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Performance evaluation of a Sewage Treatment Plant Based on Sequential Batch Reactor Technology

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ABSTRACT

The Sequential Batch Reactor (SBR) is one of the potential options for treatment of industrial wastewater. SBR is a fill-and draw, system for aerobic and anaerobic wastewater treatment. In industrial wastewater wide variety of both, inorganic and organic, pollutants are present in the effluents which include oil, greases, metallic wastes, suspended solids, phenols, toxins, acids, dyes, colors, etc., several of which are not readily susceptible to degradation and therefore creating a dilemma during disposal. SBR is one of the latest options for the treatment of industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions. Operations and Maintenance (O&M) costs associated with an SBR system may be similar to a conventional activated sludge system. The overall working of the SBR is in five steps, fill, react, settle, decant, and idle. The process modification is very easy due to the amenable nature of the SBR. The cycles, hydraulic retention time (HRT), sludge retention time (SRT) can be changed and hence it provides wide scope for treatment that is too in a single reactor which is a most advantageous factor. SBRs are also used as pre or post-treatment prospects along with other treatment facilities successfully.

Keywords-*: *Activated Sludge Process,Sequencing Batch Reactor,Wastewater treatment

I. INTRODUCTION

Sewage treatment plant (STP) plays an important role in society. The chief purpose of these plants is to make the water of the sewage clean that originates from houses.The treatment of sewage water has become the need of the hour as it stops spreading the diseases and disorder caused by the sewage water. It helps the community in making the water as well as environment clean. The research area involves a 6.5 MLD capacity of sewage treatment plant based on SBR technology near Sector-6 Vrindavan Yojana, District, Lucknow, Uttar Pradesh India. This research work assessed the performance of the STP based on SBR technology in terms of physical and chemical parameters of wastewater and effectiveness of treatment.

A sequencing batch reactor (SBR) is a fill-and-draw activated sludge system. The unit processes involved in the SBR and conventional activated sludge systems are identical. Although aeration and sedimentation/clarification are

carried out in both systems, there is one important difference; in conventional plants, the processes are carried out simultaneously in separate tanks, whereas in SBR operation the processes are carried out sequentially in the same tank .[4]

Water reuse is an engaging strategy that can significantly add to water conservation in areas experiencing from water scarcity or overconsumption. This enables the use of reclaimed water for particular purposes, which depending upon the application, requires various levels of treatment. Sewage Treatment is applied to reuse treated water.

To limit pollution of the natural environment, biological treatment, using Activated sludge process has been the common treatment process for sewage.

