

# Performance Evaluation of Sewage Treatment Plant Based on Activated Sludge Process

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## Abstract:

This study has been undertaken to assess the performance efficiency of a Sewage Treatment Plant (STP) of a Tractor making company located at MIDC, Hingna, Nagpur (Maharashtra). Existing STP is designed to operate on activated sludge - extended aeration process. this plant as per the dimensions is designed to treat sewage @ 270m<sup>3</sup>/d. Present average flow to the STP is 90m<sup>3</sup>/d. Sewage was analysed during the study for design parameters like BOD, solids besides pH, MLSS, Chemical Oxygen Demand (COD). Composite and grab samples were collected from each unit of STP every month for the six month-study period. Overall percentage removal efficiency in the COD & BOD was found to be 98.21% & 99.04% respectively on basis of inlet and outlet effluent quality. Total solids (TS), TDS,SS removal were 80.22%, 75.05% & 79.6% respectively. Overall removal efficiencies of all parameters were found to be satisfactory. All parameters (TS, TSS, TDS, BOD, and COD) were found to be within the permissible limit of Maharashtra Pollution Control Board (MPCB).

**Keywords:** Performance Evaluation, Sewage Treatment Plant, Removal efficiency.

## 1. Introduction:

The tractor plant under study has been operational in the industrial area near Nagpur for the past three decades. Besides installation of production units this multinational unit has taken precaution to provide a well-designed industrial wastewater treatment plant (ETP). In addition to this ETP, this unit has provided a separate sewage treatment plant (STP). Sanitary wastewater and washings from the kitchens is the "sewage" so far as this plant is concerned. It may be stated that MPCB does not permit mixing of sewage with industrial wastewater for combined treatment. As a result there are separate drainages for carrying process and sanitary wastewater/sewage.

Total number of workers in the factory is about 3000. Statutory requirement for drinking water supply to an industry is @ 50lpcd. About 20 percent water is consumed and 80litres is

considered as sewage/domestic wastewater. Water consumption in canteen depends on number of diners CPHEEO manual on wastewater treatment has indicated water consumption in hotels is @ 70litres/diner (as per CPCB manual). About 1000-1500 persons take food in the canteen in a day. Therefore STP must have been designed to treat total sewage/domestic wastewater @ 195m<sup>3</sup>/day (120m<sup>3</sup> sanitary waste+75m<sup>3</sup>kitchen waste).

Industrial activity/production is a function of demand of a product. Waste generation, liquid or solid depends on production. Performance of a waste treatment facility depends on the design criteria which in case STP are i) hydraulic loading, ii) volumetric loading, iii) hydraulic retention time, iv) F/M ratio, v) organic loading, etc. In turn costs of construction, mechanical and electrical facilities depend on the design criteria. Therefore it was decided to study the STP at the unit with respect to

the above, existing operational parameters, flows, etc.

Another objective of the study was to verify whether i) treated effluent quality consistently meets statutory requirements, ii) whether the treated effluent from STP can be suitably utilized after tertiary treatment in order that it can be used in the manufacturing process, iii) if yes a suitable process/plant can be suggested leading to conservation of water.

It needs to be mentioned here that the concerned plant is very conscious about water conservation and has already started using ETP treated effluent after tertiary treatment. Cost of water delivered at the industry is reported to be between Rs. 17 and 24/m<sup>3</sup>. Therefore this study would be useful for reducing recurring cost.

It was therefore decided by the company to conduct performance evaluation of STP. In this study present i) hydraulic loading, ii) volumetric loading, iii) hydraulic retention time, iv) F/M ratio, v) organic loading, etc. were calculated besides characterization of treated and un treated sewage.

## 2. Material and Methods:

### 2.1 Study Area:

This study has been carried out for STP of a tractor company located at MIDC, Hingna, Nagpur. Total area of the company is 179,966 sq.mt. Water is supplied to the company from MIDC, Hingna, Nagpur. About 120 m<sup>3</sup>/d water is required for domestic use and total generation of sewage from the tractor company is about 90m<sup>3</sup>/d. Quantity of water recovered after tertiary treatment during the study was between 65-75m<sup>3</sup>/d.

### 2.2 Requirements:

This study required collection of representative samples, preservation and estimation of various parameters. Necessary glassware, apparatus and facilities were cleaned, rinsed with de-mineralized water. Chemicals and reagents required for the analysis were of analytical reagent grade. Standard methods for analysis of wastewater were used.

### 2.3 Sample Collection and Preservation:

An existing STP at Hingna is operating on activated sludge - extended aeration system with a tertiary treatment plant where Activated Carbon

Filter unit is provided. The sewage samples were collected from each units of STP (at inlet, influent to equalization tank, Effluent to aeration, from aeration, effluent from SST, Final effluent) on monthly basis for a period of Aug-15 to Jan-16. Collection of samples was done in a plastic bottle. Before collecting the samples bottles were thoroughly cleaned with tap water. The sample bottle was then labelled and the pH was also analysed at site with pH paper. The effluent samples were preserved below 4°C until the analysis was over.

