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A study on Cyclic Activated Sludge Technology for Domestic Waste Water Treatment at Sangli

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Abstract:-The aim of this study is to evaluate the performance of 23.5MLD Sewage Treatment Plant locatedat Sangli which is based on latest C-Tech Technology (Cyclic Activated Sludge Technology). Water samples were collected from raw inlet and treated outlet and analyzed for the major waste-water quality parameters, such as pH, Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) etc**.**The overall performance efficiency of 23.5 MLD Sewage treatment plant will be evaluated by collecting samples for the period of 3 months.

Keywords: *BOD,COD,Cyclic Activated Sludge Technology, TSS etc.*

I. INTRODUCTION

Water is the prime constituent that supports human life as well as aquatic life.In recent years, the improper discharge of municipal and industrial wastewater has caused many environmental problems, such as the promotion of Eutrophication, toxicity to aquatic organisms and depletions of dissolved oxygen in receiving streams. Thus the availability of fresh clean water is becoming increasingly limited in many areas of the world. Many under developed areas of the world already face a shortage of clean drinking water and irrigation water for food production. Therefore, complete treatment of municipal and industrial wastewater before discharge has been increasingly needed.

Water scarcity forces us to look for other alternative non-conventional sources. The organic waste, sludge and garbage dumping has reduced the carrying capacity of the river and hence a threat to marine life. When untreated sewage is discharged into some river stream floating solids present in the discharged sewage may be washed up on the shore, near the point of disposal, where they decompose and create foul smell and bad odours. The large amount of organic matter present in the discharged sewage will also consume the dissolved oxygen from the river stream in getting oxidized, and may thus seriously decrease the dissolved oxygen of the river stream, causing fish kills and other undesirable effects.

When untreated sewage is discharged into some river stream, floating solids present in the discharged sewage may be washed up on to the shore, near the point of disposal, where they decompose and create foul smells and bad odours. The large amount of organic matter present in the discharged sewage will also consume the dissolved oxygen from the river stream in getting oxidized, and may thus seriously decrease the dissolved oxygen of the river stream, causing fish kills and other undesirable effects.Therefore, the aim of wastewater treatment plant to solve many problems and enable wastewater to be disposed safely, without being damaged to public health and without polluting water bodies

1.1 Study area

Sangli is a city in the state of Maharashtra, India. It is the administrative headquarters of sangli district. As per official census 2011, sangli had a population of 28, 20,575. The district is 24.5 % urban. Sangli is situated on the banks of river Krishna and its tributaries offer many irrigation and agricultural advantages which drives the economy of the district and the city.

Sangli Municipal Corporation has built SBR treatment plant in association with SFC Environmental Technology (P). Ltd. The plant has adopted the most advance cyclic effluent treatment technology in the world called C-Tech., Sangli has installed a Sewage treatment plant with a capacity of 23.5MLD for domestic wastewater generated by the Sangli city.The domestic waste collected from the sangli city is to be treated and left into the banks of river Krishna.

Figure 1.1 Aerial View of Sewage Plant at Sangli Maharashtra

1.2 Plant Description

Volume of sewage treated	23.5 MLD	Freeboard provided in C-tech basin	0.50 m
Number of basin provided	4 No.	Retention time	3-5 hrs.
Width of C-tech basin	19 m	BOD load applied per day	250 mg/l
Length of C-tech basin	35 m	Number of cycle per day/basin	8 No.
Depth of C-tech basin	6 m	Hydraulic retention time	12 hrs.

1.3Objectives of the study

1. Performance study of each treatment unit and its working principle.
2. To collect, analyse, determine strength of wastewater and performance efficiency of each treatment unit.

II. MATERIALS AND METHODOLOGY

2.1 Cyclic Activated Sludge Process

The raw sewage is collected in receiving chamber of wet-well and pumped into the Inlet chamber or stilling chamber for Primary treatment. The primary treatment includes; fine screens (mechanical and manual screens) for removal of fine floating particles, debris, etc. Grit chambers for separating out grit and other heavy particles having specific gravity >2.65. After primary treatment, sewage is taken into parallel C-Tech basins for biological degradation of organics. No additional Settling Unit, Secondary clarifier is required. The complete biological treatment is divided into Cycles with each cycle having 3 – 5 hrs duration, during which all treatment steps take place sequentially.

