Assessment of the efficiency of sewage treatment plants: a comparative study between One Town and Mudasarlova sewage treatment plants

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***Abstract*— Visakhapatnam city has two Urban Wastewater Treatment Plants (UWTPs) in the city, located at 1 town and Mudasarlova (Arilova) village, Andhra Pradesh, India. These plants are planned and built with an intend to oversee wastewater in order to minimize and/or expel organic matter, solids, nutrients, disease-causing organisms, pollutants and different toxins, before it re-enters a water body. The concentrations were assessed from two sewage treatment units; the largest STP situated at 1 Town with handling capacity of 38 MLD took after by Arilova STP of 13MLD capacity. It was uncovered from the execution, examine that effectiveness of the two treatment plants was poor concerning expulsion of total dissolved solids as rather than the evacuation in different parameters like total suspended solids, BOD and COD. In 1 Town STP,TDS, TSS, BOD and COD removal efficiency was 2.6, 97.71, 95.18, 80.54 % and respectively, while in Mudasarlova STP,TDS, TSS, BOD and COD removal efficiency was 1.0, 90.89, 89.5, 75.18 % and respectively. The order of decrease efficiency was TDS < COD < BOD< TSS and TDS < COD < BOD < TSS respectively in 1Town STP and Mudasarlova STP. Furthermore, the issues connected with the operation and support of wastewater treatment plants is examined.**

***Key words*— Total suspended solids, Total dissolved solids, Chemical oxygen demand, Biochemical oxygen demand, Mixed liquor suspended solids, Sludge volume index**

I. INTRODCTION

One-fourth of the world's population is influenced by economic water shortage. Because of the development of population, utilization of water assets is progressive and accessibility is less, so the demand for water is expanding. The irrigated areas with waste water/utilized water changes around 10% of the world's aggregate flooded zone, so the waste water can be utilized effectively. To keep the unfriendly consequences for the accepting water bodies, whether it is utilized for cultivating, recreation, water supply, or any other purposes adequate treatment of water is necessary. Wastewater/utilized water, including substances, for example, human waste, sustenance scraps, oils, cleansers, chemicals, domestic waste. Organizations and commercial ventures additionally contribute their share of utilized water/waste waters notwithstanding storm water troubled with harmful substances by means of keep running off from streets, parking garages and rooftops and this can harm our new water frameworks. Despite the fact that, nature has a amazing capacity to adapt to certain measures of contaminants, there is a need to treat the billion gallons of wastewater and sewage produced day by day by homes, commercial ventures, and business foundations before discharging it back to the earth.

II. STUDY AREA

In Visakhapatnam, Andhra Pradesh, India taking another step towards making Visakhapatnam as smart city, the Greater Visakhapatnam Municipal Corporation (GVMC) regulates the undertaking of two essential amenities the community desires, for example, supply of safe water and maintenance of hygienic sanitation facilities. Being the largest city in the truncated Andhra Pradesh, Visakhapatnam is increasingly attracting fresh population and drinking water requirements are expected to shoot up shortly beyond the existing supply limits.

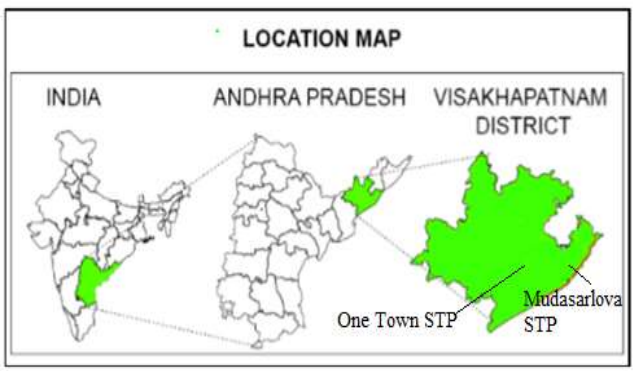

Fig: 1 Location map of One Town STP and Mudasarlova STP

The study area covers two sewage Treatment Plants namely, 1 Town and Mudasarlova Sewage Treatment Plants situated in Visakhapatnam city .The STP provided at I Town handles a design flow of 38MLD and the STP at Mudasarlova is designed to handle a design flow of 13 MLD. The STP aimed at collecting the raw sewage and treat before discharging into the Bay of Bengal or local natural water bodies in and around the city and also allocated for industrial purposes.

