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Performance Evaluation of Wastewater Treatment Plant Based on SBR Technology with PLC, SCADA system - A Case Study of Rajeev Awas Yogna Kiron ki Dhani Muhana, Rajasthan (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 Rajeev Awas Yojna, Muhana based on SBR technology was evaluated during a suitable span of time. Wastewater samples were analysed for pH, BOD, COD, TSS, phosphate and total kjeldahl nitrogen (TKN). 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 Rajeev Awas Yojna (peak factor 3.00) flow through main sewage pipe to plant under force of gravity. 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, Muhana town Jaipur. 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 1 MLD capacity, sewage treatment plant based on SBR technology near Muhana town in Jaipur Rajasthan state India. The plant was constructed under Jaipur Development Authority Department Rajasthan 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.

IV. MATERIALS AND METHODS

The experimental method for this work includes a lab research conducted in Advance Environmental Lab in Brothers Laboratories Pvt. Ltd. Jaipur, 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 Muhana town, Jaipur, Rajasthan. Samples of the inlet (from grit chamber) and outlet from the STP during the period from January 2018 to January 2019 were collected. Samples were analysed for various parameters like pH, BOD, COD, TSS, Phosphate, Total nitrogen, and basis on the result, performance of STP was evaluated. Analysis of various parameters and procedure adopted are giving in table.

Table 1 Details of measured parameters

S.No	Parameters	RSPCB LIMIT'S	METHOD OF TEST
1	pH	5.5-9.0	IS 3025 (Part 11)
2	BOD	Max 30 mg/ltr	IS 3025 (Part 44)
3	COD	Max 250mg/ltr	IS 3025 (Part 58)
4	TSS	Max 100mg/ltr	IS 3025 (Part 17)
5	Total Kjeldahl Nitrogen (TKN)	100mg/ltr	IS 3025 (Part 34)
6	Phoshate as PO ₄		IS 3025 (Part 35)

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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, BOD₅ 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 Muhana town is used for irrigation purposes. Experimental results of STPs based on SBR Technology indicate that, BOD, COD, Total Suspended Solids (TSS), Total Kjeldhal Nitrogen (TN) and Phosphate removal efficiencies were 97.88%, 96.22%, 97.40%, 84.50%, 98.87%, respectively while variation in pH is noticed as 4%. 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 7.08 mg/l) while TP concentration (Average 1.46 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.

Table 2 Analysis of some Physical and chemical parameters of STP with SBR

Sampling date	1. pH		2.TSS		3. BOD ₅ (mg/l)		4. COD(mg/l)		5. Phosphate as PO ₄		6. Total Kjeldahl Nitrogen (TKN)	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
18.01.2018	6.92	7.30	281	8.96	213.7	4.88	460	15.88	27.80	1.03	32.18	7.69
09.02.2018	7.12	7.50	663	8.68	218.4	4.88	610.6	22.5	29.4	0.94	64.8	9.40
01.03.2018	7.69	7.12	391	9.03	202.3	4.47	620.8	15.69	49.94	1.75	50.19	6.33
16.04.2018	7.09	7.24	470	9.13	196	4.69	490	15.99	43	1.93	68.30	6.12
08.05.2018	7.28	8.02	407	9.17	213	4.98	555.60	16.05	48.45	1.69	55.17	6.21
07.06.2018	8.2	7.41	298	9.03	275	4.65	610.88	16.02	60.30	1.42	32.98	6.71
27.07.2018	7.82	7.07	258	9.68	142.40	4.4	548.26	17.51	315.69	1.01	29.18	7.55
10.08.2018	7.39	7.84	397	8.97	221	4.70	499	16.11	200.20	1.91	25.03	6.69
12.09.2018	7.32	7.22	389	9.12	196	4.6	460.8	15.92	300.20	1.86	33.33	6.52
05.10.2018	7.01	7.26	265	9.11	269.70	4.80	397.3	15.78	242.99	1.77	41.08	6.52
15.11.2018	6.98	7.07	360	9.68	240.2	4.4	457	17.51	226.78	1.06	53.70	7.56
18.12.2018	7.81	7.09	359	9.68	261	4.6	386	18.10	33.39	1.04	27.03	7.69
31.01.2019	7.9	7.2	373	9.68	230	4.9	378.91	18.13	27.80	1.03	32.18	7.69
Max.	7.9	8.02	663	9.68	275	4.88	620.8	22.5	315.69	1.93	68.30	9.40
Min.	6.92	7.07	265	8.68	202.3	4.4	378.91	15.69	27.80	0.94	25.03	6.12
Average	7.46	7.20	354.69	9.20	221.42	4.68	503.14	16.99	130.33	1.46	44.78	7.08
% Removal	4%		97.40%		97.88%		96.22%		98.87%		84.50%	