The complete process takes place in a single reactor, within which all biological treatment steps take place sequentially. Additional settling unit, secondary clarifier are not required. The complete biological operation is divided into cycles. Each cycle is of 3 – 5 hrs duration during which all treatment steps take place.

- Fill / Aeration (F/A) – ((for biological reactions)
- Settling (S) – (for solids-liquid separation)
- Decanting (D) – (to remove treated effluent)

Fill / Aeration: The raw wastewater is filled in the C-tech basin up to a set operating water level. Aeration is done simultaneously for a pre-determined time to aerate the effluent along with the biomass.. Total duration for a typical fill operation is 90 minutes.

Settling: After the aeration cycle, the biomass settles under perfect settling conditions. . Total duration for a settling operation is 45 minutes.

Decanting: Once settled the supernatant is removed from the top by using decanter. Solids are wasted from the tank during decanting phase. . Total duration for decanting operation is 45 minutes.

2.2C-Tech Components

1. Biological Selector zone-Part of SBR basin- Provided at the Inlet end of SBR basins Plays substantial role in the selection of non-filamentous bacteria.

2. DO Meter - DO Meter helps in measuring DO concentration available in the basin and also Oxygen Uptake Rate (OUR) based control of the process. This ensures 30 – 40% power saving.

3. Decanter - The clean supernatant is removed from the Basin using a Decanter Assembly, complete in Stainless Steel construction.

4. Diffusers: - Fine bubble polyurethane membrane diffusers are provided for efficient transfer of oxygen from air to meet the process demand.

5. Air Blowers: - Air blowers supply required air as per process demand. Air blowers are controlled through PLC as per OUR based control logic.

2.3Sampling

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and yet large enough for analytical purposes while still accurately representing the material being sampled. The collected samples should be handled in such a way that no significant changes in composition occur before tests are made. Here, we used Grab Sampling method. Sample is collected during the time of peak hour in a bottle carefully. Samples are collected at regular interval usually after two to three days. Samples are collected at inlet and outlet point. Samples is collected by taking all precautions for collection of samples. After the collection of samples it is brought in the laboratory located itself in the treatment plant. Then different physical-chemical parameters as per standard methods for the examination of water and waste water carried out.

2.4 Methods for Analysis

2.4.1 Correlation and regression analysis: Co-variation of two independent magnitudes is known as correlation. If two variables x and y are related in such a way that increase or decrease in one of them corresponds to increase or decrease in the other, we say that the variables are positively correlated. Also if increase or decrease in one of them corresponds to decrease or increase in the other, the variables are said to be negatively correlated. The numerical measure of correlation between two variables x and y is known as coefficient of correlation. Regression is an estimation of one independent variable in terms of the other. If x and y are correlated, the best fitting straight line in the least square sense gives reasonably a good relation between x and y. The best fitting straight line of the form $y = ax+b$ (x being the independent variable) is called the regression line of y on x and $x = ay+b$ (y being the independent variable) is called the regression line of x on y.

2.4.2 Software Used

MINITAB 18 for statistical analysis.

III. RESULTS AND DISCUSSIONS

3.1 General

For sampling purpose we have selected two points such as Inlet and Outlet .Samples have been collected 20 times from date 15 th February 2019 to 20 th May 2019. Collected samples were analysed for the important parameters. Samples were collected from influent and effluent of the sewage treatment plant.Samples were collected during a period of 3 month and were analyzed in the laboratory for determining the strength of wastewater and to find out efficiencies of each unit in terms of BOD, COD, TSS, PO4 & NO3 removal percentage.