Fig. 1-: Location of the Study Area

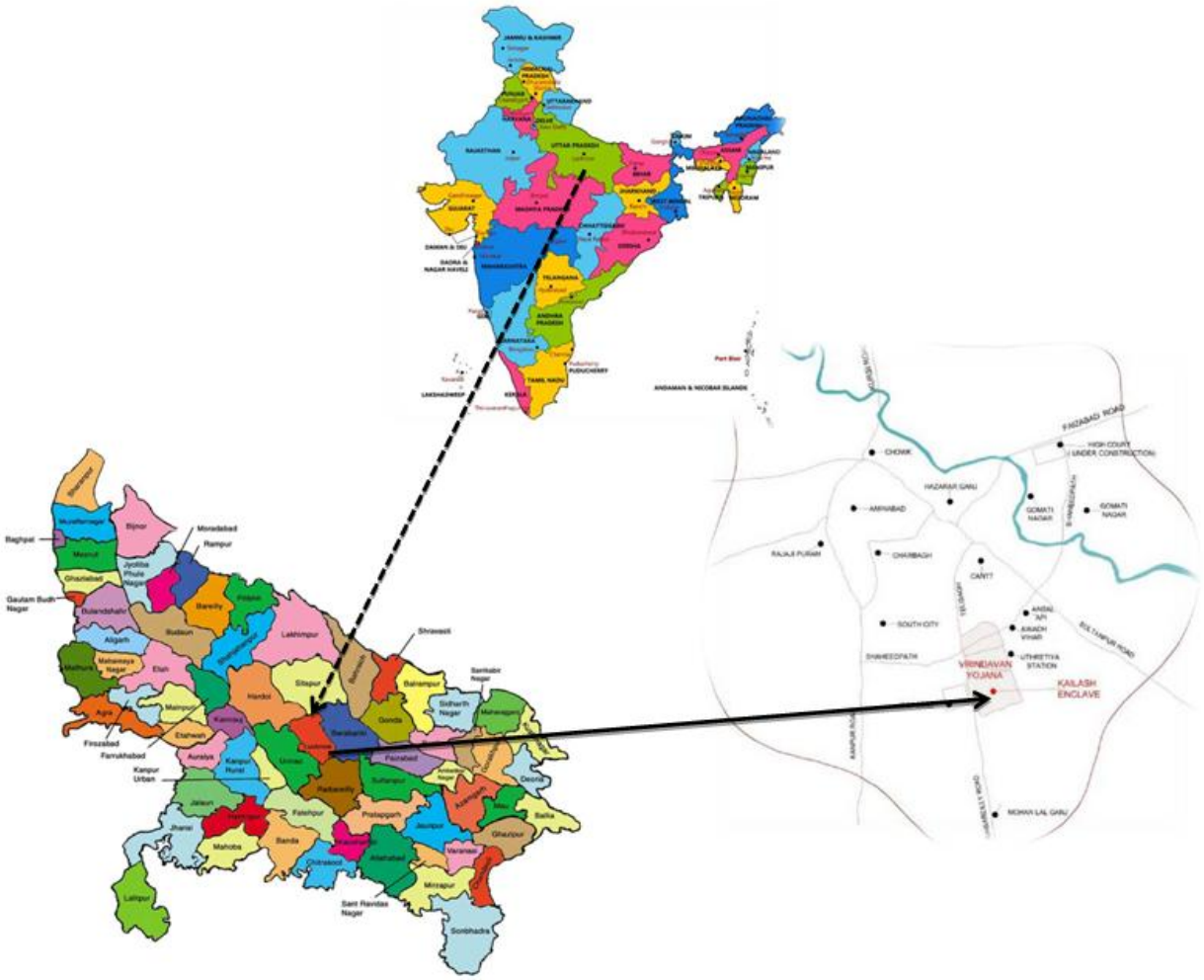

Fig. 2: Satellite Imagery of the Vrindavan Yojana STP

TABLE1:- Pictures of STP units installed at the Vrindavan Yojana

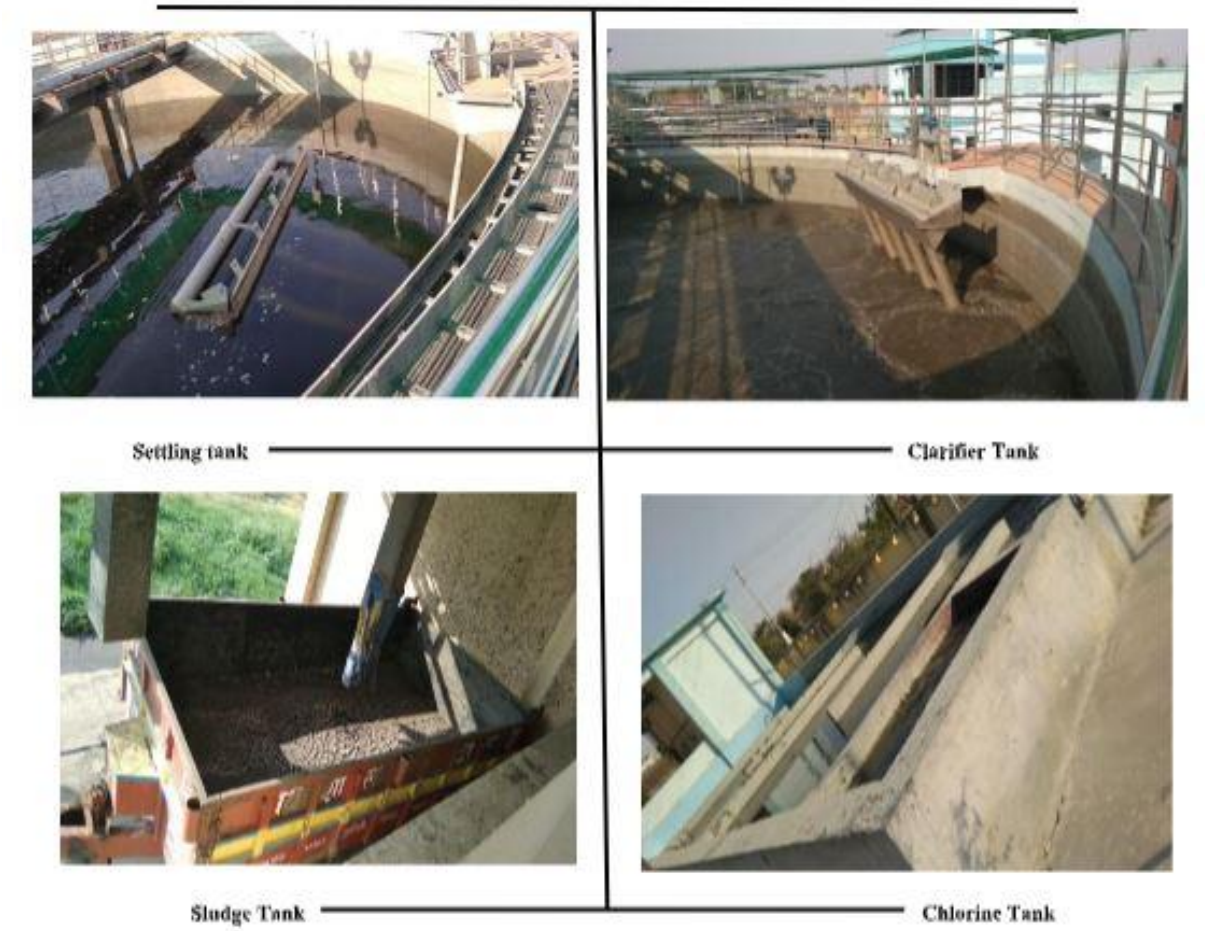

TABLE 1:- Dimensions of STP units installed at the Vrindavan Yojana

S.No.	Description	Size(mm)	Quantity
1.	Screen Chamber	800×500	1
2.	Collection Tank	2100×3650	1
3.	Aeration Tank 1 and 2	3500×3650	2
4.	Settling Tank	2800×2800	1
5.	Clarifier Water Tank	1800×2400	1
6.	Sludge holding Tank	1800×1800	1
7.	Sludge drying Beds	1100×1100	2
8.	Treated water tank	5050×4050	1

Ⅱ MATERIAL AND METHOD

The experimental method for this task includes lab analysis carried out in the Environmental Chemistry lab of Integral University Lucknow, Department of Civil Engineering, site visit to the STP, collection of sample of inlet and outlet samples, during my study have been collected from STP based on SBR technology located at sector-6, Vrindavan Yojana, Lucknow. Samples from the inlet & outlet chamber of the STP during the period from January 2019 to May 2019 were gathered. Samples were analyzed for various parameters like Turbidity, BOD, COD, TSS, and on the basis on the result, the performance of STP was assessed.

TABLE 2-: Details of some physicochemical parameters of STP with SBR Technology

S.No	Parameters	Preservation of Samples	Analysis Method	References[1]
1	Turbidity	Refrigerator below 4^0 C	Turbidity Meter	APHA,2017
2	pH	Refrigerator below 4^0 C	Potentiometry	APHA,2017
3	BOD	Refrigerator below 4^0 C	Winkler's Method	APHA,2017
4	COD	Refrigerator below 4^0 C	Dichromate Digestion	APHA,2017
5	TSS	Refrigerator below 4^0 C	Gravimetric Method	APHA,2017

There are five stages in the treatment process:

1. **Fill**
2. **React**
3. **Settle**
4. **Decant**
5. **Idle**

The inlet valve opens and the tank is being filled in, while mixing is provided by mechanical means (no air). This stage is also called the anoxic stage. Aeration of the mixed liquor is performed during the second stage by the use of fixed or floating mechanical pumps or by transferring air into fine bubble diffusers fixed to the floor of the tank. No aeration or mixing is provided in the third stage and the settling of suspended solids starts. During the fourth stage the outlet valve opens and the "clean" supernatant liquor exits the tank.[2]