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

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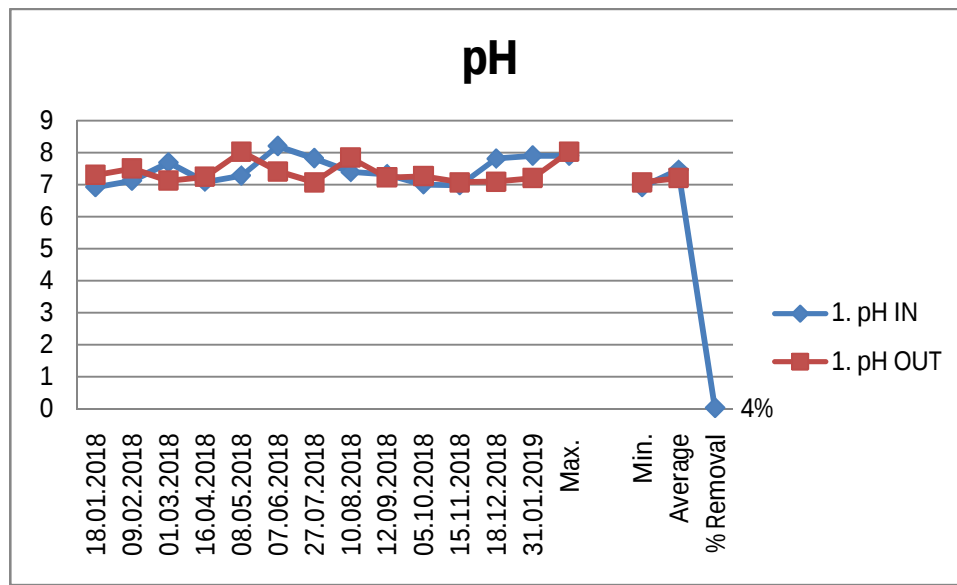


Figure 1. Values of pH at inlet and outlet(Y axis) with Date of sampling(X axis)

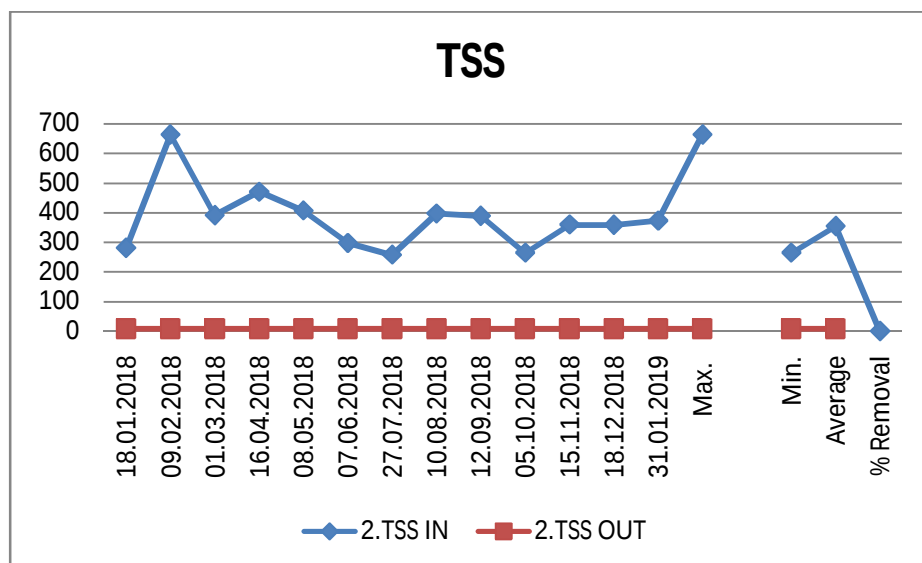


Figure 2. Values of TSS at inlet and outlet(Y axis) with Date of sampling(X axis)

