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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.**

I. 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.

II. Methodology

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.

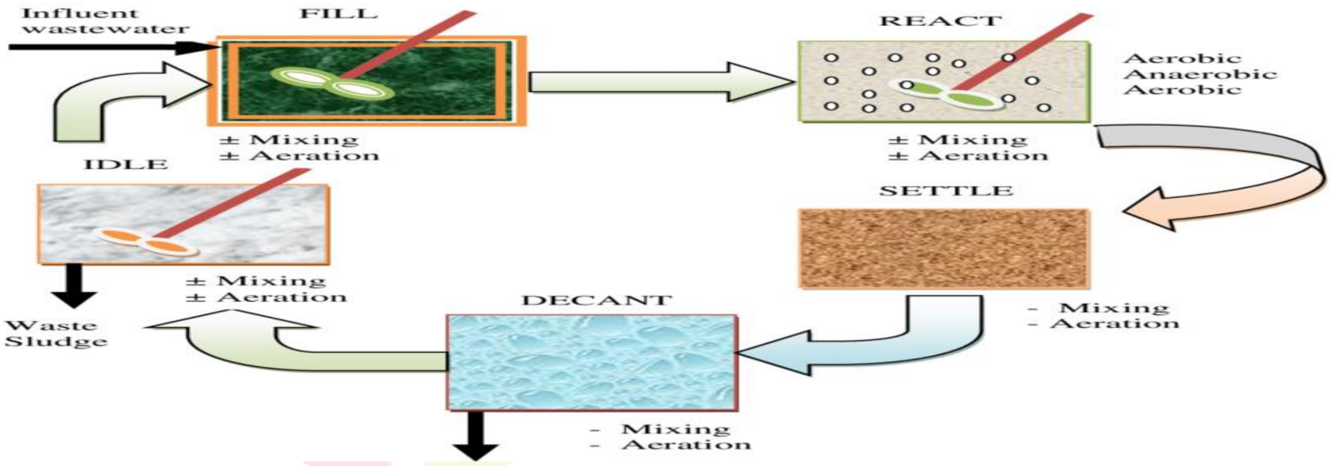


Fig.1

React:

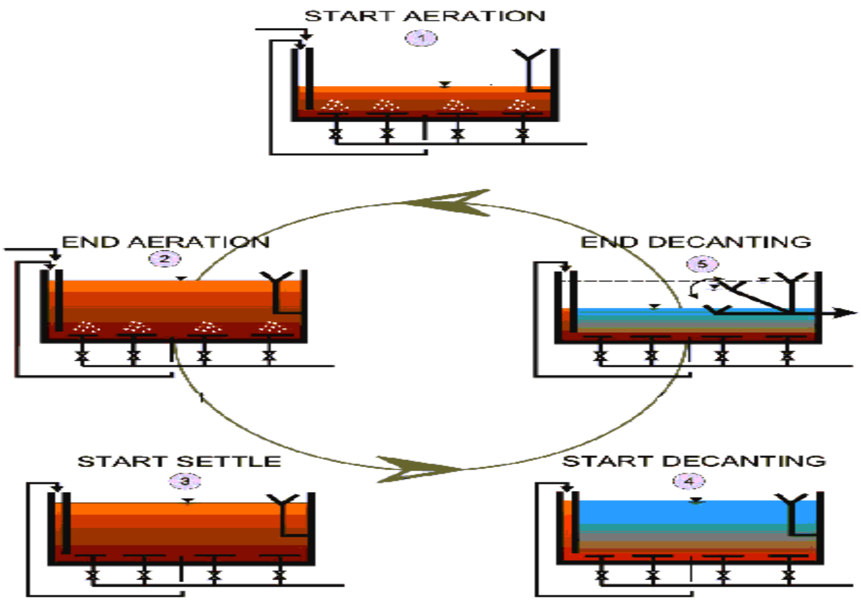
During react, wastewater flow to the tank is restricted while aeration and mixing continues. Biological reactions, which were initiated during Fill, are completed during React. As in Fill, alternating conditions of low dissolved oxygen concentrations (e.g., Mixed React) and high dissolved oxygen concentrations (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.

