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Performance Evaluation of 137 MLD Sewage Treatment Plant at Kasna – U.P., INDIA

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Abstract*— These The present study has been undertaken to assess the performance of 137 MLD Sewage Treatment Plant (STP) located at Kasna, Greater Noida, Gautam Buddha Nagar, Uttar Pradesh which is based on Sequential Batch Reactor (SBR) process. Performance of this plant is a necessary factor to be monitored as the treated effluent is used for irrigation and drinking purposes. The Performance evaluation will also help for the improved understanding of design in Sewage Treatment Plant. Sewage samples were collected from Inlet and Outlet of the Treatment Plant and analyzed for the major waste-water quality parameters, such as pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and Total Nitrogen. Actual efficiency of the 137 MLD STP will be assessed by collecting samples for the period of 1 month (1st Dec. 2015 to 31st Dec 2015). The conclusions of these evaluations will determine whether the effluent discharged is under limits given by CPCB. The conclusions drawn from this study will outline the need for continuous monitoring and performance analysis by removal efficiencies of each and every unit of STP.

***Index Terms*—STP, SBR, BOD, COD, TSS, Nitrogen, pH, Efficiency, Specification, Inlet and Outlet.**

I. INTRODUCTION

Now a day's one of the largest sources of pollution is Municipal waste water and hence before being released into the environment it should be treated. The higher the level of treatment provided by a wastewater treatment plant, the cleaner the effluent and the smaller the impact on the environment [1]. The treated waste water discharged into surface waters may contain some pollutant despite of being treated. From an environmental point of view all process, product or services must also be analyzed and hence the overall pollution associated to any activity should also be analyzed [2]. The most of the problem related water quality is due to rapid growth and urbanization over past few decades [3]. In India maximum of the population are suffering from various water and wastewater issues and many water related health hazards. Therefore the construction of sewage treatment plants nearly everywhere in India is necessary to protect human health and environment. The main purpose of the construction of sewage treatment plant is to reduce the degradation of water quality of the receiving water bodies by reducing the total pollution load on the same and to ensure a healthy environment both aesthetically along with preserving the ecosystem [4]. Due to lack of sewage treatment plants at many places within the country the undesirable water is taken up by the human beings as well as by animal which causes health hazards and sometime death. Sometimes this unwanted water is also used for irrigation which can cause adverse effect to the agriculture process. The treatment of waste water is a multilevel process in which the waste water is passed through many individual units. The first unit in the sewage treatment plant is screens which are used to remove the large objects such as rags and plastics. They are mainly of 3 types of screens-coarse, medium and fine which are used depending upon the type of waste water. Grit chamber can also be used as a primary unit in treating the water containing large amount of inorganic solids such as sand, cinders and gravel which are collectively called grit. The STP at Kasna consists of both screens and grit chamber as the influent consist lots of fine sand. The waste water at Kasna STP plant reaches directly to one of the six SBR tank from the grit chamber. At the plant there is no water or wastewater storage tank such as equalization tank. The water enters from the screens and after treatment from SBR tank it is driven for chlorination at the end. The final effluent after chlorination is used for different purposes.

II. SEWAGE TREATMENT PLANT AT KASNA

The sewage treatment plant at Kasna is designed for a input of 137MLD on average basis but at peak flow it can handle up to 274MLD of waste water which is just double for which it is designed. Hence the peak factor is 2. At present the plant is receiving the waste water mainly from two places that are Gautam Buddha University and MPS (main pumping station near Honda). The plant consists of mainly 4 individual units that are screens, grit chamber, SBR and chlorination tank. The first and the primary unit of the plant is screens which is used to remove organic matters such as plastic, rags, large objects etc. The screens used are fine and are 4 in number in which 3 works automatically and 1 mechanically. After the screen the water flows through the grit chamber which is used to remove the inorganic matter such as fine sand. Grit chambers are generally designed as long channels. In these channels the velocity is reduced sufficiently to deposit heavy inorganic solids but to retain organic material in suspension. The water from the grit chamber is received by Sequencing Batch Reactors. The plant at Kasna consists of 6 SBR units.

