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# Performance analysis of existing sewage treatment plants in Prayagraj, Uttar Pradesh

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**ABSTRACT**

This study is based on the performance assessment of seven existing sewage treatment plants (STPs) in Prayagraj, Uttar Pradesh. These STPs are based on different treatment technology comprising primary and secondary treatment system. Effective treatment of sewage is very crucial, as it is one of the most important factors for environmental degradation as it contains variety of organic and inorganic constituents, which degrade the environment. Three parameters namely Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were considered for the study. The study shows that the treatment efficiency of one of the STP is not up to the level and needs urgent attention to meet the notified discharge standards. In all the STPs the average reduction in TSS, BOD and COD is in the range of expected removal of 70-80% except Salori STP of 29 MLD in which the average reduction is 69.88, 39.69 and 40.36 % respectively, which is much below the expected removal of 70-80% indicating poor efficiency in terms of TSS, BOD and COD.

***Key words :*** *Sewage, STP, Treatment technology, Performance evaluation, Efficiency.*

## Introduction

It is a well-known fact that communities in all older civilizations grew and prospered along rivers. Most of the large Indian cities (Class I cities having a population of more than 100 000) are either along rivers or coast-line. Out of various rivers of India, Ganga occupies a special status in view of its cultural, economic and religious importance. River Ganga originating from Gomukh near Gangotri in Himalayas it flows through the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal before meeting ocean in the Bay of Bengal at Ganga Sagar. The Ganga basin covering an area of 861404sq km. Several large, medium and small rivers join Ganga at various places. There are around 100 Class I cities (population>100 000) along Ganga, which discharge around 3558.5 MLD of domestic wastewater. Till 1985 only a small fraction of this was being intercepted and treated fully or partially. Realizing the economic and socio-cultural importance of Ganga the Government of India launched a massive river clean-up plan known as Ganga Action Plan in 1986. Under this plan besides implementing several other schemes emphasis was given on improving the sewerage system and creating/improving treatment facilities. Initially important and larger cities like Haridwar, Kanpur, Allahabad (now Prayagraj), Varanasi, Patna, and Kolkata were considered under this plan.

The city of Prayagraj located about 700 km from Delhi is situated between Ganga and Yamuna has special importance due to annual Magh mela, six-yearly Half- Maha Kumbh (Ardha Kumbha) and 12-

yaerly full Kumbha Mela (Poorn Kumbha). The city currently generates around 400 to 430 MLD of sewage. Thus, it was one of the cities identified under the first phase of Ganga Action Plan (GAP) and schemes for collecting and treating city's sewage were initiated. As the treatment facility created at Prayagraj under GAP phase-I was not sufficient, several other treatment plants based on fluidized bed, high rate bio-filtration, sequential batch reactor (SBR), and up-flow anaerobic bio-reactor (UASB) systems have been installed during past two decades. From time to time, several groups of workers have carried out performance evaluation of STPs based on different treatment technologies mentioned that removal of different parameters was almost comparable and was not significantly varying (Khalil *et al.,* 2008; Singh and John, 2013; CPCB, 2013 and Tripathi and Singhal, 2013).

In view of the above in the present work, it has been planned to evaluate the performance of all seven wastewater treatment units operational at Prayagraj having diverse nature of treatment processes used for treatment of more or less identical sewage covering a period of two years.

## Materials and Methods

Based on the natural drainage topography of Prayagraj, city has been divided in to eight sewerage district namely District A, B, C, D, E, F, G and Jhusi covering area of 8609 hectare. As per 2011 census, the urban population of Prayagraj including outgrowth was 11,68,385 with total coverage area of 82 square kilometre. Approx. 1252 km water supply line is laid down for supply of 347.60 MLD of water through 252 tube wells (268.86 MLD) and river Yamuna (78.74 MLD). As per estimation, about 20 percent of the household have their own source of fresh water withdrawal. Out of 195259 households only 163100 household is connected through 1550 Km of sewerage network in the city. Approx. 16.47 percent of households are still not connected to sewerage network in city (ULB Prayagraj, 2015). As per projection, the present population of city is about 17,77,278 (Municipal Corporation, Prayagraj).

All seven sewage treatment plants having total treatment capacity of 268 MLD incorporate the biological treatment as the main unit. At Naini there is 80-MLD conventional activated sludge plant. The activated sludge process is the biological process by which non-settleable substances occurring in dissolved and colloidal forms are converted into settleable sludge which is removed from the liquid carrier.

There are three high rate bio-filters –50-MLD plant at Numayadahi, 25-MLD plant at Kodra and 10-MLD plant at Ponghat. Except for the difference in the treatment capacity, they are essentially similar. In bio-filtration system, removal of pollutants are due to biological degradation rather than physical straining. With the progress in process of filtration, microorganisms are gradually developed on the surface of the filter media and form a biological film or slime layer known as biofilm (Chaudhary *et al.,* 2003).

