Performance Evaluation and Working Efficiency of Sewage Treatment Plant at Naini, Prayagraj

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Abstract

Wastewater treatment is an essential process to make water reusable. The multi-step process includes removal of grit, BOD and other important contaminants from incoming water. At 80 MLD Naini STP, activated sludge process is used to remove impurities from raw sewage and is then dumped into river Yamuna with industrial effluent standards. This experiment is based on physico-chemical parameters analysis of water samples from Naini 80 MLD STP. The aim of the experiment is to find out the working efficiency of the same treatment plant with industrial effluent standards by CPCB. Comparison of parameters with CPCB and BIS revealed that the treatment plant is working under prescribed standards. For both TSS and BOD, Naini STP worked as per satisfactory standards range.

Keywords: Wastewater treatment, Physico- Chemical Parameters, Performance evaluation

1.1 Introduction

Wastewater is described as the contaminated water that is obtained when freshwater is delivered to a community and serves its function. Domestic wastewater, in particular, contains enormous volumes of organic material that, if left unregulated and dumped into surface streams, can be dangerous to humans and the environment **(Gangulyet *al.* 2018).**

Sewage wastewater is a kind of wastewater that is created by a local area of individuals. It is described by volume or pace of stream, state of being, synthetic and harmful constituents, and bacterial status. Evaluation of amounts of sewage production is vital to guarantee its appropriate assortment, transport, treatment, removal, and reuse. Appraisal of amounts of sewage and its treatment is being done by Central Pollution Control Board (CPCB) now and again with State Pollution Control Boards/Pollution Control Councils and indigenous Bodies. Out of all the water used in a household, about 80 percent comes out as wastewater. In most situations, effluents are dumped into the environment, where it either sinks into the ground as a possible contaminant of ground water or is dumped into the natural drainage system, causing contamination in downstream regions **(CPCB, 2013).**

Sewage treatment removes pollutants or contaminants from municipal wastewater using a chain of processes to help significantly decrease BOD and therefore increase dissolved oxygen in treated water. Sewage treatment is done for both industrial purposes and household drinking purposes. Sewage Treatment Plants (STPs) are efficient measures for removing harmful contaminants from wastewater helping environment.

STPs can treat wastewater to the point that it is safe to reuse. Good maintenance of STPs using appropriate technology, as well as essential servicing on a regular basis, are essential for positive outcomes **(CPCB, 2013)**.

An urgent requirement for improving the water nature of the Indian waterways was acknowledged in the mid-eighties when the then Central Board for Prevention and Control of Water Pollution delivered discoveries of its basin-wide thorough examination on the degree of water pollution in the Ganga basin. Extreme exhaustion of water quality was explicitly seen in Kanpur, Prayagraj, Varanasi, Patna, Kolkata, and so on **CPCB (2021).**

In the first place, the primary treatment is the point at which the water moves through settling tanks or clarifiers, and the pollutants are eliminated. Lighter materials, similar to oil and oil, settle at the top and the heavier slime settles at the base. This cycle stops about 60% of suspended solids from the wastewater that comes through.

After the primary treatment, the water goes through secondary treatment, which is when wastewater is circulated air through, permitting microbes to separate natural poisons. This interaction is exceptionally successful, as it eliminates about 90% of suspended solids from the water.

In the last stage, tertiary treatment, wastewater is cleaned with chlorine or bright light before being delivered once again into the environment. When the water has been cleaned, it's customarily funnelled once more into waterways, lakes, and seas; however, in some cases, it could be recovered, which is the point at which it is reused for purposes that don't need filtered water, for example, watering fairways, rural water system, and surprisingly a portion of those fabulous drinking fountain shows.

2.1 Review of Literature

CPCB (2016) According to a recent assessment by the Central Pollution Board, which reviewed the operation of 152 sewage treatment plants (STP) scattered across 15 states. The data showed only around 66 percent of the STPs were utilizing the actual working treatment capacity. According to such research, a considerable amount of wastewater is not treated and is disposed of straight into rivers and streams, causing degradation.

Kamal (2007) stated that water quality, in general, refers to the components of water that must be available at desirable levels in order for plants and animals to flourish properly. Temperature, alkalinity, turbidity, dissolved oxygen(DO), and hardness are all significant elements in the growth of plants and animals in water bodies; however, biological oxygen demand(BOD) indicates the contamination impact on the water bodies.

Alkhamisi and Ahmed (2014) in their study concluded that with the shortage of freshwater accessible to agriculture, the necessity for treated wastewater in agriculture has grown. Treated wastewater is being used to irrigate public gardens and green strips in metropolitan areas in the majority of Gulf countries. These utilities' irrigation requirements differ across the year, but the supply of recovered water from sewage treatment plants is quite steady.

