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# ADEQUACY AND EFFICACY OF SEQUENCING BATCH REACTOR TREATMENT PLANT

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**Abstract**
The current analyses has been undertaken to measure the performance of 137 MLD Sewage Treatment Plant (STP) located at Kasna industrial area which is based on Sequencing Batch Reactor (SBR) process. Performance of this plant is an important parameter to be supervised as the treated waste is discharged into kasna drain. The Performance evaluation will also help for the improved understanding of design and operating problems (aeration, blowers, etc.) in Sewage Treatment Plant. Sewage samples were collected from dissimilar locations i.e. Inlet, at the time of aeration Chamber and Outlet of the Treatment Plant. Analysis for the main waste-water quality parameters, such as pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), (Total phosphorus) TP and (Total kjeldahl Nitrogen) TKN is done. The effluent treatment plant was found to be working adequately. Total process involved was Fill React Settle Draw and Idle. The overall efficiency for BOD is 95.56%, for COD it is 95.63%, for TSS it is 92.85, for TN it is 75.49 and for TP it is 73.68%.

**Keywords**: BOD,TP,TKN.

## Introduction
Greater Noida Industrial Development Authority, Greater Noida has placed order on M/s SSG Infratech Pvt.Ltd., for construction, erection and commissioning of 137 MLD capacity sewage treatment plant at Greater Noida.
The proposed treatment plant comprises of the following main process units
1. Stilling chamber
2. Mechanical fine screen channels
3. Manual fine screen channel
4. Mechanical grit chamber
5. C-Tech Basin
6. Chlorine contact tank
7. Sludge slump & pump house
8. Sludge dewatering system

### STILLING CHAMBER
Stilling chamber will receive raw sewage from the raw sewage pumping station. Stilling chamber is designed for average flow of 137 MLD with a peak factor of 2.Adequate RCC access platform with railing and staircase as per requirement shall be provided.

| | |
|---|---|
| Total average flow | : 137 MLD |
| Peak factor | : 2.00 |
| Design flow | : 274 MLD |
| Number of units | : 1 |
| Detention period | : 30 sec |
| Min free board | : 0.5 m |

## FINE SCREEN CHANNELS

Three mechanical working with one manual standby screens are proposed in the screen chamber. Each screen channel shall be designed for peak flow capacity. The clear opening for mechanical screen shall be 2mm and shall be 6mm for manual screens. The mechanical screens are with 2mm thick bar and manual bar screens shall be of 6mm thick stainless steel (SS 304) flats. Conveyor Belt and chute arrangement shall be provided to take the screenings to the screenings dropped from chute will be collected in a wheel burrow. Gates are provided at the upstream and downstream ends to regulate the flow.

Total average flow : 137 MLD
Peak Factor : 2.00
Design flow : 274 MLD
Number of units : 3 mechanical +1 manual
Approach velocity at average flow (m/sec) : 0.3
Velocity through screen at average flow (m/sec) : 0.6 maximum
Velocity through screen at peak flow (m/sec) : 1.2 maximum
Min free board : 0.5 m

## GRIT CHAMBER

Four mechanical grit chambers (detritus) are provided after fine screen units. Detritus tank chamber shall have the following:

- One tapered inlet channel running along the one side with deflectors for entry sewage into the grit chamber.
- One tapered outlet channel for collecting the de-gritted sewage, which overflows over a weir into the outlet channel of adequate size and shape to ensure that no settling takes place.
- One sloping grit classifying channel into which the collected grit will be classified.
- The grit from the classifier will be collected in a wheeled trolley.
- A grit scrapping mechanism.
- Adjustable influent deflector.
- Reciprocating mechanism to remove the grit.
- Organic matter return pump.

Gates shall be provided at the entrance of chamber. To enable easy operation of the gates, RCC platforms with railing shall be provided at the upper level.

Total average flow : 137 MLD
Design peak flow : 274 MLD
Peak factor : 2.00
No. of units : 4 mechanical
Size of grit particle : 0.15 mm
Specific gravity of grit : 2.5
Maximum Surface Overflow Rate: 960 $m^3/m^2$/day
Free Board : 0.3m

## C-TECH BASINS

The biological treatment section comprising cyclic activated sludge process for average flow of 137 MLD.

## CHLORINATION SYSTEM

Treated sewage from the C tech outlet shall be taken to chlorine contact tank. Chlorine Contact Tank shall be provided for dosing of chlorine.