At Salori there are two STPs, the 29-MLD STP is based on the fluidized aerobic bioreactor and the 14-MLD STP based on the sequential batch reactor (SBR) technology. The Fluidized aerobic Bioreactor (FAB) is an attached growth process, the media packing fixed in reactor tank, and wastewater passed the biofilm. The media is moving inside the reactor continuously. Air bubbles through diffused aeration and influent wastewater keeps the media in fluidized condition. The sequencing batch reactor (SBR) is a fill-and draw activated sludge system for wastewater treatment. 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.

The 60-MLD STP installed at Rajapur is based on the upflow anaerobic sludge blanket (UASB) reactor technology. The upflow anaerobic sludge blanket reactor (UASB) is a single tank process. Wastewater enters the reactor from the bottom, and flows upward. A suspended sludge blanket filters and treats the wastewater as the wastewater flows through it. UASB technology has been effectively used for the treatment of a wide range of wastewaters (Seghezzo L. 2004 and Wolmarans B. & De Villiers G. H. 2002).

Out of seven STPs, two STPs namely Naini and Numayadahi STP are discharging treated sewage into river Yamuna and rest five STPs namely Ponghat, Rajapur, Kodra and Salori (29 MLD and 14 MLD) are discharging into river Ganga.

Central Pollution Control Board (CPCB) carried out monitoring of these STPs during March 2018 to December 2019 and total nine composite samples were collected to check to efficient working of the STPs. Composite sampling were carried out as per standard protocol of CHPEEO. The samples were

analysed for relevant parameters as per American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater (APHA, 2005). The treatment efficiency of these STPs are calculated based on reduction in Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) after treatment.

## Results and Discussion

Percentage reduction of Pollution Load at Naini, Numayadahi, Salori (29 MLD & 14 MLD), Rajapur, Kodra and Ponghat STPs are shown as Fig. 1, 2, 3, 4, 5, 6 and 7 respectively.

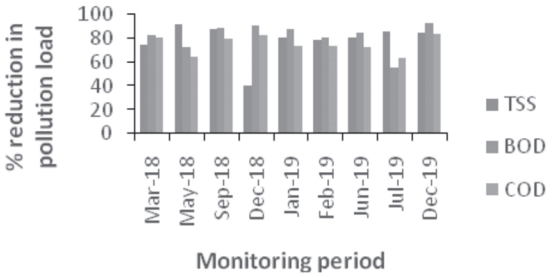


**Fig. 1.** Percentage reduction of Pollution Load in Naini STP

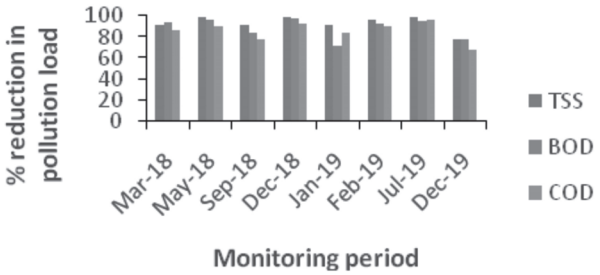


**Fig. 2.** Percentage reduction of Pollution Load in Numayadahi STP

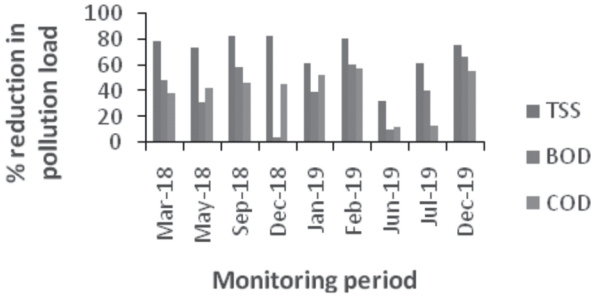


**Fig. 3.** Percentage reduction of Pollution Load in Salori STP (29 MLD)

***Naini STP-*** The quality of treated wastewater w.r.t. TSS, BOD and COD ranges between 16.5 – 46.5mg/L; 7.6-31.6 mg/L and 42.8-84.5mg/L respectively. The quality of effluent is meeting the discharge norms of CPCB except TC/FC on few occasions and BOD in month of July 2019.

***Numayadahi STP-*** The quality of treated wastewater w.r.t. TSS, BOD and COD ranges between 6.4 – 47.3mg/L; 5-16.2 mg/L and 10.3-69.3mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except TC/FC on few occasions.