Fig: 2 One Town STP

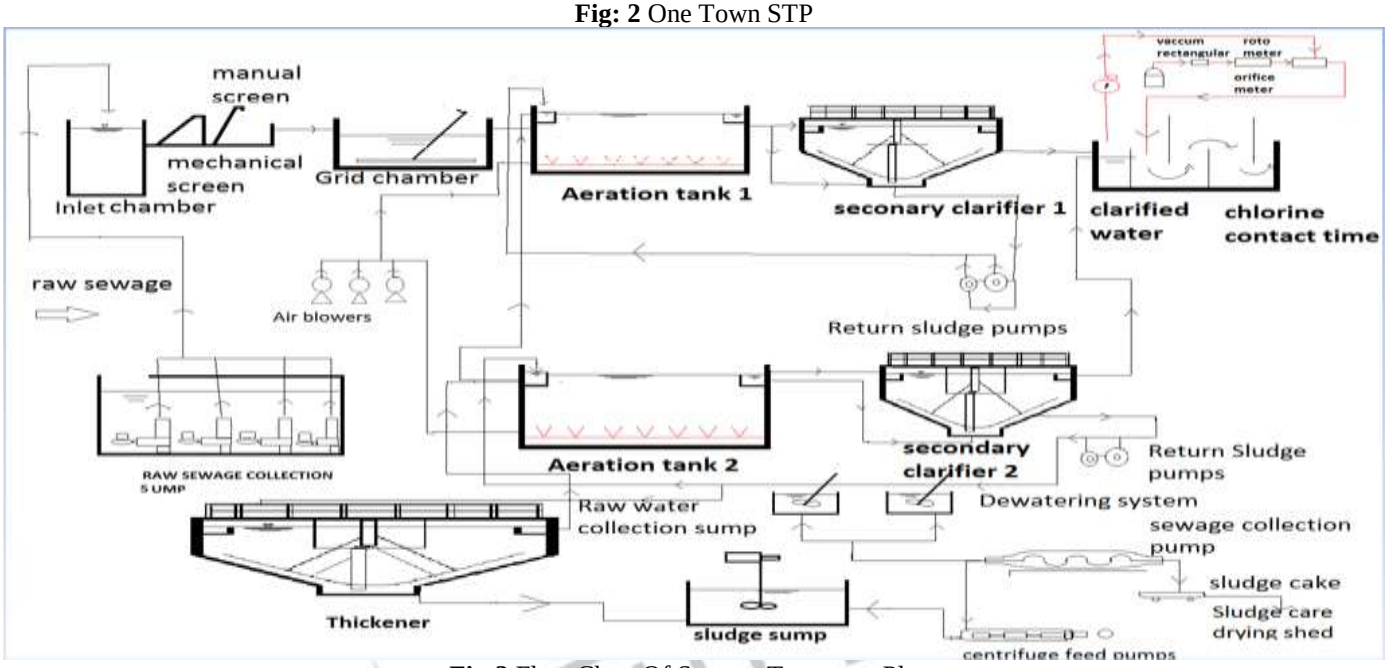

Fig:3 Flow Chart Of Sewage Treatment Plant

This paper describes the execution of the sewage treatment plants as far as wastewater characterization to determine a comparative record between the contamination load, priority and then afterward the treatment processes, additionally, recognizing their effectiveness.

III. MATERIALS AND METHODS

The experimental methods/techniques included the accumulation of composite samples in clean plastic holders of 5-liter capacity at three unique units of the treatment plant, in particular, a) Influent to the treatment plant, b) Effluent of air circulation tank/aeration tank (considered for the influent of Secondary Clarifiers) and c) Effluent from secondary Clarifiers and final effluent from chlorine contact time (CCL) for 90 days (12 samples).

Fig: 3 Mudasarlova STP

The samples were analyzed utilizing the Standard Methods (APHA, AWWA, and WCF 1998) [1]. The primary parameters included pH, total dissolved solids (TDS), total suspended solids (TSS), Dissolved oxygen (DO), 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), while secondary parameters are MLSS and SVI, covering physical, chemical, and biochemical properties of the wastewater. The pH was assessed by using a pH meter and DO was estimated by using DO meter.

Mixed Liquor Suspended Solids (MLSS, mg/L) was computed by drying the settleable solids, at the base of Imhoff cones in a liter of sample taken. The settleable solids were dried in the oven and weighed.

