

PERFORMANCE EVALUATION OF SEWAGE TREATMENT PLANT BASED ON SBR AND MBBR TECHNOLOGY

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Abstract: A huge gap exists in developing countries in the collection and treatment of domestic wastewater. Despite having multiple wastewater treatment facilities, the discharge of pollutants is still being done into natural water bodies, as the treatment facilities often work below design standards, thus creating a negative impact on the environment. In this study, a performance assessment of SBR (Sequential Batch Reactor) and MBBR (Moving Bed Bio Reactor) based wastewater treatment plant in Delhi, Gurgaon and Ludhiana is done. These plants are designed and constructed with an aim to manage wastewater so as to minimize or remove organic matter, solids and other pollutants before it enters a water body. In the present study samples were collected at inlet and outlet of the sewage treatment plant, and analysed for various Physico-chemical Parameters of 3 STP's namely STP at Behrampur, Gurgaon- 120 MLD, STP at Delhi Gymkhana Club- 200 KLD and STP at Village Balloke, Ludhiana- 105 KLD. The parameters were evaluated and compared with the Central Pollution Control Board (CPCB) General Standards. The performance of each STP was evaluated in terms of Removal/Reduction Efficiency and it was revealed from the performance study that efficiency of the three STP's under study was higher with respect to removal of TSS (Total Suspended Solids) 92-96.5% , BOD (Biochemical Oxygen Demand) 90.5-95% and COD (Chemical Oxygen Demand) 89-92%. in contrast to the removal of TDS (Total Dissolved Solids) 30-46% which was quite low. In comparison with each other, out of the three STP's , the STP located at Behrampur, Gurgaon based on SBR technology showed better results for the effluent, its reduction efficiency for BOD is 95% and is highest among the other two STP's. Overloading of the plant beyond its design capacity and poor maintenance practices were identified to be the main causes for the poor performance of the plant at Village Balloke. Given the cost of running the plant, it is essential that improvements are made to increase the performance.

Keywords: Wastewater; SBR; MBBR; Sewage treatment; Efficiency.

I. INTRODUCTION

Sewage treatment is the process of converting the wastewater collected from mainly households into treated water which can be disposed off safely into the environment. Sewage treatment plant basically consists of primary, secondary and tertiary treatment processes with variation in treatment technologies depending upon the type of influent to be treated with the ultimate aim of producing treated effluent which can be discharged into the environment with minimal harm to the water bodies. Although a lot of sewage treatment plants exist but the natural water bodies are still being polluted due to the discharge of heavy pollutants from industries and effluents from nearby sewage treatment plants as many treatment facilities often work below their design standards thereby creating a negative impact on the environment.

A number of sewage treatment plants exist in the country based on different treatment technologies with some using the conventional Activated Sludge process and some using advanced technologies such as SBR, FAB, MBBR, etc. The treatment plants under study are based on advanced treatment technologies such as SBR (Sequential Batch Reactor) and MBBR (Moving Bed Biofilm Reactor) for higher performance rate with respect to removal of pollutants and enhanced efficiency of operation and maintenance.

Thus the primary objective of this study was to investigate the current situation of Sewage Treatment Plants based on SBR and MBBR technology in India.

II. OBJECTIVES OF THE STUDY

- 1.To analyse the physio-chemical parameters of influent and effluent of all the STP's under study.
- 2.To evaluate the percentage removal efficiency of the three STP's.
- 3.To know practically about the working principle of all the STP's under study.

III. SEWAGE TREATMENT PLANTS UNDER STUDY

3.1 GHARPURE PVT LTD., BEHRAMPUR GURGAON

The STP at Behrampur, Gurgaon is based on SBR technology and has a capacity of 120 MLD. The STP was commissioned in the year 2014 and is used for the treatment of municipal sewage and the effluent is discharged into the nearby channel of the area.

Table 1. Details of STP at Behrampur, Gurgaon.

LOCATION	BEHRAMPUR, GURGAON
SOURCE	MUNICIPAL SEWAGE
EFFLUENT DISPOSAL/REUSE	DISCHARGE TO NEARBY CHANNEL
TECHNOLOGY	SBR
CAPACITY	120 MLD
COMMISSIONED	JUNE 2014

Process cycle of operation-

- Filling, Aeration & Recirculation- 108 mins.
- Settling & Removing of Sludge- 50 mins.
- Decanting- 58 mins.
- Total- 216 mins.

3.2 DELHI GYMKHANA CLUB STP, DELHI

The STP at Delhi Gymkhana Club is constructed by Brisanzia Private Ltd for the treatment of waste from the Club. It has a capacity of 200KLD and uses the technology **MBBR with PVA Gel**.

The MBBR (Moving Bed Biofilm Reactor) technology is a type of advanced wastewater technology that uses a media in suspension for providing greater surface area for the microbes to grow and thus resulting in higher efficiency.