(a) Physico-chemical analysis

(b) Removal Efficiency

(b) Correlation and Regression analysis

3.2 Physico-chemical analysis

Table No. 3.2 a) Sampling Point -1 at Inlet Point

SL.NO	pH	DO	BOD	COD	TSS	SVI	MLSS	NO3	PO4
1	6.4	0.0	200.0	264.0	192.0	36.6	7924.0	53.4	11.0
2	7.0	0.0	225.0	208.0	250.0	38.2	6025.0	54.2	18.0
3	6.8	0.0	145.0	352.0	324.0	51.3	4682.0	41.4	19.0
4	6.9	0.0	165.0	272.0	350.0	35.0	6007.0	56.7	14.0
5	6.8	0.0	210.0	250.0	258.0	68.1	3965.0	58.7	11.0

6	6.7	0.0	225.0	255.0	249.3	61.9	3875.0	49.7	17.0
7	6.8	0.0	269.0	269.0	247.0	68.3	4833.0	52.2	14.0
8	7.0	0.0	154.0	247.0	164.0	61.4	5045.0	54.0	8.0
9	6.5	0.0	160.0	356.0	181.0	51.8	6955.0	32.0	13.0
10	6.3	0.0	196.0	321.0	220.0	44.2	5876.0	48.4	14.0
11	6.5	0.0	200.0	369.0	269.0	33.7	6236.0	58.1	16.0
12	6.4	0.0	189.0	348.0	249.0	55.6	5935.0	34.5	15.0
13	6.9	0.0	224.0	357.0	236.0	45.0	4891.0	38.8	18.0
14	6.8	0.0	138.0	324.0	256.0	30.1	6650.0	59.0	12.0
15	6.9	0.0	228.0	242.0	248.0	89.2	3810.0	57.0	13.0
16	6.9	0.0	155.0	224.0	256.0	46.9	6818.0	38.0	16.0
17	6.9	0.0	165.0	252.0	347.0	44.4	5850.0	48.0	17.0
18	6.8	0.0	215.0	260.0	269.0	47.1	5950.0	39.0	17.0
19	6.5	0.0	255.0	248.0	258.0	65.3	4899.0	45.0	11.0
20	7.0	0.0	248.0	245.0	301.0	53.5	5045.0	48.2	10.9
MAX	7.0	0.0	269.0	369.0	350.0	89.2	7924.0	59.0	19.0
MIN	6.3	0.0	138.0	208.0	164.0	30.1	3810.0	32.0	8.0
MEAN	6.7	0.0	196.7	288.4	260.1	52.9	5406.8	47.7	14.2
SD	0.2	0.0	38.5	50.8	48.3	14.6	1095.8	8.5	3.0
%CV	3.3	0.0	19.6	17.6	18.6	27.5	20.3	17.8	21.1
SUM	158.0	0.0	4627.8	6596.9	5965.2	1242.0	129527.8	1131.3	350.2

Table No. 3.2 b) Sampling Point -1 at Outlet Point

SL.NO	pH	DO	BOD	COD	TSS	SVI	MLSS	NO3	PO4
1	7.16	6.4	4.8	84	8.8	68.09	4700	12	5.5
2	7.17	6.5	5.2	72	9	74.74	4616	11	4.9
3	7.29	6.5	5.2	68	9.5	102.62	3021	20	4.8
4	7.36	6.9	3.6	80	7.5	47.03	4890	31	4.6
5	7.49	5.69	6.6	52	6	57.62	4165	17	3.2
6	7.16	6.7	6.8	49	6.5	43.30	4365	18	3.4
7	7.4	7.2	6.6	36	7.2	64.31	4665	41	5.6
8	7.9	7.7	4.6	84	5.9	39.33	4526	19	3.9
9	7.18	8.5	3.6	64	6	42.55	4230	28	5.4
10	7.7	7.9	4.8	80	6.5	28.47	5620	24	5.5
11	7.56	6.5	5.1	72	5.5	44.13	5212	11	5.9
12	7.48	6	4.7	68	7	48.15	4569	17	5.7
13	7.36	7.5	3.4	76	8.5	70.59	4533	26	4.5
14	7.87	7.9	4.4	60	7	39.87	6521	23	6.3
15	7.7	5.7	5.1	88	7	49.89	5412	19	8
16	7.89	6.2	3.6	48	5.2	56.38	4523	25	6.4
17	7.23	6.3	3.8	84	5.5	57.92	5352	12	5.4
18	7.63	5.8	5.5	56	6.5	76.94	4289	20	7.2
19	7.59	7.1	5.6	44	7	69.08	5211	11	7.3