***Salori STP-*** The quality of treated wastewater dischargedby Salori STP (29 MLD) w.r.t. TSS, BOD

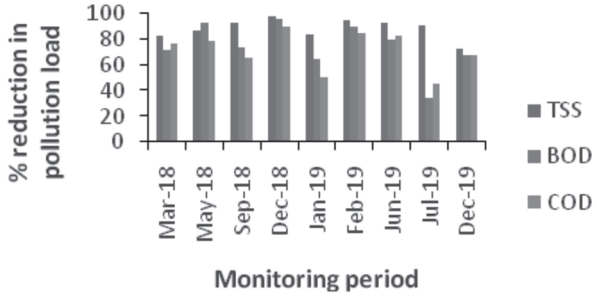


**Fig. 4.** Percentage reduction of Pollution Load in Salori STP (14 MLD)

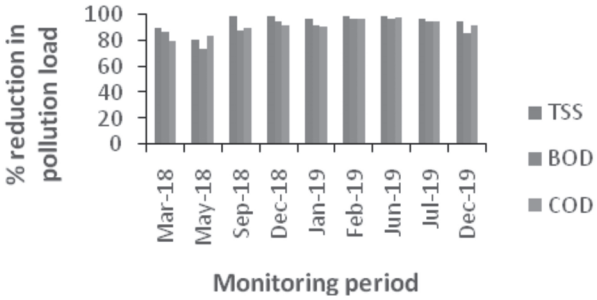


**Fig. 5.** Percentage reduction of Pollution Load in Rajapur STP

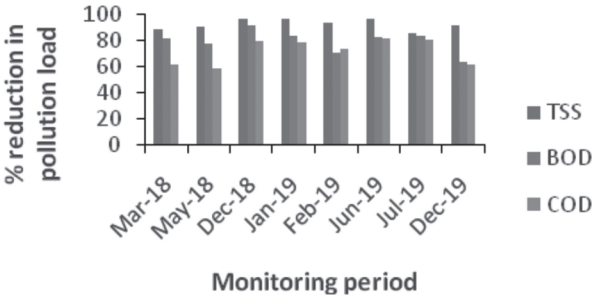


**Fig. 6.** Percentage reduction of Pollution Load in Kodra STP

and COD ranges between 34.2-79.6mg/L; 12.6-56.5 mg/L and 89.8-143.3mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except BOD and TC/FC on most of the occasions. The quality of treated wastewater discharged by Salori STP (14 MLD)w.r.t. TSS, BOD and COD ranges between 4.6-20.8mg/L; BDL-5.2 mg/L and 7.6-37.8mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except TC/FC on few occasions.

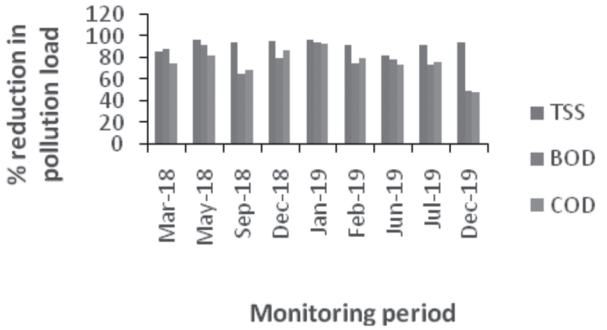


**Fig. 7.** Percentage reduction of Pollution Load in Ponghat STP

***Rajapur STP***- The quality of treated wastewater w.r.t. TSS, BOD and COD ranges between 9.8-25.4mg/L; 7.88-23.4 mg/L and 28.7-86.8mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except TC/FC on most of the occasions.

***Kodra STP***- The quality of treated wastewater w.r.t. TSS, BOD and COD ranges between 10.4-41.6mg/L; 4-27.7 mg/L and 15.3-90.2mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except TC/FC on most of the occasions.

***Ponghat STP-*** The quality of treated wastewater w.r.t. TSS, BOD and COD ranges between 7.35-53.4mg/L; 4-33.3 mg/L and 35.5-74.8mg/L respectively The quality of effluent is meeting the discharge norms of CPCB except TC/FC on most of the occasions. The pH levels are found to be constant for all monitoring at all seven STPs.

## Conclusion

Significant variation was found in influent/sewage quality among the all STPs during the study period. The average removal efficiency of TSS in these STPs are as Salori (14 MLD)>Numayadahi> Rajapur >Kodra>Ponghat>Naini>Salori(29MLD). The average removal efficiency of BOD in these STPs are as Salori (14 MLD)>Numayadahi>Naini>Rajapur> Kodra>Ponghat>Salori(29MLD) and the average removal efficiency of COD in these STPs are as Salori (14 MLD)>Numayadahi > Kodra > Naini > Rajapur>Ponghat>Salori (29MLD). On the basis of general overall efficiency approach, "14 MLD STP at Salori" which is based on Sequential Batch Reactor (SBR) treatment technology is ranked 1st with the actual general removal efficiency of 80.90–99.33% for TSS, 73.75–96.91% for BOD and 80.21–97.46% for COD. The ranking to the STPs is provided based on general removal efficiency obtained from the actual influent and effluent data sets. 29 MLD STP at Saloriwhich is based on Fluidized Aerobic Bio-reactor (FAB) Technology has the lowest actual removal efficiency of 32.11–82.98% for TSS, 3.55–66.22% for BOD and 12.11–57.73% for COD. In all the STPs the average reduction in TSS, BOD and COD is in the range of expected removal of 70-80% except Salori STP of 29 MLD in which the average reduction is 69.88, 39.69 and 40.36 % respectively, which is much below the expected removal of 70-80% indicating poor efficiency in terms of TSS, BOD and COD. Out of seven STPs only three STPs namely Nain, Numayadahi and Salori (14 MLD) has shown progressive improvement in control of Coliforms in treated sewage. The Chlorination system in all the STPs need to be upgraded so that the level of Coliforms in treated sewage shall be well within the prescribed standard. By providing the tertiary treatment, the treated wastewater quality for reuse and recycle of water can be achieved.

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