Dean (1953) discovered that 82.5 percent of the 1699 plants surveyed released wastewaters directly into streams or lakes, while 10.5 percent discharged them into storm sewers or surface drains. As a result, the wastewaters from 93 percent of the plants were subsequently released into watercourses untreated.

Srivastava (2011) studied different water samples collected different locations and analysed data for their physio-Chemical parameters. He analysed data through Agglomerative Cluster Analysis by grouping similar sites. The overall perspective of the water quality parameters of the analysed region indicated that the majority of the studied regions were found to be severely to extremely contaminated.

Kumar *et al.*(2010) a comparison research was performed, the efficiency of two treatment plants in Bangalore was examined, sludge activated process, and the treatment facilities were both incapable of treating significant amounts of dissolved solids identifying poor efficiencies.

3.1 Experimental Site:

The site for the experiment was set to be 80MLD Sewage Treatment Plant at Naini, Prayagraj STP at Naini is located near Yamuna River Bank. The treatment plant is provided with ASP treatment system for treatment of waste from Prayagraj city. The treated water is released from the plant for irrigation to Naini and Dandi areas.

Prayagraj city has been split into seven sewage districts A-G, according to the most current master plan for city development. The capacity of Naini STP is 80 MLD. It has surface aerator and air diffuser in which surface aerator contains 60 MLD capacity and air diffuser contain 20 MLD capacity of wastewater. By which wastewater get aerated and further used for treatment. As Naini plant was firstly has capacity of only 60 MLD by surface aerator after expansion of the city and population it require to expand the treatment plant then 20 MLD of air diffuser is attached to the Naini plant for getting the better result. The purpose of this study was to analyze the performance of sewage treatment plants using Activated Sludge Process + Chlorination technology. Personal visits and surveys, site monitoring, laboratory analysis, and discussions with plant personnel were used to acquire the necessary data and information.

3.2 Collection of Data

During the initial part of the research, information and data on plant units, how they function, sludge disposal, and so on were gathered for the Naini sewage treatment facility. The present sewage treatment plant performance was tested by collecting and analysing samples in their laboratories as well as at Environmental Science Laboratory at College of Forestry of SHUATS.

3.3 Collection of Samples and Analysis

The effluent water samples were taken using plastic bottles from each to be tested unit, that had been thoroughly cleaned before use. During collection of samples, any unwanted item was avoided to avoid contamination. The obtained samples were taken to the laboratory, where they were analysed. Units analysed under this study

- Raw sewage from Inlet (T1)
- Primary Sedimentation Tank (T2)
- Aeration cum Activated Sludge Chamber (T3)
- Secondary Sedimentation Tank (T4)
- Disinfection/ Chlorination (outlet) (T5)

The sampling and testing was done for 10 weeks,from 20thJanuary till end of March. Samples were collected every Wednesday of the week and testing was initiated the same day.

4.1 Results and Discussion

This study worked on overall efficiency of the Naini STP with 2 parameters i.e. BOD and TSS. This section further explains both of the parameters with all other parameters.

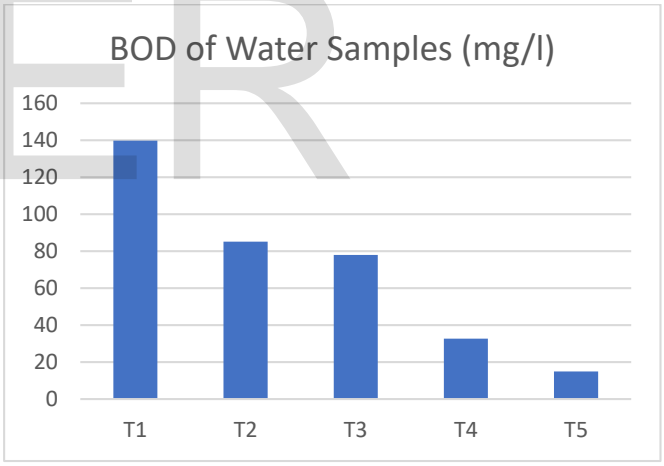

Figure 4.1.1: BOD (mg/l) of Sewage Water Samples Treated in Different Units of Sewage Treatment Plant, Naini, Prayaraj

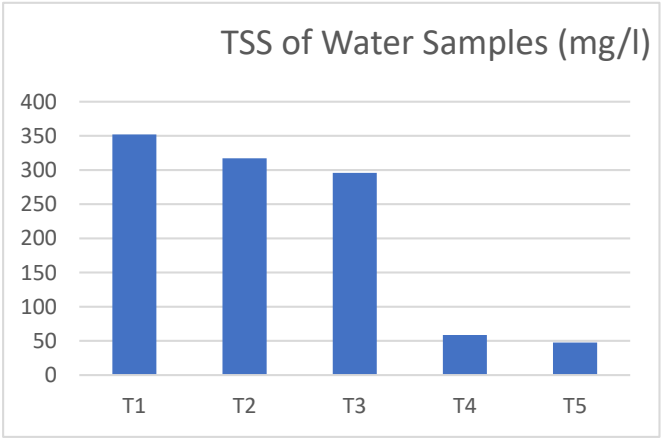

Figure 4.1.2: TSS (mg/l) of Sewage Water Samples Treated in Different Units of Sewage Treatment Plant, Naini, Prayaraj.