20	7.46	7.25	4.9	74	6.7	69.48	5325	19	6.3
MAX	7.9	8.5	6.8	88.0	9.5	102.6	6521.0	41.0	8.0
MIN	7.2	5.7	3.4	36.0	5.2	28.5	3021.0	11.0	3.2
MEAN	7.5	6.9	4.9	65.7	6.7	56.0	4801.6	21.2	5.5
SD	0.2	0.8	1.0	15.2	1.2	17.3	711.4	7.6	1.2
%CV	3.3	11.7	20.7	23.2	18.0	30.8	14.8	36.1	22.6
SUM	175.7	169.8	134.7	1567.1	179.4	1385.7	110814.8	520.9	150.4

3.3 Removal Efficiency

Removal Efficiencies are collected from inlet and outlet parameter.

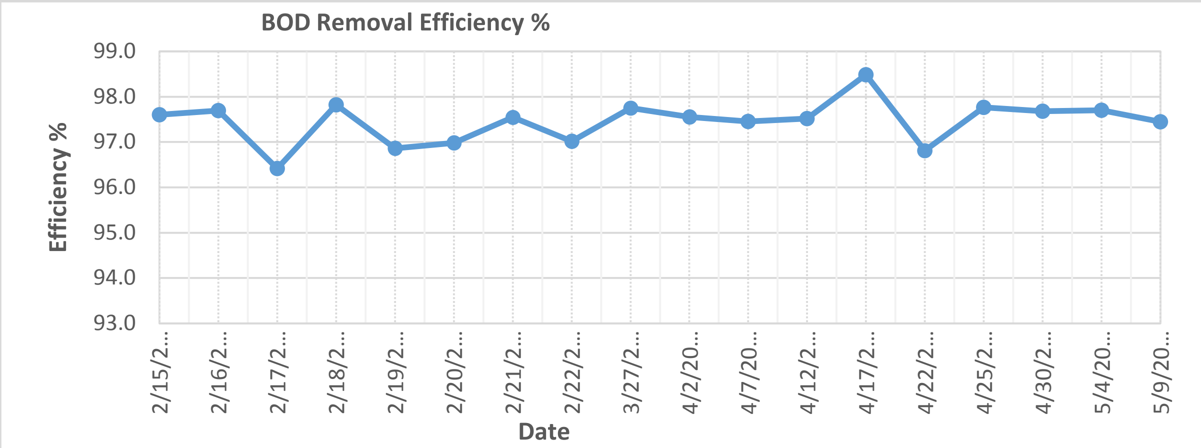

Figure 3.3.1 BOD removal efficiency

Maximum BOD Removal Efficiency is 98.5 % and Minimum BOD Removal Efficiency is 96.5 %.

