

# Performance Evaluation of Wastewater Treatment Plant Based on SBR Technology- A Case Study of Kaithal Town, Haryana (India)

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**ABSTRACT:** The need for wastewater treatment plants based on appropriate technologies and working effectively is rising rapidly on global scale, especially in those regions where availability of pure water is in challenging phase. Construction of sewage treatment plants (STPs) based on latest emerging treatment technologies in different parts of India is necessary and environmental friendly approach to reduce problem of water pollution. The Sequence Batch Reactor (SBR) technology is an emerging advanced wastewater treatment technology that has come into practice recently in many parts of the world. Sequence batch reactor (SBR) technology is being used successfully to treat both municipal and industrial wastewaters, particularly in areas characterized by low or varying flow patterns. The performance of STPs at Kaithal town based on SBR technology was evaluated during a suitable span of time. Wastewater samples were analysed for pH, BOD, COD, TSS, turbidity, nitrate, phosphate, total nitrogen (TN) and total phosphorous (TP). The treated effluents from treatment plants meet the discharge standards with reference to evaluated parameters. Treated effluent is finally used for agriculture purposes and it meets guideline for reuse. Sludge generated is sold to farmers, and they use it as manure.

**KEYWORDS:** Wastewater, Performance Evaluation, STPs, SBR, Environmental friendly approach.

## I. INTRODUCTION

Sewage from Kaithal town (population = 144633 according to 2011 census, peak factor 2.25) flow through main sewage pipe to plant under force of gravity. Approximately 6-7 MLD flow in winter and up to 9-10 MLD flow generated in summer. Sequence batch reactor (SBR) is fill and draw activated sludge system for wastewater treatment. Main aim of selecting any technology is to achieve treated effluent of good quality, which contains parameters within permissible limits. Generally, SBR system has two tanks which operate fill and draw basis. Sewage from main pumping station (MPS) filled in to tank; after desired treatment mixed liquor get settled and clarified water is drawn out from tank. SBR treatment cycle contains five phases Fill, React, Settle Draw and Idle, having defined time period (depend on aeration and mixing pattern) for each phase. Aeration times vary according to the plant size and the composition/quantity of the incoming liquor, but are typically 60 to 90 minutes. Aeration supports formation of Nitrogen from its reduced ammonia in the form of nitrite and nitrate. To remove phosphorous compounds from the liquor, ammonium sulphate (alum) is generally added during this period. It reacts to form non-soluble compounds, which settle into the sludge in the next stage. Some facultative and anaerobic bacteria's start to use oxidized nitrogen instead of oxygen gas (as electron acceptor) and converts the nitrogen to gaseous state. This is known as denitrification.

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## II. OBJECTIVE OF STUDY

To study Performance Evaluation on the sewage after treating with SBR technology at STP, Kaithal town Haryana. In this study attempt has been made to study Performance of STP in respect of different Physical and Chemical parameters after treatment process is done. Process followed is as under

- (1) Collection of the sample
- (2) Determination of the selected parameters to analysed performance evaluation.

## III. LOCATION OF SITE

Study area covers 10 MLD capacity, sewage treatment plant based on SBR technology near Gadli village in Kaithal town, Haryana state India. The plant was constructed under Public Health Department Haryana Government. This research work evaluated the performance of the STP based on SBR technology in terms physical and chemical parameters of wastewater and efficiency of treatment.



Figure 1: 10 MLD, STP at Kaithal town (Haryana) India.

## IV. MATERIALS AND METHODS

The experimental method for this work includes a lab research conducted in Advance Environmental Lab in NIT Kurukshetra, site visits to the STP, Collection of samples of inlet and outlet. Samples, throughout my study have been collected from STP based on SBR technology located at Gadli village, Kaithal town Haryana. Samples of the inlet (from grit chamber) and outlet from the STP during the period from January 2014 to April 2014 were collected. Samples were analysed for various parameters like pH, BOD, COD, TSS, Turbidity, Nitrates, Phosphate, Total nitrogen, Total phosphorous, and basis on the result, performance of STP was evaluated. Analysis of various parameters and procedure adopted are giving in table.