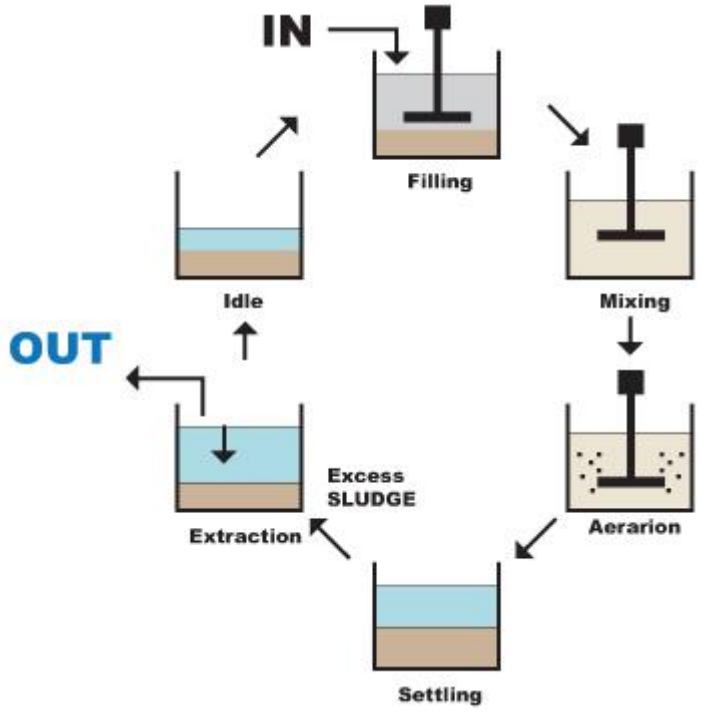

Figure 3. Process Cycle of a Sequential Batch Reactor[5]

Ⅱ.1 TECHNOLOGY DESCRIPTION

Typically the SBR system is consists of a separate tank, where all operations are carried out (Figure 1). The series of operation is divided into five discrete periods: (a) fill, (b) react (aeration), (c) settle, (d) draw, and (e) idle, which complete the whole cycle. The cycle of each SBR system undergoes one or more cycle during a day.

(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.[7]

(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 , 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**-: During the settlement period, solids and liquids are separated, which provides clarified supernatant to be discharged as effluent. In an SBR, this process is normally much more efficient than a continuous flow system because in the settle mode the reactor contents are completely quiescent. The time should be between 0.5 to 1 hour so that sludge blanket remains below the withdraw mechanisms during the draw and does not rise before a draw is completed.

(d) **Draw**-: The goal of the draw is to remove treated water from the reactor

(e) **Idle**-: Provide time for one reactor to complete its full cycle before switching to another SBR cycle [3]

III RESULTS AND DISCUSSION

Colmenarejo et al., (2006) determined the general efficiency indicator to compare overall performance of the different plants in terms of average TSS, COD, and BOD_3 removal efficiencies. The pH of waste water impacts a significance effects on rate of microbiological growth, pH (basic) after the structure of enzymes and stop growth. Favorable range of pH is 6.5 - 8.5[7].

Experimental determinations of STPs based on SBR Technology symbolize that Turbidity, BOD, COD & Total Suspended Solids (TSS), removal efficiencies were calculated to be 89.81%, 94.1%, 90.46%, 96.11%, respectively. According to Environmental protection rules 1986 [Schedule vi] published in CPCB report August 2013, treated effluent is safe against disposal on land and used in irrigation. Discharge of the final effluent from the Sewage Treatment Plant may not cause health risks or any major environmental problems.

Table 3-: Analysis of some physicochemical parameters at inlet & outlet of STP with SBR Technology

Date of Sampling	**1. pH**		**2.BOD3(mg/l)**		**3.COD(mg/l)**		**4.TSS(mg/l)**		**5.Turbidity**	
	IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**
15/1/2018	7.24	6.69	276	7	365.18	28.14	359	11	1282	112
15/5/2018	7.94	7.26	275	25	425.12	48.27	425	20	1358	158
%Removal	**8.07**		**94.1**			**90.46**	**96.11**		**89.81**	

IV CONCLUSION

The performance of SBRs is typically comparable to conventional activated sludge systems and depends on system design and site specific criteria. Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent.[4]

The BOD, COD, and TSS in effluent are within permissible limits due to proper aeration and settling mechanisms. Discharge of the final effluent from the sewage treatment plant may not cause health risks or any major environmental problems. Guidelines of treated wastewater by different agency working for environmental protection like CPCB, WHO etc.

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