A. Sequencing Batch Reactor

A treatment process that operates in repetitive cycles of sequenced aeration, settling, decant phase to treat batches of waste water. Sequencing batch reactor (SBR) is a fill-and-draw activated sludge treatment system. Although the processes involved in SBR are identical to the conventional activated sludge process, SBR is compact and time oriented system, and all the processes are carried out sequentially in

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the same tank. SBR system is the upgraded version of the conventional activated sludge process, and is capable of removing nutrients from the wastewater [5]. The essential difference between the SBR and the conventional continuous flow activated sludge system is that SBR carries out functions such as equalization, aeration and sedimentation in a time rather in a space sequence [5].

B. Operating Principal

Phase 1: The phase is called as FILL in which the waste water enters the tanks. The Biomass (MLSS) which is remained from the previous cycle is mixed with the influent. At Kasna plant aerated FILL is used which results in aerobic reactions. Aeration can be regulated to maximize co-current nitrification-dinitrification that takes place and to insure the aerobic uptake of phosphorous previously released during anaerobic operation.

Phase 2: This phase is known as REACT phase in which the air is still on but the influent in the reactor basin is stopped. Aeration is used to increase the aerobic sludge age for efficient pollutant removal. High dissolved oxygen concentration is maintained in this phase. To achieve the desired level of effluent quality sufficient time should be allocated for react phase. More than 50% of the total cycle time is taken up by this phase. Biological/chemical oxygen demand (BOD/COD) and ammonia nitrogen (NH3) are reduced under aerated conditions while NOX is reduced under anoxic conditions.

Phase 3: This phase is termed as SETTLE phase. In this phase air is turned off and the influent in the reactor basin is stopped. During the first five minutes in this phase, the residual mixing energy within the reaction basin is consumed. At this time gentle bio-flocculation initially takes place, a solid-liquid interface forms under partial hindered settling conditions. Rising sludge does not occur.

Phase 4: This the last phase of the operation known as DECANT phase which is an extension of above phase where a moving weir lowering decanter is used to take operating liquid level in a basin to its designated bottom water level reference position. In this way supernatant is withdrawn under laminar flow condition. This allows optimum removal over decant depth without entrainment of settle solids or floating debris. After completion of supernatant liquid removal, the moving weir decanter returns to it's out of liquid rest position. Typically, FILL phase begins while the decanter is travelling to upper rest position.

C. Specification of Plant

1. Capacity of plant: 137MLD
2. BOD considered at inlet: 85 mg/l (avg.)
3. Screens
   - Type : mechanically cleaned bar screen
   - No. of bar screens: 4
   - Size of screens: 8.0m × 1.6m × 1.5m SWD
   - Inclination of screens:60O to horizontal with 20mm spacing between bars
4. No. of reactors: 6
5. Size of reactors:70.0m × 34.0m × 5.2m + 0.5FB
6. In FILL phase influent is filled up to: 4.7m to 5m
7. Decant is up to: 4m
8. The total time for completion of one cycle: 4 hours
   - Fill phase: 1 hour
   - React phase: 1 hour
   - Settle phase: 1 hour
   - Decant phase: 1 hour
9. No. of cycle on daily basis:
10. The 137MLD plant produces an effluent with following parameters limits:
    - BOD: ≤10mg/l
    - COD: ≤100mg/l
    - pH: 6.5-8
    - TSS: ≤10mg/l
    - Total Nitrogen: ≤2mg/l

III. OBSERVATIONS

The observed values at the inlet of five parameters are given below in Table I.

TABLE I. OBSERVED VALUE OF 5 PARAMETERS FROM SAMPLE-DAILY (1ST DEC TO 31ST DEC 2015)