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**Table 1 Details of measured parameters**

S.No	Parameters	Bottle Type	Preservation of samples	Analysis Methods	References
1	Turbidity	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	Turbidity meter	
2	pH	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	pH meter	
3	BOD	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	5 day BOD at 20 <sup>0</sup> C	APHA,2005
4	COD	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	CRT Method	APHA,2005
5	TSS	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C		APHA,1998
6	Nitrates(NO <sub>2</sub> +NO <sub>3</sub> )	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	Flow injection analyzer	
7	Phosphate(PO <sub>4</sub> )	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	Flow injection analyzer	
8	Total Nitrogen	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	Flow injection analyzer	
9	Total Phosphorous	Sampling bottle	Refrigerator, below 4 <sup>0</sup> C	Flow injection analyzer	

### V. RESULT AND DISCUSSION

Colmenarejo et al., (2006) determined the general efficiency indicator to compare overall performances of the different plants in terms of average TSS, COD, BOD<sub>5</sub> and ammonia removal efficiencies. The pH of wastewater imparts a significance effect on rate of microbiological growth, pH affects growth of metabolic enzymes. Low pH (acidic) and high pH (basic) alter the structure of enzymes and stop growth. Favourable range of pH is 6.5-8.5. The STP was designed to treat domestic wastewater to meet the standards given by CPCB for disposal in to inland surface water but generally treated waste water from plant at Kaithal town is used for irrigation purposes. Experimental results of STPs based on SBR Technology indicate that Turbidity, BOD, COD, Suspended Solids (SS), Phosphate, Nitrates, Total Nitrogen (TN) and Total Phosphorous (TP) removal efficiencies were 91.14%, 95.96%, 90.89%, 96.74%, 35.29%, 42.59%, 46.20%, 43.34%, respectively while variation in pH is noticed as 7.42%. According to Environmental protection rules 1986 [Schedule vi] published in CPCB report August 2013, treated effluent is safe against disposal on land and used for irrigation. Total Nitrogen concentration of effluent is satisfactory (Average 14.86 mg/l) while TP concentration (Average 2.17 mg/l) are found as per expectation. 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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**Table 2 Analysis of some Physical and chemical parameters of STP with SBR**

Sampling date	1. pH		2. Turbidity(NTU)		3. BOD <sub>5</sub> (mg/l)		4. COD(mg/l)	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
03/01/14	7.73	7.18	1573	109	275	06	365.17	29.12
11/01/14	7.19	6.75	1281	113	247	06	367.19	32.12
17/01/14	7.62	7.21	1276	154	261	08	371.2	29.2
24/01/14	7.14	6.59	1685	146	230.7	07	372.09	22.12
30/01/14	7.20	6.39	1505	124	240.2	08	378.91	27.12
05/02/14	7.74	7.09	1113	129	241	09	355	36
12/02/14	7.63	7.13	1498	123	256	12	381	37
18/02/14	7.53	7.09	1273	144	251	09	417	38
23/02/14	7.46	7.12	1365	102	230	11	405	40.12
28/02/14	7.49	7.09	1414	98	215	10	390	25
06/03/14	7.84	7.15	1358	108	196	08	353	49
10/03/14	7.10	6.19	1734	110	234	06	330	37.12
14/03/14	7.45	6.80	1534	90	261.4	10	355	26.0
19/03/14	7.78	7.39	1276	80.10	240	07	370.71	32.57
24/03/14	7.34	7.18	1364	170	269.70	09	341.10	29.13
30/03/14	7.87	7.16	1358	159	248	12	386	31.12
06/04/14	7.84	7.05	1713	202	213	10	425	48.28
Maximum	7.87	7.39	1734	202	275	12	457	43
Minimum	7.10	6.19	1113	80.10	196	06	341.10	22.12
Average	7.528	6.974	1430.5	127.1	241.7	9.76	383.7	34.93
<b>% Removal</b>	<b>7.42%</b>		<b>91.14%</b>		<b>95.96%</b>		<b>90.89%</b>	