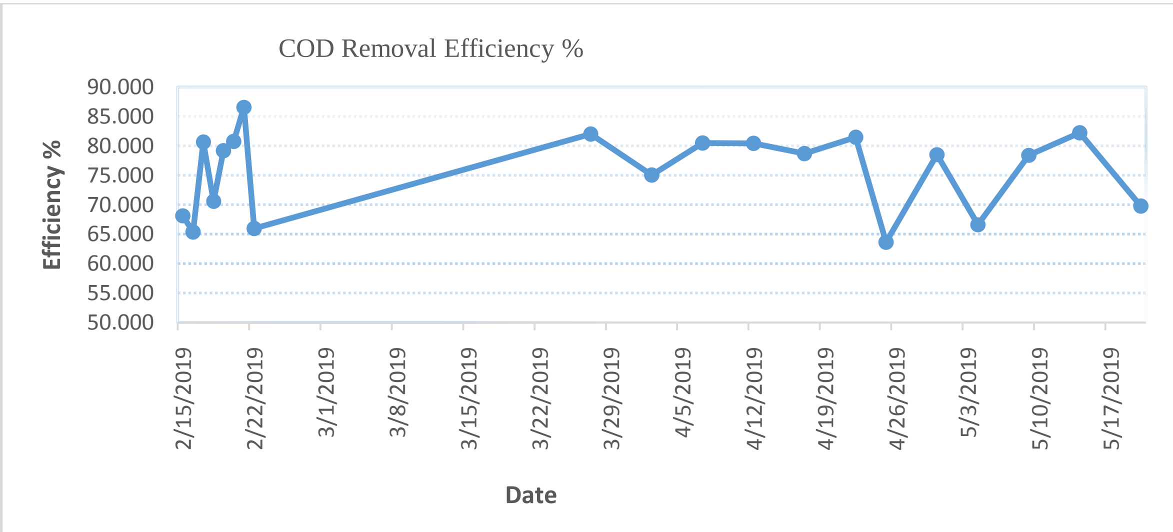

Figure 3.3.2 COD removal efficiency

Maximum COD Removal Efficiency is 86.6 % and Minimum COD Removal Efficiency is 70.1%.

3.4 Correlations and Regression Analysis

3.4.1 Correlation of Inlet Point

In the present study the correlation coefficient between the parameters is computed. The degree of line of association between any two water quality parameters is measured by correlation coefficient which is represented in table 3.3.1. The highest positive correlation between different parameters was found out to be

0.737 i.e., between Biological Oxygen Demand and Total Suspended Solids and the highest negative correlation between different parameters was found out to be -0.731 i.e., between Nitrate and Sludge Volume Index.

Table 3.4.1: Correlation Coefficient of Various Parameters of Inlet point

	pH	DO	BOD	COD	TSS	SVI	MLSS	(NO3)	(PO4)
pH	1								
DO	0.36	1							
BOD	0.063	0	1						
COD	0.016	0	0.205	1					
TSS	-0.278	0	**0.737**	0.6	1				
SVI	0.128	0	0.539	0.61	-0.108	1			
MLSS	-0.357	0	-0.589	0.197	0.0554	-0.037	1		
Nitrate (NO3)	0.229	0	0.118	0.63	0.009	-0.731	-0.238	1	
Phosphate (PO4)	-0.332	0	0.414	-0.125	-0.742	-0.14	-0.124	0.455	1

If the correlation coefficient is ≥0.67 there exists a relation between two parameters so BOD and TSS are best correlated. For such parameters regression equations are computed and best fit line is drawn in figure 3.4.1

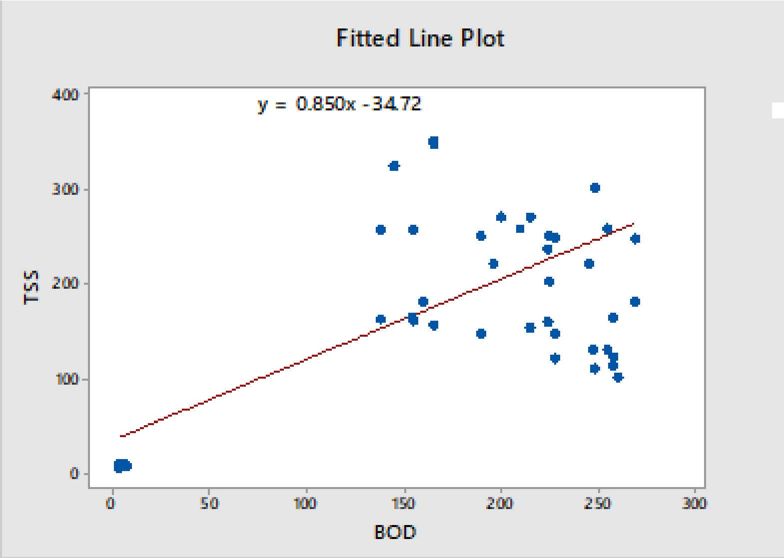

Figure 3.4.1: Regression Line for TSS v/s BOD

3.4.2 Correlation of Outlet Point

In the present study the correlation coefficient between the parameters is computed. The degree of line of association between any two water quality parameters is measured by correlation coefficient which is represented in table 3.3.2. The Biological Oxygen Demand and Chemical Oxygen Demand are highly interrelated among themselves. The highest negative correlation between different parameters was found out to be -0.83 i.e., between Total Dissolved Oxygen and pH.