Table 2. Details of STP at Delhi Gymkhana Club.

LOCATION	DELHI GYMKHANA CLUB
SOURCE	SEWAGE
EFFLUENT DISPOSAL/REUSE	REUSE IN GARDENING
TECHNOLOGY	MBBR WITH PVA GEL
CAPACITY	200KLD
COMMISSIONED	SEPTEMBER 2015

3.3 STP at Balloke, Ludhiana

The STP at Balloke, Ludhiana is based on SBR technology and has a capacity of 105 MLD. The STP is used for the treatment of sewage and the effluent is discharged into the nearby Budha nala of the area.

Table 3. Details of STP at village Balloke, Ludhiana.

LOCATION	BALLOKE, LUDHIANA
SOURCE	SEWAGE
EFFLUENT DISPOSAL/REUSE	BUDHA NALA
TECHNOLOGY	SBR
CAPACITY	105 MLD

SBR (Sequential Batch Reactor) is an advanced form of the conventional Activated Sludge System with major difference in the operation cycle as in SBR system aeration, settling and decanting all take place in the same basin based on time sequence as opposed to Activated Sludge system. During the fill operation, volume and substrate (raw waste water or primary effluent) are added to the reactor. During the react period, the biomass consumes the substrate under controlled environmental conditions.

IV. METHODOLOGY

4.1 Sampling points:

The sampling points for the STP's under study were:

- Inlet and Final Outlet of Behrampur STP, Gurgaon.
- Inlet and Final Outlet of Delhi Gymkhana Club STP, Delhi.
- Inlet and Final Outlet of Village Balloke STP, Ludhiana.

4.2 Sampling procedure:

Grab samples were collected from different STP's under study at inlet and final outlet and were stored in one litre plastic bottles and kept in an air tight ice box and transported to the Environmental Engineering Laboratory, Department of Civil Engineering, Jamia Milia Islamia University, Delhi, India. Analysis of all the physio-chemical parameters of wastewater that includes pH, BOD, COD, TS, TSS were performed in accordance with standard methods of wastewater treatment.

V. RESULT AND ANALYSIS

Table 4. Mean values of the parameters under study.

Parameters*	Behrampur STP, Gurgaon (SBR Technology)		Delhi Gymkhana Club STP, Delhi (MBBR technology)		Village balloke STP, Ludhiana (SBR technology)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
pH	7.8	8.2	7.2	7.7	7.3	7.8
TS	980	370	790	320	1100	522
TDS	600	322	500	270	690	482
TSS	350	12	250	20	410	25
BOD ₅	200	10	250	20	190	18
COD	380	30	420	45	400	35

*All the values except for pH are in mg/l.

5.1 Performance evaluation-

For evaluating overall performance /efficiency of an STP, four major parameters are considered which are TSS, TDS BOD and COD.

Removal/Reduction efficiency is calculated as-

$$E_r = [(\text{Initial Amount} - \text{Reduced Amount}) / \text{Initial Amount}] * 100$$

Table 5. Mean Removal efficiency of the STP's.

Removal / Reduction Efficiency	TSS	TDS	BOD	COD
Behrampur STP, Gurgaon (SBR Technology)	96.5%	46.3%	95%	92.10%
Delhi Gymkhana Club STP (MBBR Technology)	92%	46%	92%	89.2%
Village Balloke STP, Ludhiana (SBR Technology)	93.9%	30%	90.5%	91.25%