5 TSS		6 NO <sub>2</sub> + NO <sub>3</sub>		7 PO <sub>4</sub> <sup>-</sup>		8 Total N		9 Total P	
IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
259	07	0.55	0.33	2.40	1.45	32.23	15.39	3.98	2.15
359	10	0.58	0.32	2.67	1.34	28.10	14.13	3.12	1.43
281	12	0.66	0.30	2.86	1.38	29.10	15.32	2.65	1.54
360	08	0.65	0.41	2.47	1.12	26.15	14.23	2.98	1.15
373	08	0.65	0.38	2.53	1.59	35.50	11.98	3.71	3.58
265	12	0.71	0.51	2.33	1.11	24.32	13.34	4.12	1.66
389	12	0.67	0.40	2.38	1.54	25.13	12.32	3.65	2.07
470	12	0.58	0.41	2.42	1.32	27.14	15.76	3.06	1.64
407	13	0.53	0.45	2.98	1.56	23.42	13.49	2.89	1.95
550	12	0.66	0.48	2.99	1.74	26.98	16.56	2.95	1.71
390	12	0.69	0.51	3.20	1.86	29.96	14.27	2.71	1.14
389	13	0.72	0.43	3.41	1.76	31.10	17.43	3.31	2.60
370	14	0.82	0.45	2.67	1.65	28.17	18.42	2.87	2.23

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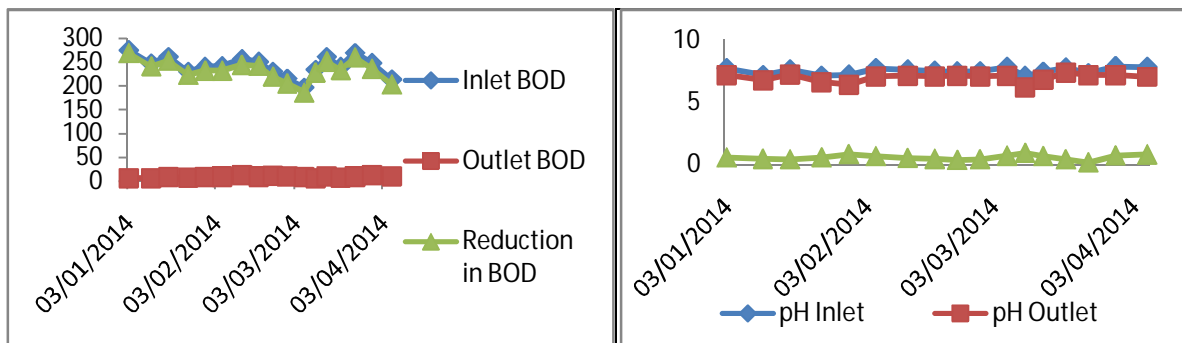
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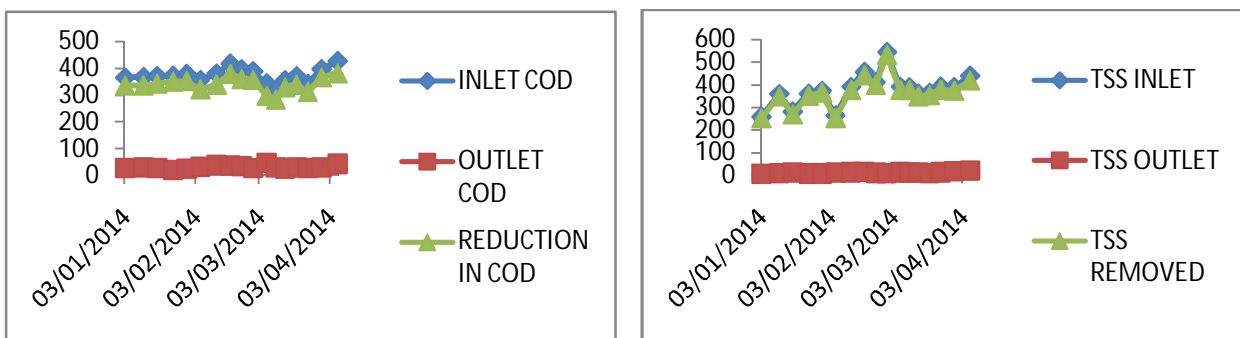
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375	14	0.71	0.41	2.14	2.06	22.12	12.14	3.22	3.13
395	15	0.62	0.38	2.78	2.10	32.20	16.40	2.63	2.52
400	16	0.97	0.72	3.32	1.62	20.71	14.23	7.30	3.12
425	20	0.38	0.26	3.57	1.82	27.62	17.23	10.10	3.31
<b>550</b>	<b>20</b>	<b>0.97</b>	<b>0.72</b>	<b>3.57</b>	<b>2.10</b>	<b>35.50</b>	<b>17.23</b>	<b>10.10</b>	<b>3.58</b>
<b>259</b>	<b>07</b>	<b>0.38</b>	<b>0.26</b>	<b>2.14</b>	<b>1.59</b>	<b>20.71</b>	<b>11.98</b>	<b>2.60</b>	<b>2.50</b>
<b>379.82</b>	<b>12.35</b>	<b>0.65</b>	<b>0.42</b>	<b>2.77</b>	<b>1.59</b>	<b>27.62</b>	<b>14.86</b>	<b>3.83</b>	<b>2.17</b>
<b>96.74%</b>		<b>96.74%</b>		<b>35.29%</b>		<b>42.59%</b>		<b>46.20%</b>	
								<b>43.34%</b>	

