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SECONDARY TREATMENT OF PAPER AND PULP WASTE WATER BY USING SEQUENTIAL BATCH REACTOR (SBR)

[1]Preethijohnevelin.S, [2]Evanjeline Libie.P

[1,2]Assistant Professor, Department Of Civil Engineering, Kgisl Institute Of Technology

***Abstract** - The Paper and pulp mill waste water was collected from the ITC paper mill, Meetupalayam and it is immediately used for the experiment conducted using SBR. The following experiments were conducted to determine the efficiency of the SBR system in treating the waste water. (I) Initial characteristics of the wastewater were determined (ii) Determination of COD removal efficiency (iii) Determination of BOD removal efficiency (IV) Determination of TSS removal efficiency. The Initial characteristics of waste water were: TSS 460 mg/l, pH 6.73, BOD 52 mg/l, and COD 2140 mg/l. The Following Parameters are varied (I) Temperature (II) Aeration rate*

Key words: SBR, COD, BOD, Optimization Cycle

I. INTRODUCTION

The pulp and paper industry is one of the oldest industries in our country. But there has been a tremendous expansion in this industry during the last twenty five years. Varieties of papers and similar products are now manufactured in different mills throughout the country. The paper industry, as it stands now, is one of the largest industries in our country. And also this is one of the major industries which contribute a lot towards the pollution of our water environment. The paper mills use the "pulp" as the material, which is again produced utilizing different cellulosic material like wood, bamboo etc., in the pulp mills. However, most of the paper producing unit in India is integrated pulp mills. Few mills in our country produce pulp only, using the same manufacturing process, for the production of Rayon fabrics. The pulp and paper mill wastes characteristically contain very high COD and colour; the presence of lignin in the waste, which is derived from the raw cellulosic materials and is not easily biodegradable, make the COD/BOD ratio of the waste very high. It may be noted that, the pollution potential of the paper mills. As such, it is the pulp making process which is responsible for the pollution problems associated with the integrate pulp and paper mills. The peculiar pollution potential of the industry, their location mostly on the banks of the small rivers, and the general awareness for the conservation of the water resources has led to a considerable research of an economical solution of the pollution abatement problems of the industry.

II. OBJECTIVES OF THE PROJECT

The objective of this study was to design and develop lab-scale sequential batch reactor for the Treatment of Paper and Pulp mill wastewater.

- To characterize the collected Paper and Pulp mill waste water. To optimize the kinetic parameters (temperature, aeration) for the efficient performance of SBR
- To standardize the treatment cycle for SBR.
- To study the performance (BOD removal, COD removal, TSS) of laboratory scale SBR in Treatment of Paper and Pulp Mill wastewater

III. MATERIALS AND METHODOLOGY

DESIGN OF SEQUENTIAL BATCH REACTOR FOR EFFLUENT TREATMENT

The sequential batch reactor used in the present study was designed and developed for the Treatment of Paper and Pulp Mill waste water.

Key design parameters

The sequencing batch reactor is a fill – and – draw activated sludge system for wastewater treatment. The reactor dimensions were showed in figure 3.1. In this system, wastewater is added to a single "batch" reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor.

Table no.1 Dimensional specifications for Lab-scale SBR

Key design Parameter	Dimensional specification
Height(cm)	75.0
Breadth (cm)	20.0
Length(cm)	20.0
Volume (litres)	20
Water level (cm)	55.0

Tank and equipment description

The SBR system consists of a treatment tank, provision for aeration (Fish tank Diffuser), decanter valves (effluent decanter valve and sludge decanter valve) and a control system.

Laboratory scale reactors A lab scale reactor of 30 Lreactor constructed with plexi-glass material was used in this study. The dimensions of the reactor were 70 cm height, 30 cm width and 30 cm length. The working volume was 20 L. An equalization tank made of plexi-glass was provided to feed the influent to the reactor by adjusting the flow rate. An aquarium-type air pump with diffusers was also installed to provide sufficient aeration in the reactor.A digital temperature controller along with heaters was used to vary the required temperature.

(i) AERATOR

It is carried out by using aquarium air pump which has a capacity of producing aeration rate of 2.5 l/min, 5 l/min,7 l/min are used. Diffusers are also used to provide sufficient aeration in the reactor

(ii) DIGITAL TEMPERATURE CONTROLLER

This type of temperature controller with heater is capable of adjusting the temperature from 22 to 32^{o}C.It helps to maintain the temperature level of the tank.