Sludge Volume Index (SVI): 1000 ml sample collected from Aeration tank was permitted to settle for 30 minutes and the measure of sludge settled in measuring jar is given as

$$SVI = (Settalability/MLSS) \times 1000$$

IV.RESULTS AND DISCUSSION

Colmenarejo et al., (2006) [2] determined the general efficiency indicator to look at general exhibitions of the diverse plants regarding normal TSS, COD, BOD_5 and smelling. Also, the proficiency of plants is for the most part measured as far as removal of organic matter (CPHEEO, 1993) [3]. The pH specifically influences the execution of a secondary treatment process (Metcalf and Eddy, 1991 and 2003) [4] [5] due to the presence of most biological life is needed upon narrow and critical range of pH. Since, the solids removal is a critical measure for the accomplishment of a primary treatment unit (McGhee, 1991) [6] and the dissolved solids substance of the wastewater is of concern as it influences the reuse of wastewater for rural purposes, by diminishing the hydraulic conductivity of irrigated area if the total dissolved solids content in the water surpasses 480 mg/l (Bouwer, 1978) [7]. Likewise, BOD removal is demonstrative of the efficiency of biological treatment processes (Sincero and Sincero, 1996) [8]; special consideration has been given in the present study to the organic substance, characterized by BOD_5, COD. Based on the performance study conducted for various primary and secondary parameters for a period of 90 days (12 samples), a comparative record was drawn on the accompanying:

Characteristics/qualities of Waste Water Influent to Inlet of the Treatment Plants

At 1 Town STP, at the inlet, the pH varies from 7.3 to 7.7 and the concentration of total dissolved solids (TDS), total suspended solids (TSS), BOD_5 and COD were 620-879mg/L, 80-580mg/L, 155-272mg/L, 160-300mg/L respectively (Table 1). Similarly, at Mudasarlova STP, at the inlet, the pH varies from 7.2 to 7.6 and the concentration of total dissolved solids (TDS), total suspended solids (TSS), BOD_5 and COD was 642-761mg/L, 143-187mg/L, 145-165mg/L, 150-276mg/L respectively.

After the execution of samples, the highest value of total dissolved solids (879 mg/L), total suspended solids (580 mg/L), BOD_5 (272 mg/L), COD (300 mg/L) were ascribed due to heavy organic and inorganic loading with less quantity of water. Similarly, at Mudasarlova STP, the highest value of total dissolved solids (761 mg/L), total suspended solids (187 mg/L), BOD_5 (165 mg/L), COD (276 mg/L) were attributed due to heavy organic and inorganic loading with less quantity of water. . In both the plants, the DO was "nil" at the inlet of the plant, animated by oxidation of sewage ammonia to nitrates, septic condition, heavy organic loadings.

Characteristics/qualities of Waste Water Effluent to Aeration Tank of the Treatment Plants

The air circulation/aeration tank with both the treatment plants is viewed as a most essential step in activated sludge process and the need was expected to expand the dissolved oxygen level of sewage so that the efficient aerobic digestion facilitates decay of organic matter. This must be ensured as a result of low dissolved oxygen content (nil) in the influent. In 1Town STP, there are two aeration tanks because of large volume of water is to be treated .In 1Town and Mudasarlova STPs, the DO in aeration tank ranged from 0.5 to 1.4 mg/L (tank 1), 0.4 to 1.3 mg/L (tank 2) and 1.5 to 1.8 mg/L respectively. The pH varied from 7.5 to 7.9 (tank 1), 7.5 to 7.7 (tank 2) and 7.4 to 7.9 in 1Town and Mudasarlova STPs (Table 2).

Efficiency of the aeration tank was calculated by considering percentage reduction of BOD. The percentage removal of BOD in both the treatment plants is 50%and 65% respectively against the expected value of 70-85%, illustrating that BOD reduction is little less than the expected. This slight decrease is attributed to the reusing of old sludge that contained less number of

microorganisms, other than inadequacy of MLSS for the aerobic digestion of the organic matter. The DO amid the air circulation was consumed by the microorganisms because of less accessibility of fresh organic matter.

The MLSS concentration in the aeration tank ranged between 2100-5275mg/L (Tank 1), 1600-3875mg/L (tank 2) and 2600-4100 mg/L in both the treatment plants against the expected concentration of 1500-3000mg/L, confirming suitability of secondary clarifier in terms of microbial content.

A SVI value of 100-150 indicates good settling of suspended solids that can be achieved for proper MLSS concentration. The SVI was151-765 in Mudasarlova STP, quite low compared to the expected value, while it was closer to anticipated values in 1Town STP (68-405 in Tank1), (105-288 in Tank 2)

Characteristics of Wastewater Effluent to Secondary Clarifier

At the secondary clarifier of 1 Town Treatment plant, the concentration of Total Dissolved Solids, total suspended solids and COD 613-774mg/L, 4-10 mg/L and 6.9 to 8.0 mg/L respectively. The pH varied from 7.8 to 8.2. At the secondary clarifier of Mudasarlova Treatment plant, Total Dissolved Solids, Total Suspended Solids and COD were 620-771 mg/L, 13-17 mg/L and 9.0-63 mg/L respectively. The pH varied from 7.8 to 8.0 (Table 3).