Design Flow : 137 MLD or Decant Flow whichever is more
No. of units : 1 no.
Detention time in CCT: 20 min of average flow
Freeboard : 0.5
Number of Chlorinator: 2 (1W + 1S)

Type : Vacuum type
Chlorine Dosing : 3 ppm max.
Capacity of Chlorinator: 18 kg/h

## SLUDGE SUMP & PUMP HOUSE

Sludge sump shall be provided to collect the excess sludge from Cyclic Activated Sludge Process. There is one common sludge sump for all basins. The sump shall be equipped with coarse bubble air grid made from HDPE/PVC pipes and Air Blower Assembly to facilitate mixing of contents of sludge sump on continuous basis.

Number of Units : 1 no.
Free Board : 0.5 m
Detention time : 4 h
Air Mixing Rate : 1.2 $m^3/h/m^3$ of liquid volume

## MECHANICAL DEWATERING UNIT

The mechanical dewatering units are designed so as to give a 100 % trouble free operation at all times.

- The dewatering system is located at first floor so that the de-watered sludge can be collected into trolleys/ drums /bins directly without requirement of another material handling unit.
- The de-watered sludge is truck-able & suitable for disposal by open body truck

No. of units : 6 nos. (5 working+1 standby)
Operating Hours : 20 hrs per day maximum
Poly Dosing Rate : 1.5 kg/

## PROCESS AND HYDRAULIC DESIGN

### Inlet chamber

Number of units =1
Designed for = Peak flow
=11416.7
=3.172 $m^3$/sec
Hydraulic Retention Time (HRT) at peak flow = 30 sec
Volume of tank =peak flow ×HRT
=3.172×30
=95.2 $m^3$
Side water depth, SWD =3.50 m
Width =7.30m
Length =4.00m
Providing stilling chamber of size 7.3m × 4m × 3.5m

### Fine screens

Total working screens = 3
Total standby screens =1
Total number of screens =4
Fine screen – Mechanical
Designed for =peak flow
=11416.7$m^3$/h
=3.172$m^3$/sec
Average flow =5708.3$m^3$/h
=1.5806 $m^3$/sec
Number of mechanical screens =1
Provided screen channel of size 1.6m wide ×1.5 depth × 8m long
Velocity in channel at average flow = average flow / cross sectional area of screen channel
=0.529/ (1.6×1.5)
=0.3 m/sec
>3 OK

Fine screen –Manual

| | |
|---|---|
| Designed for | =Peak flow |
| | =3805.6$m^3$/h |
| | =1.057$m^3$/sec |
| Average flow | =1902.8$m^2$/h |
| | =0.5287$m^3$/sec |
| Number of mechanical screens | =1 |
| Design flow in each screen | =1.0573/1 |
| | =1.0573$m^3$/sec |
| Average flow in each screen | =0.5287/1 |
| | =0.5287$m^3$/sec |
| Velocity through screen at peak flow | =1 m/sec |
| Velocity through screen at average flow | =0.50 m/sec |

Provide screen channel of size 1.6m wide × 1.5m depth ×8m long

| | |
|---|---|
| Velocity in channel at average flow | =Average flow/cross sectional area of screen channel |
| | =0.5287/ (1.6×1.5) |
| | =0.3 m/sec |
| | >0.3 OK |

### Grit chamber

| | |
|---|---|
| Number of working units | = 4 |
| Number of standby units | = 0 |
| Number of units to be provided | = 4 |
| Designed flow | = Peak flow |
| | = 11416.7 $m^3$/h |
| | =274001 $m^3$/day |
| Designed flow for each grit chamber | =274001/4 |
| | =68501 $m^3$/day |
| Considering over flow rate as | =960 $m^3/m^2$/day |
| Area of grit chamber required | =68501/960 |
| | =71.36 $m^2$ |
| Size of grit chamber required | =8.45 m |
| Size of grit chamber provided | =8.50 m |
| Detention time in grit chamber | = 60 sec |
| Volume of grit chamber required | =0.793 × 60 |
| | =47.58 $m^3$ |
| Depth required | =47.58 / (8.5×8.5) |
| | = 0.66 m |
| Grit storage depth | =0.30 m |
| Total depth required | =0.96 m |
| Depth provided | =1 m |