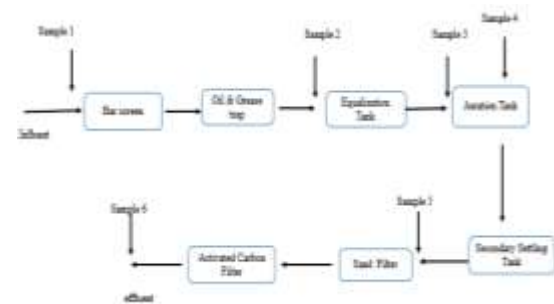


Fig. 1. Flow Chart of STP

### 2.4 Physico – chemical study:

The collected samples were analysed for pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Solids (TS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD)

## 3. Results and Discussion:

The experimental data on physico-chemical properties of samples collected from various units of STP is represented in the Table. No.1. In present study with an average flow of 90m<sup>3</sup>/d. By providing tertiary treatment the overall percentage removal efficiency in the COD & BOD was 98.21% & 99.04% respectively, whereas TS removal was 80.22%; TDS and TSS was 75.05% & 79.6% respectively. The efficiencies after biological treatment for COD and BOD were found to be 91% and

92% respectively, whereas TDS and TSS it was found to be 50% & 58% respectively.

The computation of design parameters for this system was carried out for rate of flow of 90m<sup>3</sup>/d taking inlet BOD 250mg/l in aeration tank as STP has aeration tank of specific capacity, by trial &

error of F/M (Food to Micro-organism) and MLSS (Mixed Liquor Suspended Solid) and all the parameters excluding HRT and volumetric loading rate was found within the design criteria for extended aeration activated sludge process. Volumetric loading found less than the design criteria whereas HRT is exceeding the limit.

Table No. 1 : Physico-chemical Properties

Physico-chemical parameter	Months	Samples						% Removal
		Sample 1 (inlet to STP)	Sample 2 (inlet to equalization tank)	Sample 3 (inlet to aeration)	Sample 4 (from aeration)	Sample 5 (outlet to SST)	Sample 6 (final effluent)	
pH	Aug-15	7.5	7.0	7.1	7.2	7.3	7.8	---
	Sep-15	7.0	6.9	7.1	7.0	6.6	6.8	---
	Oct-15	6.5	6.7	7.1	7.2	7.5	7.8	---
	Nov-15	6.6	6.2	7.2	7.2	7.5	7.8	---
	Dec-15	6.7	6.9	7.2	7.4	7.4	7.7	---
	Jan-16	6.5	6.8	7.3	7.4	7.5	7.6	---
TDS	Aug-15	600	800	600	800	800	510	15
	Sep-15	870	778	888	880	568	112	87.12
	Oct-15	780	792	655	694	358	108	86.15
	Nov-15	776	798	646	738	354	98	87.37
	Dec-15	774	800	648	740	356	98	87.33
	Jan-16	780	801	641	752	355	99	87.3
TSS	Aug-15	800	200	400	4000	200	20	97.5
	Sep-15	222	262	248	3010	128	68	69.36
	Oct-15	316	352	486	2956	336	74	76.58
	Nov-15	326	354	486	2900	338	76	78.65
	Dec-15	330	356	490	2904	340	80	75.75
	Jan-16	345	349	506	2952	346	70	79.7
COD	Aug-15	694	304	296	---	24	16	97.59
	Sep-15	576	920	520	---	52	8	98.61
	Oct-15	580	920	600	---	48	12	97.85
	Nov-15	528	960	680	---	44	8	98.48
	Dec-15	756	960	720	---	52	12	98.36
	Jan-16	701	945	694	---	61	11	98.4
BOD	Aug-15	266	101	118	---	10	3.2	98.79
	Sep-15	230.4	367.5	208	---	20.8	1.6	99.3
	Oct-15	224	306.6	240	---	99.6	2.6	98.8
	Nov-15	211.2	320	272	---	17.9	1.8	99.14
	Dec-15	294.4	320	288	---	21.22	2.7	99.08
	Jan-16	280.4	281.6	277.8	---	24.8	2.4	99.1

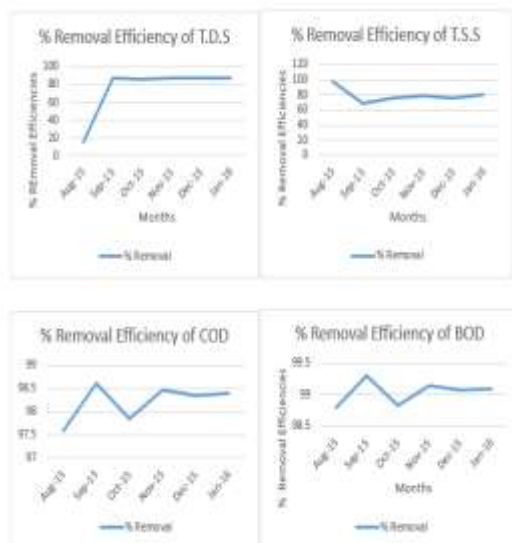


Fig. 2. Graphs showing % removal efficiencies of TDS, TSS, COD, BOD

#### 4. Conclusion:

Performance evaluation of existing STP has shown that treated effluent quality from STP has been consistently satisfactory in terms of BOD, COD, and suspended solids. Such treated effluent can be conveniently used as input to a quaternary treatment plant in case the company decides to utilise this water in the processes in the plant.

Options for quaternary treatment were treating the effluent after activated carbon column would be i) ion exchange or ii) reverse osmosis (RO). Presently plant is operating a RO unit to treat effluent generated from industrial wastewater treatment plant (ETP).

Therefore it has been suggested that a RO unit of appropriate configuration be considered so as to enable further recycle and reuse of wastewater @80m<sup>3</sup>/d.

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