The BOD ranged from 7-15mg/L at secondary clarifier of 1 Town STP with highest BOD at second sample (15 mg/L) of performance study, while in Mudasarlova STP, the BOD ranged from 14-20 mg/L, highest at first sample (20 mg/L). The efficiency of BOD removal in secondary clarifier is 94 and 89.5% respectively in 1Town and Mudasarlova treatment plants, confirming efficiency of the secondary clarifier and its suitability to be discharged.

Overall Efficiency of the Two Treatment Plants

The overall efficiency of the two treatment plants was calculated by considering the TDS, TSS, COD and BOD of the influent and the final effluent from the secondary clarifier. The reduction in COD is 80 and 75.18 % in 1 Town and Mudasarlova STP respectively. The percentage reduction in total dissolved solids is 2.6 % and 1.0 %, respectively, in 1 Town and Mudasarlova STPs, much below the expected removal of 70-80% indicating poor efficiency in terms of total dissolved solids removal. However, the removal of total suspended solids and BOD was found to be very satisfactory.

The reduction in total suspended solids is 97.71% and 90.89 % in 1 Town and Mudasarlova STPs respectively against the expected value of 85-90 %, while the reduction in of BOD is 95.18 % and 89.50% at 1 Town and Mudasarlova STP respectively against the expected value of 85-90 %.

There is normally no relationship amongst BOD and COD in wastewater with gradually biodegradable organic suspended solids and in complex waste effluents containing unmanageable substances (Eckenfelder, 1989) [9].

This demonstrates relatively higher extent of the non-biodegradable substance in treated emanating than raw wastewater. As a result, the effectiveness of BOD removal is higher than that of COD removal.

V. CONCLUSION

The performance studies on the 1 Town and Mudasarlova Sewage Treatment Plants located in Visakhapatnam city, collected samples for a period of 90 days (12 samples), and indicated a positive efficiency of the system. The overall efficiency is in the order TDS < COD < BOD< TSS in 1 Town while in Mudasarlova, it is TDS < COD < BOD < TSS. The performance of the aeration tank and secondary clarifier was nearly up to the mark in both the cases. In order to achieve better performance, fresh sludge with higher microorganism populations ought to be reused and the aerators must be operated continuously. The treated effluent can be safely discharged into streams, rivers, bay, lagoon or wetland, or it can be reused for irrigation of green way, park or for groundwater recharge as opined by (Fatta *et al.*, 2005) [10].

At present, about 56 MGD of water has been allotted to meet the drinking water needs of the two million people in the city. In addition, about 20 MGD water is being supplied for industrial purposes to organisations including HPCL, Hindustan Zinc, Visakhapatnam Port and other establishments apart from about 35 MGD being supplied by Visakhapatnam Industrial Water Supply Company (VIWSCO) to Visakhapatnam Steel Plant and NTPC Simhadri. From these STP's to make optimum usage of available water resources and supply about 15 MGD of treated water for industrial purposes every day. The same quantity of water allocated for industrial purposes can be used for domestic consumers. The treated water is discharging into the Bay of Bengal or local natural water bodies in and around the city and also allocated for industrial purposes.

VI.REFERENCES

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ABLE 1: **Descriptive statistics of the Waste water characteristics at the inlet of treatment plants**

	Sewage Treatment Plant at 1 Town					**Sewage Treatment Plant at Mudasarlova**				
	pH	***TDS***	***TSS***	***BOD_5***	***COD***	***pH***	***TDS***	***TSS***	***BOD_5***	***COD***
Mean	7.54	704.75	298.58	176.58	232.58	7.325	682.25	167.5	155.66	178.33
Standard Deviation	0.1164	72.698	171.71	32.728	35.67	0.1602	43.585	12.236	7.5838	32.689
Minimum	7.3	620	80	155	160	7.2	642	143	145	150
Maximum	7.7	879	580	272	300	7.6	761	187	165	276

TABLE 2: Descriptive statistics of the Waste water characteristics (effluent) at the aeration tanks of treatment plants