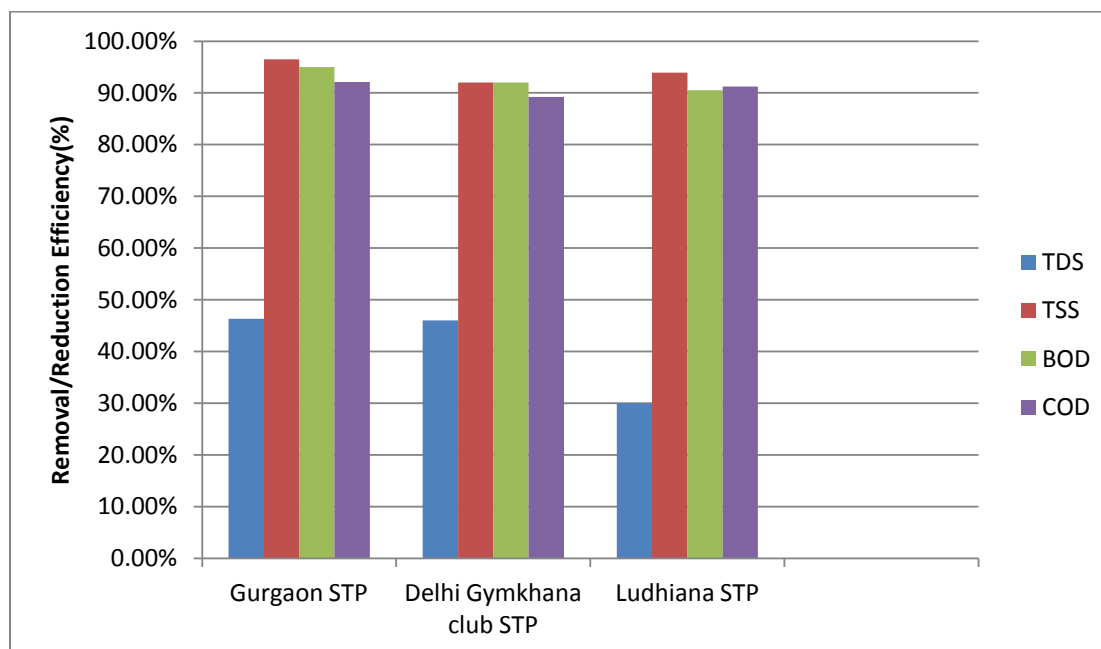


Fig 1. Graphical representation of the overall Removal / reduction efficiency of the 3 STP's.

5.2 pH

The pH value of sewage is an indicator of the alkalinity or acidity of sewage. The sewage is alkaline if pH is more than 7 and acidic if the pH of sewage is less than 7. The determination of pH value is important because of the fact that efficiency of certain treatment methods depends upon the availability of a suitable pH value. The pH directly affects the performance of a secondary treatment process because the existence of most biological life is dependent upon the narrow and critical range of pH.

During the course of study, it was recorded that the pH value of the influent was 7.8, 7.2 and 7.3 for Gurgaon STP, Gymkhana club STP and Ludhiana STP respectively indicating that the influent was alkaline in nature for all the 3 STP's. It was also recorded that the pH value of the effluent was 8.2, 7.7 and 7.8 for Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively indicating that the effluent was also alkaline in nature for all the 3 STP's.

The effluent of all the 3 STP's was under the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface water.

5.3 TSS

In the present study it was recorded that the TSS value was 350 mg/l, 250 mg/l and 410 mg/l for the influent from Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively. The TSS value for influent from all the 3 STP's indicates much variation which is attributed to the large difference in the organic and inorganic loading of solids with liquid content in all the 3 STP's.

The TSS value of the effluent was recorded as 12 mg/l, 20 mg/l and 25 mg/l for Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively which indicates that the TSS values are under the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface water.

5.4 TDS

In the present study it was recorded that the TDS value was 600 mg/l, 500 mg/l and 690 mg/l for the influent from Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively. The TDS value for influent from all the 3 STP's indicates much variation which is attributed to the large difference in the organic and inorganic loading of solids with liquid content in all the 3 STP's.

The TDS value of the effluent was recorded as 322 mg/l, 270 mg/l and 482 mg/l for Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively which indicates that the TDS values are under the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface water.

5.5 BOD

During the study it was recorded that the BOD value was 200 mg/l, 250 mg/l and 190 mg/l for the influent from Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively, high average value of BOD for all the three STP's indicates the degree of pollution of Influent in each STP.

Out of all the three STP's mentioned above the average BOD value was maximum in Gymkhana club STP, Delhi. The BOD value of effluent was recorded as 10 mg/l, 20 mg/l and 18 mg/l for Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively. It was observed that the BOD value for effluent of all the STP's was well below the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface water.

5.6 COD

During the study it was recorded that the average COD value was 380 mg/l, 420 mg/l and 400 mg/l for the influent from Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively.

Out of all the three STP's mentioned above the average COD value was maximum in Ludhiana STP, Delhi. The COD value of effluent was recorded as 30 mg/l, 45 mg/l and 35 mg/l for Gurgaon STP, Gymkhana Club STP and Ludhiana STP respectively. It was observed that the COD value for effluent of all the 3 STP's was well below the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface water.

VI. CONCLUSION

Based on the laboratory analysis and operating data of the sewage treatment plants under study, it is concluded that:

- During the course of study all the physico-chemical parameters evaluated for the 3 STP's were under the permissible limit according to CPCB Effluent Discharge Standards into Inland Surface Water and Public sewers.
- The reduction efficiencies for TSS (Total Suspended Solids), BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) was high in all the 3 STP's under study in contrast to the reduction of TDS (Total Dissolved Solids) which was quite low.
- In comparison with each other, out of the three STP's, Behrampur STP located at Gurgaon showed better results than the other STP for the effluent quality, its removal / reduction efficiency for BOD is 95% and is highest among Delhi Gymkhana club STP and Village Balloke STP which is 92% and 90.5% respectively. The greater removal / reduction efficiency for Gurgaon STP is attributed to the proper maintainance and working of the STP.
- Direct comparison between the technologies could not be done as such because of the difference in the source of influent wastewater for SBR and MBBR based STP's but an overall view can be seen from the removal efficiency that SBR technology has a higher efficiency to remove BOD and COD than MBBR.

VII. REFERENCES

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