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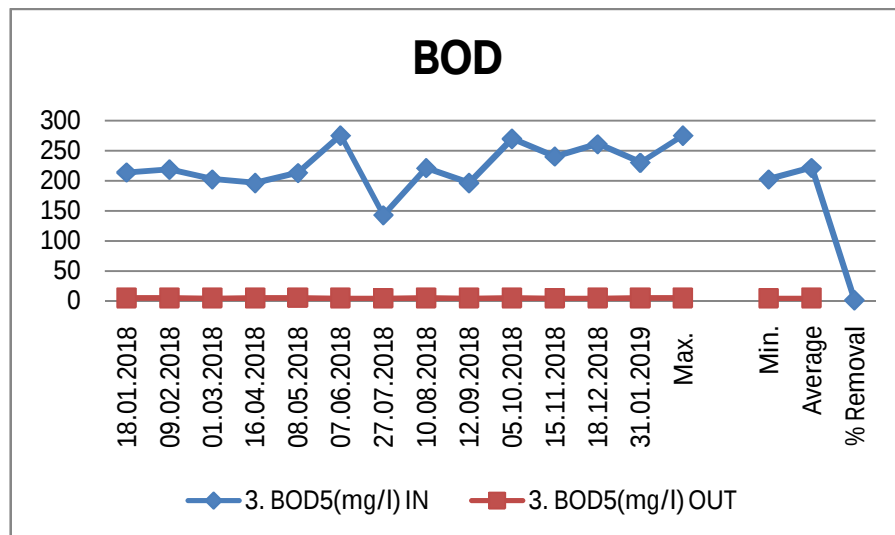


Figure 3. Values of BOD₅ at inlet and outlet(Y axis) with Date of sampling(X axis)

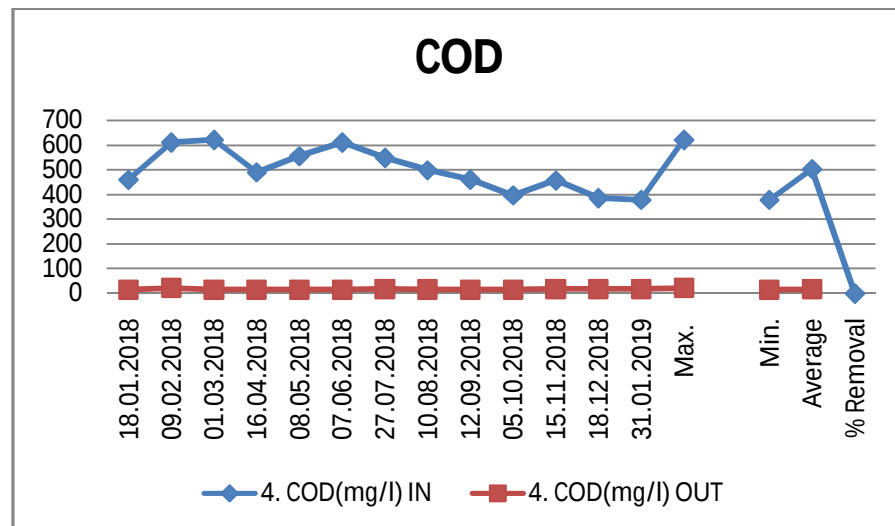


Figure 4. Values of COD at inlet and outlet(Y axis) with Date of sampling(X axis)

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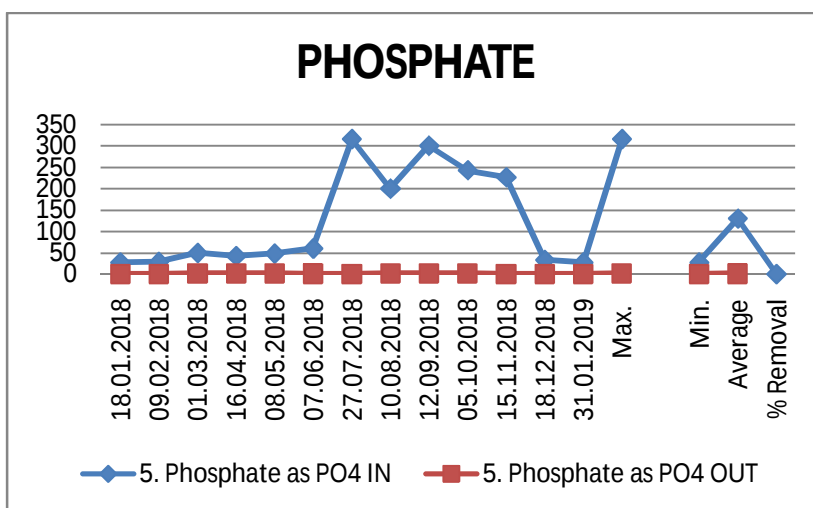


Figure 5. Values of pH and BOD₅ at inlet and outlet(Y axis) with Date of sampling(X axis)