Variation of pH, Turbidity, BOD, COD, TSS, Total Nitrogen and Total Phosphorous with respect to each sample collection are shown with the help of following graphs.



**Figure 2 Values of pH and BOD<sub>5</sub> at inlet and outlet( Y axis) with Date of sampling( X axis)**



**Figure 3 Value of COD and TSS at inlet and outlet in mg/l(Y axis) with Date of sampling(X axis)**

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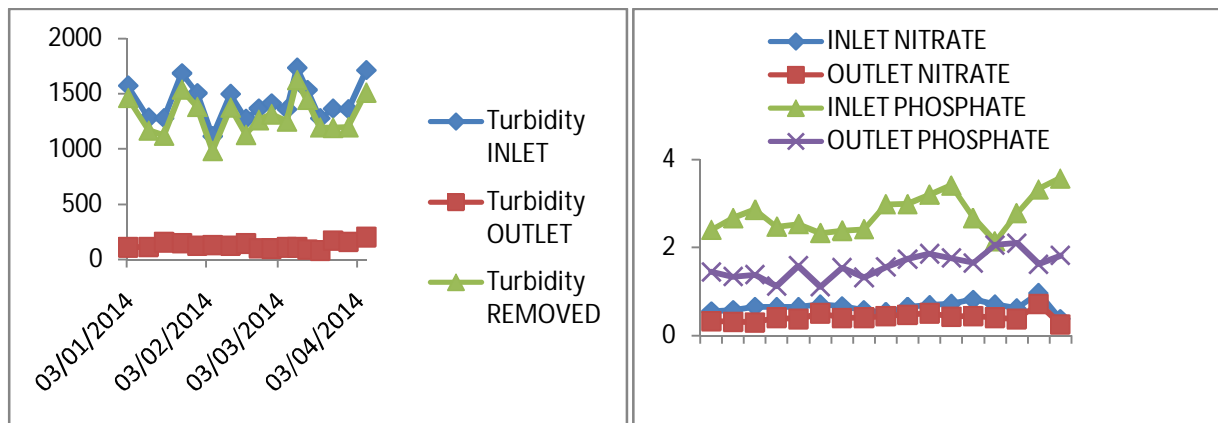


Figure 4 Value of Turbidity and Nitrate and Phosphate at Inlet and Outlet in NTU(Y-axis) with Date of sampling X-axis)