TREATMENT PROCESSES

In its most basic form SBR is a set of tanks that operate on a fill-and-draw basis. After desired treatment the mixed liquor is allowed to settle and clarified supernant is drawn from the tank.

The cycle for each tank in typical SBR is divided into five discrete time periods-Fill, React, Settle, Draw and Idle.

(A) Fill

The fill process is where the reactors is filled with wastewater between a low water level & a high water level. Fill could occur under mixed, unmixed, aeration or unaeration condition. The time of fill depends on the capacity of each reactor, the number of parallel reactors in operation, & the variation 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)>2mg/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

(C) Settle

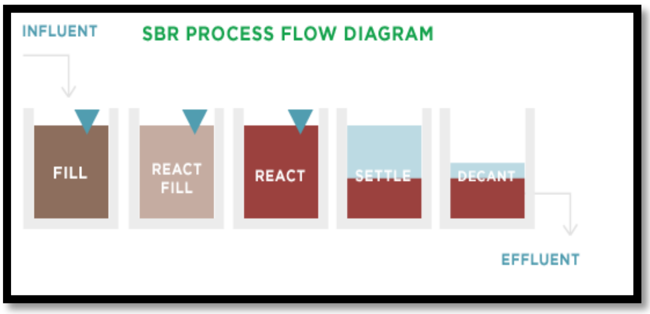
Clear supernatant appears in the upper part of the reactor. The duration of settle can be adjusted for sludge settle ability.

(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.



SBR CYCLE OPTIMIZATION

Table 2. Cycle settings for the SBR design

SBR phases	Phase length (hours)		
	Optimal cycle setting for each scenario		
	1	2	3
	6 hrs	7 hrs	8 hrs
Filling	30 min	30 min	30 min
Aeration only	3 hrs	4 hrs	5 hrs
Mixing	1 hr	1 hr	1hr
Settling	1 hr	1 hr	1 hr
Decant	30 mins	30 mins	30 mins
Total cycle length	6 hrs	7 hrs	8 hrs

IV. RESULTS AND DISCUSSION

CHARACTERISTICS OF INFLUENT

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S. No.	Parameters	Results
1	pH @27.0°C	6.73
2	Total dissolved solids (TDS)	1143(mg/L)
3	Total suspended solids (TSS)	460(mg/L)
4	Acidity	330(mg/L)
5	Alkalinity	750(mg/L)
6	Total Hardness as $CaCO_3$	880(mg/L)
7	Turbidity	200.0 NTU
8	Dissolved Oxygen	0.60(mg/L)
9	Biochemical oxygen demand (BOD)	520(mg/L)
10	Chemical oxygen demand (COD)	2140(mg/L)

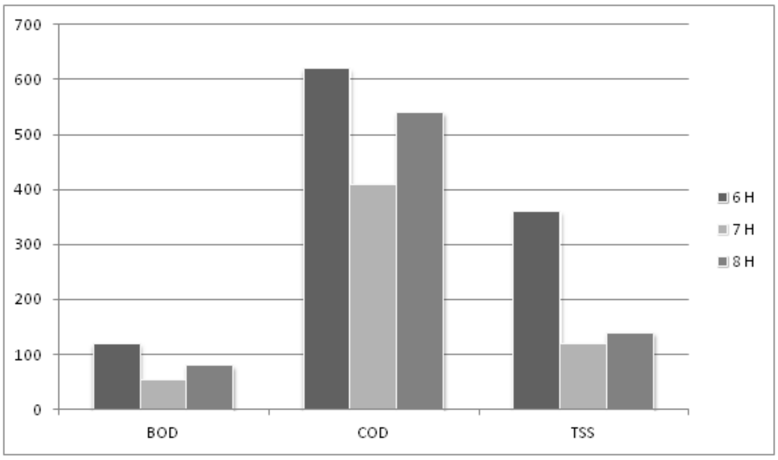
OPTIMIZATION OF DESIGN PARAMETER FOR SBR TREATMENT SYSTEM

SBR CYCLE OPTIMIZATION

TABLE NO 3. SBR CYCLE

Parameters	BOD (mg/L)	COD (mg/L)	TSS mg/L)	Ph
6 hr cycle	120	620	360	6.26
7 hr cycle	54	410	120	6.51
8 hr cycle	80	540	140	6.77

