low strength swine wastewater with municipal wastewater in enhanced SBR which involves eight steps of treatment i.e. fill, contact, settle, decant, nitrification, refill, react and idle. It was proved that independent nitrification can be achieved by incorporating the contact period within the system and nitrification in the external reactor. The COD, TN and TP removal were 87%, 81 % and 60 % respectively which can be considered far better than conventional treatments. As the ammonia nitrogen was nitrified 70% in the external reactor, this system does not require any externally added carbon for effective removal of nutrients and biodegradation of organic matter. Finally it was concluded that the system is best suited for regular as well as advanced wastewater treatment particularly for low strength wastewaters.

Nardi et al. (2011) carried the research work for advanced wastewater treatment of poultry slaughterhouse for its reclamation. The advanced treatment consisted of use of SBR, chemical-DAF and UV disinfection. The wastewater was given anaerobic pretreatment in the form UASB. The use of SBR was aimed denitrification. The total denitrification efficiency was more than 90%, also the TCOD removal was 54±24% and TP 43%. The sludge also presented good settling characteristic with SVI 118 ± 35 mL g-1. Authors concluded that the SBR system along with chemical-DAF and UV disinfection is appropriate for anaerobically pretreated poultry wastewater.

CONCLUSION

SBR has wide applicability for treating domestic wastewater. SBR is efficient biological treatment for domestic wastewater when it is assessed for the effect of variations in operating parameters. Further studies are required to assess its performance by varying operational parameters like F/M, OLR, cycle time and time-periods of various phases in a cycle.

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