Table 4.1.3: Average values of Water Samples Treated in Different Units of Sewage Treatment Plant, Naini, Prayagraj

Sr. No.	Avg pH	Avg temperature (C*)	Avg EC (dSm^{-1})	Avg DO (mg/l)	Avg BOD (mg/l)	Avg Alkalinity (mg/l)	Avg Acidity (mg/l)	Avg Chlorides (mg/l)	Avg Hardness (mg/l)
Inlet (T1)	7.45	25.2	0.869	0.04	139.8	11.3	80.5	110.56	312.5
Outlet PST1 (T2)	7.54	25.15	0.783	0.09	85.2	11.3	77	107.10	315.5
Outlet ASP (T3)	7.44	24.80	0.743	0.32	78	11.4	97.5	106.58	324
Outlet PST 2 (T4)	7.60	25.47	0.429	0.83	32.7	11.3	79	103.87	305.5
Final outlet	7.61	25.86	0.288	1.25	15	10.9	50.5	108.63	302.5

Table 4.1.4: Prescribed Standards and Results of Water Samples Treated in Different Units of Sewage Treatment Plant, Naini, Prayagraj

SR. NO.	Parameters	Standards		Results	
		Surface Water Bodies	Irrigation	Inlet	Outlet
1.	pH	6.5-9.0	5.5-9.0	7.45	7.61
2.	TSS	<100	<200	352.13	44.55
3.	BOD	<30	<100	139.8	15
4.	Temperature	Should not exceed 5° from receiving body		25.2	25.86
5.	EC			0.869	0.288
6.	Alkalinity			11.3	10.9
7.	Acidity			80.5	50.5
8.	Hardness			312.5	302.5
9.	DO			0.04	1.25
10.	Chlorides			110.56	108.63

Table 4.1.4: Calculated Efficiency of Water Samples Treated in Different Units of Sewage Treatment Plant, Naini, Prayagraj

Sr No.	Parameters	Inlet	Outlet	Calculated Efficiency
1.	TSS	352.13	47.55	86.49%
2.	BOD	139.8	15	89.27%
3.	EC	0.869	0.288	66.85%
4.	Acidity	80.5	50.5	37.26%
5.	Alkalinity	11.3	10.9	3.5 %
6.	Chlorides	110.56	108.63	1.74%
7.	Hardness	312.5	302.5	3.2%

5.1 Summary

In this present research work on various physico-chemical parameters of water samples from Naini sewage treatment plant were analysed and results are summarised as below-

The pH of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 6.77 to 8.11. The pH ranges for various samples fell into the standard set range by CPCB and BIS.

The EC of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 0.19 dSm^{-1} to 0.92 dSm^{-1}. The EC ranges for various samples fell into the standards set range by CPCB and BIS.

The Total Soluble Solids of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 42 mg/l to 370.3 mg/l. The TSS ranges for various samples fell into the standard set range by CPCB and BIS.

The Dissolved Oxygen of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 0 mg/l to 4.9 mg/l. The TSS ranges for various samples fell into the standard set range.

The Biological Oxygen Demand of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 0 mg/l to 4.9 mg/l. The BOD ranges for various samples fell into the standard set range given by CPCB and BIS.

The Alkalinity of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 9 mg/l to 14 mg/l. The alkalinity ranges for various samples fell into the satisfactory category.

The Acidity of water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 0 mg/l to 245 mg/l. The Acidity ranges for various samples fell into the satisfactory category.

The amount of chlorides in water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 39.05 mg/l to 127.8 mg/l. The chlorides ranges for various samples fell into the satisfactory category.

The amount of hardness in water samples tested and collected from Naini 80 MLD sewage treatment plant ranges from 290 mg/l

to 355 mg/l. The hardness ranges for various samples fell into the satisfactory category.

5.2 CONCLUSION:

Based on various physic-chemical parameters analysed, it was concluded that the Naini 80 MLD STP is working under the prescribed standards as mentioned by CPCB and BIS. The overall efficiency of the Naini 80 MLD treatment plant was evaluated based on TSS and BOD and thus was found to be 87.88%.

The characteristics of water influent at inlet provided information that water at the inlet is highly polluted with BOD ranging from 90-168 mg/l, DO ranging from 0-0.2 mg/l with average total suspended solids at 225 mg/l.

The Naini sewage treatment plant was found to be working at higher efficiencies for TSS, BOD, and EC but apart from it, a lower range of efficiencies was found for acidity. There was not much remarkable effect of alkalinity, hardness, pH, and chlorides on treatment process.

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