Date	pH	BOD	COD	TSS	NITROGEN
		mg/l	mg/l	mg/l	mg/l
01-12-2015	7.73	80.4	200	121	19.7
02-12-2015	7.71	76.8	184	98	17.5
03-12-2015	7.74	79.4	192	127	18.3
04-12-2015	7.79	81.1	224	152	19.8
05-12-2015	7.78	65.8	144	75	17.6
06-12-2015	7.79	86.4	224	183	18.1
07-12-2015	7.71	78.7	192	123	19.8
08-12-2015	7.75	80.4	208	155	18.5
09-12-2015	7.77	84.2	224	165	17.6
10-12-2015	7.72	76.8	184	121	19.7
11-12-2015	7.71	79.5	192	105	20.1
12-12-2015	7.79	75.9	184	98	20.4
13-12-2015	7.7	80.3	192	115	18.6
14-12-2015	7.71	82.5	208	124	18.4
15-12-2015	7.77	81.3	232	147	19.7
16-12-2015	7.71	78.6	184	97	18.4
17-12-2015	7.77	82.7	216	152	18
18-12-2015	7.7	88.4	208	105	17.3
19-12-2015	7.89	81.1	200	178	18.4
20-12-2015	7.84	94.8	248	184	18.8
21-12-2015	7.71	82.3	200	151	20.4
22-12-2015	7.74	79.3	192	97	19.7
23-12-2015	7.7	80.4	200	98	17.6
24-12-2015	7.78	82.6	220	114	18.4
25-12-2015	7.77	86.1	216	145	19.2
26-12-2015	7.55	71.5	152	95	18.6
27-12-2015	7.81	95.3	256	248	19.8
28-12-2015	7.71	81.1	216	122	18.7
29-12-2015	7.73	84.5	224	157	20.5
30-12-2015	7.79	88.7	232	178	19.5
31-12-2015	7.74	86.4	224	167	18.7

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IV. RESULTS

Based on the laboratory analysis, the inlet and the outlet values of all the parameters have been identified through which the removal efficiency of each parameter have been calculated.

TABLE II. BOD REMOVAL EFFICIENCY

DATE	Inlet (mg/l)	Outlet(mg/l)	Efficiency
01-12-2015	80.4	8.1	89.92537
02-12-2015	76.8	7.7	89.97396
03-12-2015	79.4	7.9	90.05038
04-12-2015	81.1	8.0	90.13564
05-12-2015	65.8	7.3	88.90578
06-12-2015	86.4	7.9	90.85648
07-12-2015	78.7	8.0	89.83482
08-12-2015	80.4	7.7	90.42289
09-12-2015	84.2	8.2	90.26128
10-12-2015	76.2	7.9	89.71354
11-12-2015	79.5	7.5	90.56604
12-12-2015	75.9	7.3	90.38208
13-12-2015	80.3	8.1	89.91283
14-12-2015	82.5	7.8	90.54545
15-12-2015	81.3	7.7	90.52891
16-12-2015	78.6	8.4	89.31298
17-12-2015	82.7	7.5	90.93108
18-12-2015	88.4	7.2	91.8552
19-12-2015	81.1	8.0	90.13564
20-12-2015	94.8	8.3	91.24473
21-12-2015	82.3	7.0	91.49453
22-12-2015	79.3	8.4	89.40731
23-12-2015	80.4	7.7	90.42289
24-12-2015	82.6	7.5	90.9201
25-12-2015	86.1	7.2	91.63763
26-12-2015	71.5	8.1	88.67133
27-12-2015	95.3	8.3	91.29066
28-12-2015	81.1	7.8	90.38224
29-12-2015	84.5	7.5	91.12426
30-12-2015	88.7	7.2	91.88275
31-12-2015	86.4	8.1	90.625

TABLE III. TSS REMOVAL EFFICIENCY

Date	Inlet(mg/l)	Outlet(mg/l)	Efficiency
01-12-2015	121	7	94.21488
02-12-2015	98	6	93.87755
03-12-2015	127	6	95.27559
04-12-2015	152	7	95.39474
05-12-2015	75	6	92
06-12-2015	183	7	96.17486
07-12-2015	123	8	93.49593
08-12-2015	155	7	95.48387
09-12-2015	165	7	95.75758
10-12-2015	121	7	94.21488
11-12-2015	105	7	93.33333
12-12-2015	98	6	93.87755
13-12-2015	115	7	93.91304
14-12-2015	124	7	94.35484
15-12-2015	147	7	95.2381
16-12-2015	97	6	93.81443
17-12-2015	152	7	95.39474
18-12-2015	105	6	94.28571
19-12-2015	178	6	96.62921
20-12-2015	184	7	96.19565
21-12-2015	151	8	94.70199
22-12-2015	97	7	92.78351
23-12-2015	98	6	93.87755
24-12-2015	114	6	94.73684
25-12-2015	145	7	95.17241
26-12-2015	95	6	93.68421
27-12-2015	248	7	97.17742
28-12-2015	122	7	94.2623
29-12-2015	157	7	95.5414
30-12-2015	178	6	96.62921
31-12-2015	167	7	95.80838