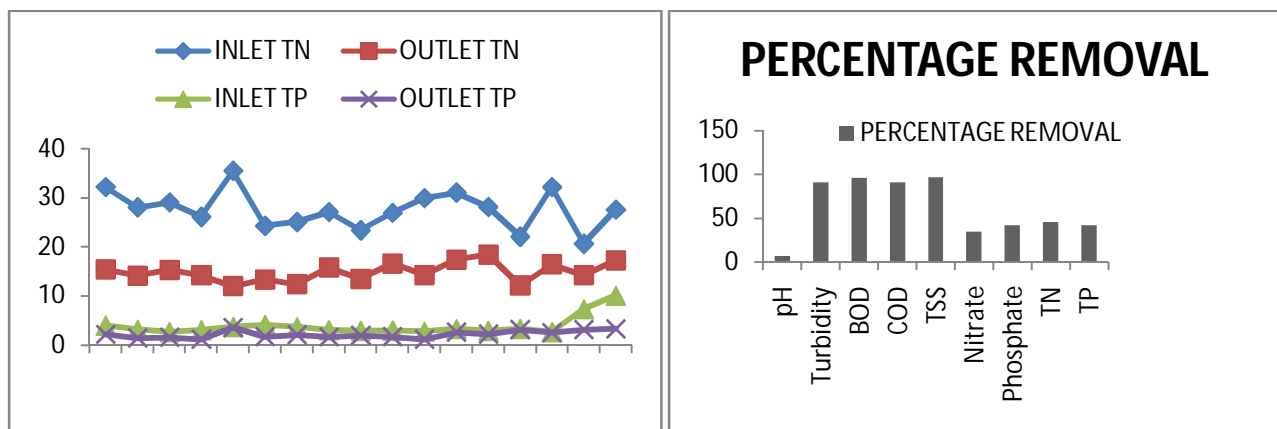


Figure 5 Value of TN, TP and percent removal of all the parameters at Inlet and Outlet.

## VI. CONCLUSION

Experimental results of STPs based on SBR Technology indicate that Turbidity, BOD, COD & Total Suspended Solids (TSS), Phosphate, Nitrates, Total Nitrogen (TN) and Total Phosphorous (TP) removal efficiencies were calculated to be 91.14%, 95.96%, 90.89%, 96.77%, 42.59%, 35.29%, 46.20%, 43.34% 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. Total daily Power requirement (avg.) 153.70 kWh/d/MLD less than MBBR technology while area requirement is 550 m<sup>2</sup>/MLD same as MBBR technology. Study of performance evaluation of STP based on SBR technology shows that BOD and COD removal efficiencies of plant are 95.96%, 90.89%, which is satisfactory. BOD removal depends on aeration time provided. Aeration times vary according to the plant size and the composition/quantity of the incoming sewage, but are typically 60 – 90 minutes. Nitrate + nitrite and TN concentrations in untreated wastewater are in the ranges 0.97- 0.38 mg/l and 35.50-20.71 mg/l respectively and that in treated wastewater are in the range 0.72-0.26 mg/l and 17.23-11.98 mg/l, respectively. These concentrations are safe against disposal and reused. The addition of oxygen to the wastewater supports bacterial action and they consume the

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nutrients and supports nitrification process. Phosphate and total phosphorous concentrations in untreated wastewater and treated effluent are 3.57-2.14 mg/l and 2.10-1.59 mg/l, respectively. To improve removal efficiency of phosphorus compounds from the wastewater aluminium sulphate (alum) is often added during this period. It reacts to form non-soluble compounds, which settle into the sludge in the next stage. The settling stage has usually the same length of time as the aeration. The pH value is 7.528-6.928 for untreated wastewater and same after treatment is 6.9, that is again within limits (6.5-8.5). The concentrations of TSS in untreated and treated wastewater are 550-259 mg/l and 20 - 07 mg/l, respectively which is good enough for safe disposals. Turbidity is found very high for influent and slight high for effluent and needs to proper settling.

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