Effluent Quality for optimized SBR cycles



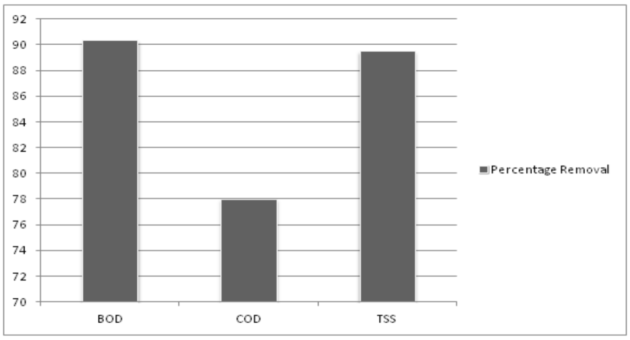
Nearly 85 % reduction in the effluent parameters was achieved at 7 h Cycle i.e., with the following cycle settings: filling – 30mins, aeration only – 4hrs, mix only – 1hr, settling – 1hr, decant – 30mins, with the total cycle time of 7 hrs.

STUDIES ON THE PERFORMANCE PROPERTIES OF SBR

TABLE NO 4 Optimum operation for BOD, COD and TSS removal

Parameter	SBR Influent	SBR Effluent	% Removed
COD (mg/L)	2140	490	78
BOD (mg/L)	520	50.24	90.34
TSS (mg/L)	460	48	89.5

% Removal in Optimized 7 h Cycle



V. SUMMARY AND CNOCLUSION

A major environmental problem facing the Paper and Pulp Mill waste water produces large volumes of high strength aqueous waste continuously. The discharge of wastewaters containing recalcitrant residues into river and lakes lead to higher biological oxygen demand (BOD) causing serious threat to native aquatic life. In the current research work, the Paper and Pulp Mill waste water effluent collected was biologically treated using indigenous microorganisms present in the effluent by designing and developing lab-scale sequential batch reactor (SBR).

The SBR was design and constructed for the biodegradation of Paper and Pulp Mill waste water. The reactor with two decanter valves for the effluent and sludge, diffuser with bubble diffuser for aeration was used for the treatment operated at room temperature.

The physical and chemical characteristics of the raw effluent were studied as per standard methods. The Paper and Pulp Mill waste water effluent was allowed for degradation in sequential batch reactor. The reactor parameters such as incubation time, temperature, rate of aeration were standardized for the effective degradation of the effluent. The results of the study indicated that the effective reduction of effluent parameters were achieved after 7 hours of incubation, at 33ºC, pH 7.45, with aeration rate of 6 L/min. +

After the optimization of the operation parameters, the SBR cycle timings were standardized by varying the hours of various phases (filling, mixing, settling, decanting and desludging). Of the three different cycle settings, 7 hr cycle with various phases was found to be efficient for the degradation of the effluent.

The sludge settling characteristics during the treatment was studied by periodic sampling and followed by analysis of the sedimentation properties. It was found that as the hours of sampling increases, the settling properties of the sludge also increases. Under these optimized conditions, the rate of removal of BOD, COD and TSS were studied and the results showed about 90 % removal. Similarly, the rate of aeration on the working of SBR was studied and it was observed that when the SBR was operated at alternative aerobic and anoxic conditions, maximum degradation of the effluent was obtained. It is understood that there is about 80-90% reduction in the parameters studied under optimized conditions (7 h Cycle). COD was reduced by about 88 %, BOD by 87.9% and TSS reduction was 80 %. The conclusion from the results was that the optimized parameters were effective for the degradation of the Paper and Pulp Mill waste water.

When the reactor was run under complete aerobic or anoxic condition, only up to 67 % reduction in parameters was achieved. But when operated under alternative aerobic and anoxic conditions more than 90-93 % degradation of effluent parameters was obtained as shown in table 4.15. Combined aerobic and Anoxic treatment in SBR was also found very efficient in the mineralization of recalcitrant pollutant.

SUGGESTIONS FOR FUTURE STUDY

1. To optimize the kinetic parameters (pH and nutrients) for the efficient performance of SBR.
2. To standardize the treatment cycle for SBR.
3. To study the performance of nitrogen removal on laboratory scale SBR in biodegradation of Paper and Pulp Mill waste water.

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