Provide grit chamber of size 8.5 m × 8.5 m × 1 m

### 3.2.4 Chorine contact tank

| | |
|---|---|
| Number of unit | = 1 |
| Average flow | =5708.34 $m^3$/h |
| Decanting flow | =5708.34 $m^3$/h |
| Hydraulic Retention time (HRT) | =20 min |
| Volume of chlorination tank | =Flow ×HRT |
| | =1902.78 $m^3$ |
| Providing length of tank | =38 m |
| Width of Tank provided | =26 m |

Volume provided =1976 m
Total depth of chlorine contact tank =2.5 m
Providing chlorine contact tank of size 38 m × 26 m × 2m
SAMPLING Schedule
A total number of 30 samples were collected and analyzed for the period of March and April. Samples were collected from various unit of treatment plant such as raw water at inlet basin, from the SBR tank at the time of aeration and at chlorine contact tank (outlet basin) from the sequencing batch reactor located at Kasna industrial area.
SAMPLE 1: Raw water at inlet basin
SAMPLE 2: From the SBR tank at the time of aeration
SAMPLE 3: From the Chlorine contact tank

**Experimental work:**

The study was carried out within a period of March to April. The samples were collected and experimented. The results were not having much variations so can be considered of homogenous nature.

**Table - Results Of Sample**

| DATE | SAMPLE | PARAMETERS | | | | | |
|---|---|---|---|---|---|---|---|
| | | pH | BOD (mg/l) | COD (mg/l) | TSS (mg/l) | TN (mg/l) | TP (mg/l) |
| 2.3.2015 | 1 | 6.9 | 138 | 416 | 140 | 8 | 4.4 |
| | 2 | - | 85 | 255 | 116 | - | - |
| | 3 | 7.2 | 7 | 17 | 12 | 1.4 | 0.8 |
| 18.3.2015 | 1 | 7 | 140 | 326 | 147 | 7.2 | 4.3 |
| | 2 | - | 83 | 245 | 125 | - | - |
| | 3 | 7.3 | 5 | 16 | 10 | 1.6 | 0.9 |
| 26.3.2015 | 1 | 7.3 | 147 | 441 | 145 | 7.5 | 4.2 |
| | 2 | - | 86 | 257 | 125 | - | - |
| | 3 | 7.5 | 6 | 19 | 9 | 1.8 | 1 |
| 1.4.2015 | 1 | 6.8 | 149 | 448 | 149 | 8 | 4.8 |
| | 2 | - | 90 | 265 | 129 | - | - |
| | 3 | 7.2 | 8 | 21 | 11 | 1.6 | 0.8 |
| 6.4.2015 | 1 | 7 | 150 | 451 | 153 | 7.7 | 4.6 |
| | 2 | - | 90 | 269 | 131 | - | - |
| | 3 | 7.3 | 6 | 17 | 9 | 1.8 | 0.9 |
| 9.4.2015 | 1 | 6.9 | 140 | 420 | 143 | 7.2 | 4.4 |
| | 2 | - | 85 | 255 | 120 | - | - |
| | 3 | 7.3 | 7 | 17 | 9 | 1.5 | 0.9 |
| 14.4.2015 | 1 | 7 | 120 | 365 | 128 | 6 | 2 |
| | 2 | - | 80 | 246 | 102 | - | - |
| | 3 | 7.2 | 5 | 16 | 10 | 1.6 | 0.8 |
| 17.4.2015 | 1 | 6.8 | 125 | 391 | 126 | 6.1 | 2.5 |
| | 2 | - | 84 | 241 | 97 | - | - |
| | 3 | 7.3 | 6 | 15 | 10 | 1.8 | 0.8 |
| 22.4.2015 | 1 | 7 | 131 | 401 | 131 | 6.2 | 2.6 |
| | 2 | - | 97 | 289 | 100 | - | - |
| | 3 | 7.2 | 5 | 18 | 90 | 1.9 | 0.8 |
| 27.4.2015 | 1 | 6.9 | 135 | 409 | 132 | 6.6 | 2.7 |
| | 2 | - | 110 | 320 | 101 | - | - |
| | 3 | 7.1 | 6 | 21 | 11 | 2 | 1.1 |

### 5.2.1 Biochemical Oxygen Demand Removal Efficiency.

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water. BOD can be used as a gauge of the effectiveness of wastewater treatment plants. BOD of collected sample varies between 120-150 mg/L at the inlet and 5-8 mg/L at the outlet.