	Sewage Treatment Plant at 1 Town								**Sewage Treatment Plant at Mudasarlova**			
	pH		**DO**		**MLSS**		**SVI**		**pH**	**DO**	**MLSS**	**SVI**
	Tank1	Tank2	Tank1	Tank2	Tank1	Tank2	Tank1	Tank2				
Mean	7.68	7.61	0.66	0.65	2974.5	2792.0	187.75	161.41	7.5	1.575	3013.3	259.75
Standard Deviation	0.083	0.057	0.253	0.246	931.75	841.86	94.166	5.638	0.1676	0.1138	424.20	220.806
Minimum	7.5	7.5	0.5	0.4	2100	1600	68	105	7.4	1.5	2600	151
Maximum	7.8	7.7	1.4	1.3	5275	3875	405	288	7.9	1.8	4100	765

TABLE 3: Descriptive statistics of the Waste water characteristics (effluent) at secondary clarifier of treatment plants

	Sewage Treatment Plant at 1 Town			**Sewage Treatment Plant at Mudasarlova**		
	pH	**TDS**	**DO**	**pH**	**TDS**	**DO**
Mean	7.991	719.08	1.54	7.94	713.58	1.54
Standard Deviation	0.09	46.51	0.0514	0.0668	25.674	0.0514
Minimum	7.9	612	1.5	7.8	669	1.5
Maximum	7.8	774	1.6	8.0	742	1.6

TABLE 4: Descriptive statistics of the Waste water characteristics at effluent tank chlorine contact time (CCL) of treatment plants

	Sewage Treatment Plant at 1 Town						**Sewage Treatment Plant at Mudasarlova**					
	pH	**DO**	**COD**	**BOD_5**	**TSS**	**TDS**	**pH**	**DO**	**COD**	**BOD_5**	**TSS**	**TDS**
Mean	8.0	1.541	45.25	8.5	6.833	723.58	7.94	1.50	44.25	16.33	15.25	681.75
Standard Deviation	0.09	0.1504	18.55	2.236	1.80	46.127	0.7929	0.1164	12.963	1.874	1.1381	54.669
Minimum	7.8	1.2	6.9	7	4	613	7.8	1.2	9	14	13	620
Maximum	8.2	1.8	8.0	15	10	774	8.0	1.6	63	20	17	771

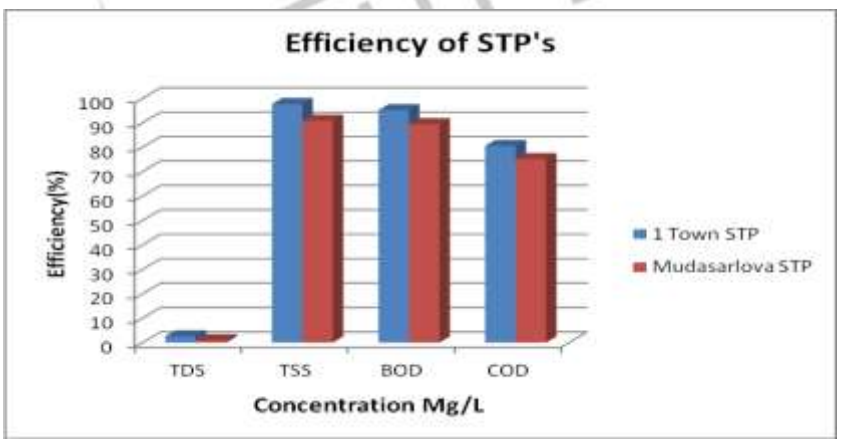

Fig:4 Comparative Study on Efficiency of Sewage Treatment Plants at OneTown and Mudasarlova

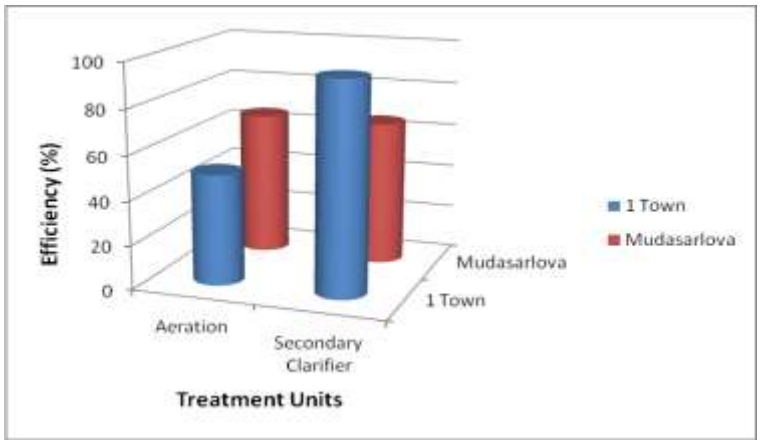

Fig:5 BOD Removal Efficiency at Mudasarlova