Table 3.4.2: Correlation Coefficient of Various Parameters of Outlet point

	pH	DO	BOD	COD	TSS	SVI	MLSS	NO3	PO4
pH	1.00								
DO	-0.83	1.00							
BOD	-0.78	-0.86	1.00						
COD	-0.76	-0.86	**0.89**	1.00					
TSS	0.04	0.06	0.03	0.06	1.00				
SVI	-0.04	0.01	0.16	-0.03	-0.12	1.00			
MLSS	0.05	-0.02	-0.12	0.08	0.15	-0.65	1.00		
Nitrate (NO3)	-0.60	-0.73	**0.77**	0.588	0.14	-0.10	0.05	1.00	
Phosphate (PO4)	-0.12	-0.29	0.30	0.30	-0.87	0.02	-0.09	0.28	1.00

BOD and COD are best correlated. For such parameters regression equations are computed and best fit line is drawn in figure 3.4.2

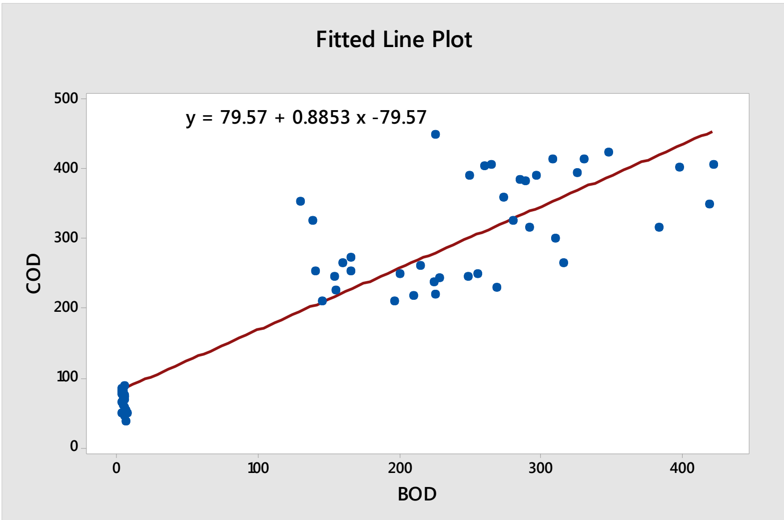

Figure 3.4.2: Regression Line for COD v/s BOD

BOD and Nitrate best correlated. For such parameters regression equations are computed and best fit line is drawn in figure 3.4.3

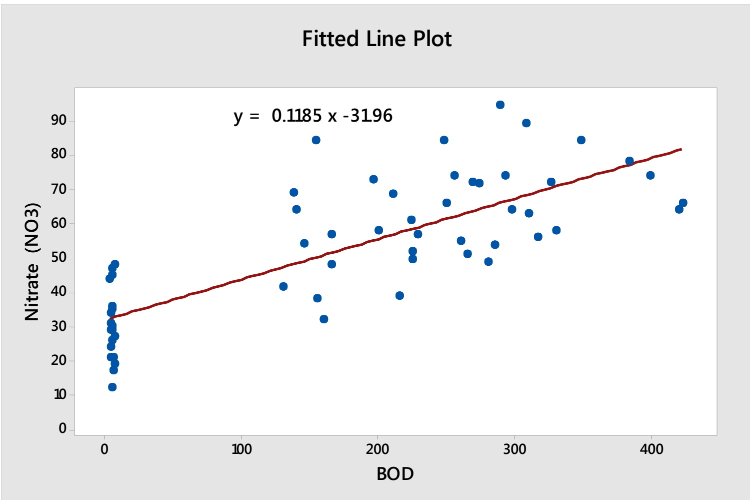

Figure 3.4.3: Regression Line for BOD v/s Nitrate

IV. CONCLUSION

After the careful study of analysis, interpretation and discussions of the numerical data following are the conclusions: -

- The average BOD removal efficiency of the plant is 98.5%.
- The average COD removal efficiency of the plant is 86.6%.
- The results obtained indicates the present waste water treatment unit is working very effectively.
- C-tech system simplify the operation of total wastewater plant and provide excellent quality of treated effluent which can be reused.
- The treated sewage or effluents can be reused for agriculture use.
- It provides highest treatment efficiency possible in single step biological process.

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