**Table - BOD Removal Efficiency**

| DATE | INLET (mg/l) | OUTLET (mg/l) | EFFICIENCY |
|---|---|---|---|
| 2.3.2015 | 138 | 7 | 94.92 % |
| 18.3.2015 | 140 | 5 | 96.42 % |
| 26.3.2015 | 147 | 6 | 95.91 % |
| 1.4.2015 | 149 | 8 | 94.63 % |
| 6.4.2015 | 150 | 6 | 96 % |
| 9.4.2015 | 140 | 7 | 95 % |
| 14.4.2015 | 120 | 5 | 95.83 % |
| 17.4.2015 | 125 | 6 | 95.2 % |
| 22.4.2015 | 131 | 5 | 96.18 % |
| 27.4.2015 | 135 | 6 | 95.55 % |

### Chemical Oxygen Demand Removal Efficiency

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. Chemical oxygen demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid ($H_2SO_4$). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay. The COD values of the samples in the study area were in the range 326-451 mg/L at inlet and 15-21 mg/l at outlet.

**Table - COD Removal Efficiency**

| DATE | INLET (mg/L | OUTLET (mg/L) | REMOVAL EFFICIENCY |
|---|---|---|---|
| 2.3.2015 | 416 | 17 | 95.91 % |
| 18.3.2015 | 326 | 16 | 95.09 % |
| 26.3.2015 | 441 | 19 | 95.69 % |
| 1.4.2015 | 448 | 21 | 95.31 % |
| 6.4.2015 | 451 | 17 | 96.23 % |
| 9.4.2015 | 420 | 17 | 95.95 % |
| 14.4.2015 | 365 | 16 | 95.61 % |
| 17.4.2015 | 391 | 15 | 96.16 % |
| 22.4.2015 | 401 | 18 | 95.51 % |

| | | | |
|---|---|---|---|
| 27.4.2015 | 409 | 21 | 94.86 % |

Total Suspended Solids Removal Efficiency

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns (average filter size) is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration. These solids include anything drifting or floating in the water, from sediment, silt and sand. Even chemical precipitates are considered a form of suspended solids. Total suspended solids are a significant factor in observing water clarity.

Some suspended solids can settle out into sediment at the bottom of a body of water over a period of time. Heavier particles, such as gravel and sand, often settle out when they enter an area of low or no water flow. Although this settling improves water clarity, the increased silt can smother benthic organisms and eggs. The remaining particles that do not settle out are called colloidal or nonsettleable solids. These suspended solids are either too small or too light to settle to the bottom. TSS of the collected samples varies between 126-153 mg/L at inlet and 9-12 mg/L at outlet.

**Conclusion**

Sewage treatment plant using the SBR technology is among the finest techniques and it provides a virtuous efficiency which includes removal of BOD, COD, TSS, Nitrogen, Phosphorus and pH. On the other hand it is economic as well. This treatment technology is used where the type of sewage is rich in nutrients like BOD, COD, TSS, pH, Nitrogen and Phosphorus.

This study basically revolves the efficacy of the whole treatment plant, which includes a FILL, REACT, SETTLE, DRAW and IDEL stages of the treatment plant. The major criteria in this treatment are removal of BOD, removal of nitrates and phosphates. The higher efficiency is due to the proper maintenance of aeration equipment’s (blowers and diffused aerators).

On the basis of laboratory investigation and the operating statistics of sewage treatment plant, the following conclusion has been drawn.

- Average BOD at inlet is 137.5 mg/L with maximum of 150 mg/L and minimum of 120mg/L. After the advance treatment, average BOD at outlet is 6.1 mg/L with maximum of 8 mg/L and minimum of 5 mg/L. The overall BOD removal efficiency is 95.56 %.
- Average COD at inlet is 406.8 mg/L with maximum of 451 mg/L and minimum of 326 mg/L respectively. After the advance treatment, average BOD at outlet is 17.7 mg/L with maximum of 21 mg/L and minimum of 15 mg/L. The overall BOD removal efficiency is 95.63 %.
- Average TSS at inlet is 139.4 mg/L with maximum of 153 mg/L and minimum of 126 mg/L respectively. After the advance treatment, average TSS at outlet is 10 mg/L with maximum of 12 mg/L and minimum of 9 mg/L. The overall BOD removal efficiency is 92.85 %.

**Recommendations for future work:**

The work can be further carried out in any other technology Activated sludge process, flow anaerobic sludge blanket reactor and comparison can be done.

- For a similar type of sewage any other technology can be used and can be compared with the SBR

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