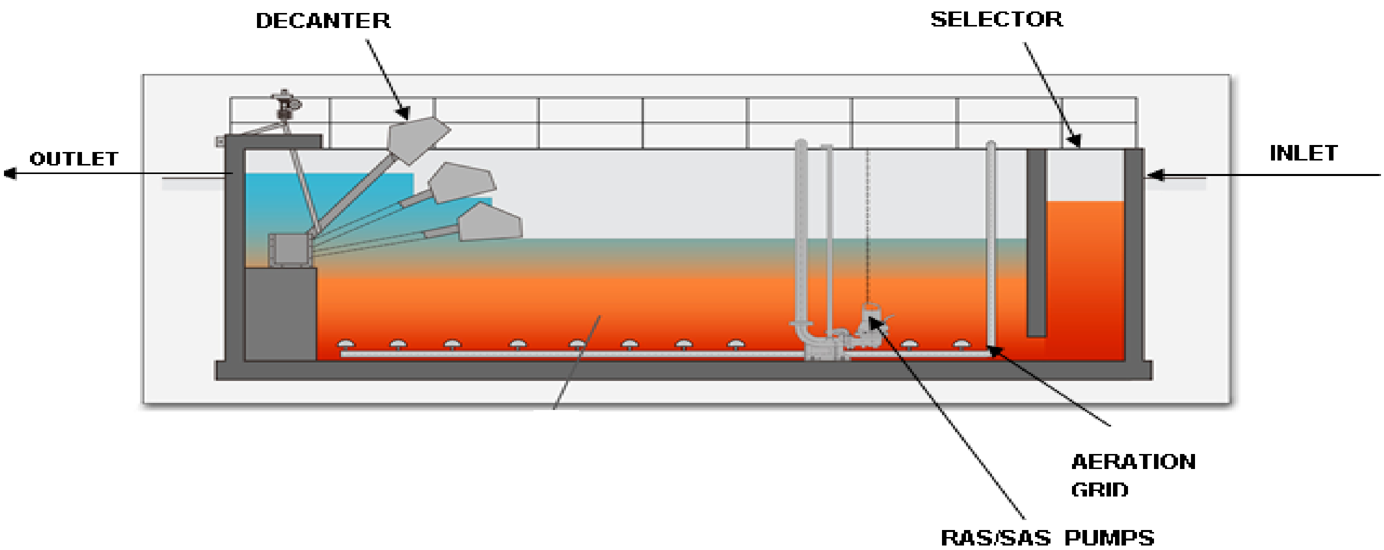
Settle:

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.

Co Current Nitrification and De nitrification, Phosphorous removal:-

A balanced process is achieved and regulated by online-measuring of the specific oxygen uptake rate in the basin in such a way that the floc reaction profile allows for nitrification at the peripheral sections and denitrification at the inner parts of the floc as shown in Figure below.

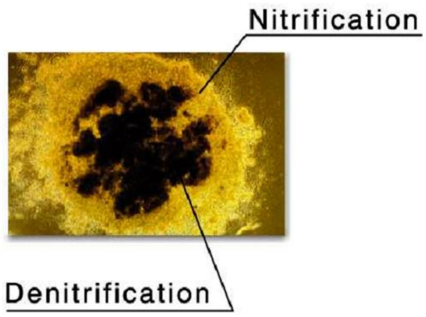


Fig.: Representative view of a sludge floc under a light microscope with suggested zones for co-N/DN.

Nitrate penetration is governed by its rate of diffusion which is of the order of ten times that of dissolved oxygen. Under aerated conditions there is typically no nitrate limitation in the interior zone of the floc. Sufficient carbon provision for denitrification is achieved through the carbon storage (bio sorption) mechanism and the proportional DO demand regulation which minimizes the use of substrate carbon by toxic metabolization.

III. Sewage Parameter -

SR. NO.	PARAMETER	UNIT	DESIGN VALUE
1	pH		6.7 – 7.8
2	Suspended Solids	mg/l	400
3	Biochemical Oxygen Demand (BOD5)	mg/l	200
4	Chemical Oxygen Demand (COD)	mg/l	400
5	Ammonical Nitrogen	mg/l	20
6	Total Phosphorus	mg/l	05
7	Total Alkalinity		220
8	Total Dissolved Solids		1200
9	Volatile Suspended Solids	mg/l	240
10	Chlorides	mg/l	130
11	Total Coliforms	MPN/100 ml	>160000

IV. CONCLUSIONS

1. SBR has wide applicability for treating domestic wastewater.
2. SBR is efficient biological treatment for domestic wastewater when it is assessed for the effect of variations in operating parameters.
3. 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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