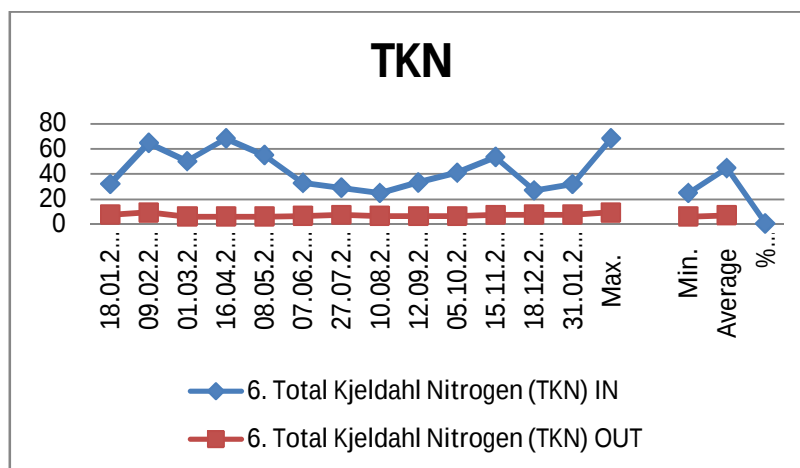


Figure 6. Values of TKN at inlet and outlet(Y axis) with Date of sampling(X axis)

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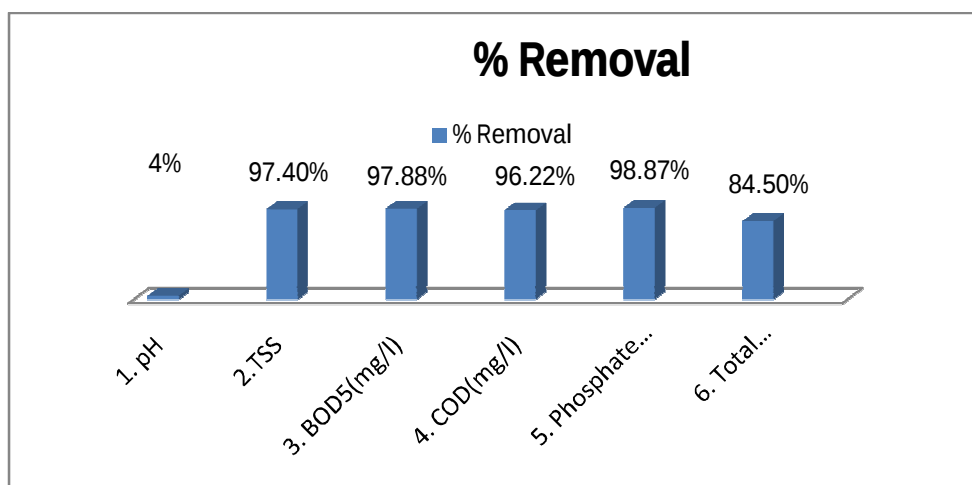


Figure 7. % removal efficiency (Y axis) of different Parameters(X axis)

VI. CONCLUSION

Experimental results of STPs based on SBR Technology indicate that BOD, COD & Total Suspended Solids (TSS), Phosphate, and Total Kjeldahl Nitrogen (TN) removal efficiencies were calculated to be 97.88%, 96.22%, 97.40%, 98.87%, 84.50% 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.) 172.5 kWh/d/MLD less than MBR and ASP technology while area requirement is 400 m²/MLD same as MBBR technology, double of MBR technology, and half of ASP technology. Study of performance evaluation of STP based on SBR technology shows that BOD and COD removal efficiencies of plant are 97.88%, 96.22%, 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. TKN concentrations in untreated wastewater are in the ranges 25.03- 70.9 mg/l and that in treated wastewater are in the range 6.21-9.40 mg/l. These concentrations are safe against disposal and reused. The addition of oxygen to the wastewater supports bacterial action and they consume the nutrients and supports nitrification process. Phosphate concentrations in untreated wastewater and treated effluent are in ranges 27.80-315.69 mg/l and 0.94-1.93 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 8.2-6.9 for untreated wastewater and same after treatment is 7.4(avg.), that is again within limits (6.5-8.5). The concentrations of TSS in untreated and treated wastewater are 470-258 mg/l and 9.68 – 8.68 mg/l, respectively which is good enough for safe disposals. Specialities of SBR- In built equalization, BOD/COD/SS removal, Settling, Decanting, Nitrification, Denitrification, Bio-P removal. All process are done in single stage.

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