TABLE IV. COD Removal Efficiency

Date	Inlet(mg/l)	Outlet(mg/l)	Efficiency
01-12-2015	200	36	82
02-12-2015	184	24	86.95652
03-12-2015	192	24	87.5
04-12-2015	224	32	85.71429
05-12-2015	144	24	83.33333
06-12-2015	224	32	85.71429
07-12-2015	192	36	81.25
08-12-2015	208	32	84.61538
09-12-2015	224	36	83.92857
10-12-2015	184	36	80.43478
11-12-2015	192	36	81.25
12-12-2015	184	30	83.69565
13-12-2015	192	32	83.33333
14-12-2015	208	32	84.61538
15-12-2015	232	36	84.48276
16-12-2015	184	30	83.69565
17-12-2015	216	32	85.18519
18-12-2015	208	32	84.61538
19-12-2015	200	32	84
20-12-2015	248	36	85.48387
21-12-2015	200	32	84
22-12-2015	192	36	81.25
23-12-2015	200	32	84
24-12-2015	220	30	86.36364

25-12-2015	216	24	88.88889
26-12-2015	152	32	78.94737
27-12-2015	256	40	84.375
28-12-2015	216	36	83.33333
29-12-2015	224	36	83.92857
30-12-2015	232	32	86.2069
31-12-2015	224	36	83.92857

TABLE V. **Total Nitrogen Removal efficiency**

Date	Inlet(mg/l)	Outlet(mg/l)	Efficiency
01-12-2015	19.7	0.8	95.93909
02-12-2015	17.5	0.7	96
03-12-2015	18.3	0.9	95.08197
04-12-2015	19.8	0.6	96.9697
05-12-2015	17.6	0.8	95.45455
06-12-2015	18.1	0.7	96.1326
07-12-2015	19.8	0.9	95.45455
08-12-2015	18.5	0.7	96.21622
09-12-2015	17.6	0.9	94.88636
10-12-2015	19.7	0.6	96.95431
11-12-2015	20.1	0.9	95.52239
12-12-2015	20.4	0.7	96.56863
13-12-2015	18.6	0.8	95.69892
14-12-2015	18.4	0.6	96.73913
15-12-2015	19.7	0.9	95.43147
16-12-2015	18.4	0.7	96.19565
17-12-2015	18	0.5	97.22222
18-12-2015	17.3	0.7	95.95376
19-12-2015	18.4	0.9	95.1087
20-12-2015	18.8	0.7	96.2766
21-12-2015	20.4	0.9	95.58824
22-12-2015	19.7	0.6	96.95431
23-12-2015	17.6	0.8	95.45455
24-12-2015	18.4	0.5	97.28261
25-12-2015	19.2	0.9	95.3125
26-12-2015	18.6	0.8	95.69892
27-12-2015	19.8	0.9	95.45455
28-12-2015	18.7	0.9	95.18717
29-12-2015	20.5	0.7	96.58537
30-12-2015	19.5	0.8	95.89744
31-12-2015	18.7	0.9	95.18717

V. CONCLUSION

From the study above it is concluded that:
The average inlet BOD in the plant is 81.71mg/l and average outlet BOD is 7.78mg/l and hence the average removal efficiency of BOD of the plant is 90.43%.
The average inlet TSS in the plant is 135.38mg/l and average outlet TSS is 6.70mg/l and hence the average removal efficiency of TSS of the plant is 94.75%.
The average inlet COD in the plant is 205.54mg/l and average outlet COD is 32.45mg/l and hence the average removal efficiency of COD of the plant is 84.10%.
The average inlet nitrogen in the plant is 18.9 mg/l and average outlet nitrogen is 0.76mg/l and hence the average removal efficiency of nitrogen of the plant is95.94 %.
The average inlet pH in the plant is 7.74 while pH at outlet is 7.47.
The average removal efficiency of BOD, TSS and nitrogen are acceptable while the average removal efficiency of COD is low but the outlet parameters of the plant are within the range.

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