SEWAGE AND EFFLUENTS DISPOSAL FACILITIES IN HYDERABAD METRO DEVELOPMENT AUTHORITY AREA, INDIA

T.Vidya Sagar
AP Pollution Control Board
Gurunanak Rd, Vijayawada,
Andhra Pradesh, India
sagvid@gmail.com

ABSTRACT

The catchments of some Lakes in Hyderabad Metro Development Authority area are remediated to some extent by diverting their inlet sewage or effluent drains through Sewage treatment plants (STPs), Effluent treatment plants (ETPs) and Common ETPs (CETPs), thereby improving the quality of water before joining Lakes /River Musi. This study during 2012-2013 was on six STPs on Lakes inlet drains, three STPs on River inlet drains and two CETPs. Irrigation Water Quality Hazard Rating (Ir.WQHR) on Electrical Conductance (EC), Sodium Absorption Ratio (SAR) and Percent Sodium at outlets of STPs resulted in Medium, Low and High Hazard Classes. The percentages of efficiencies of treatment facilities for *Biological Oxygen Demand* (BOD), *Chemical Oxygen Demand* (COD) and *Total Suspended Solids* (TSS) are 62-86, 57-90 and 81-95 mg/L, respectively. The Amberpet and Nagole STPs are generating methane through anaerobic digester (Modified UASB Digester) which in turn is connected to in house power generator. The Hyderabad Metro Water Supply and Sewerage Board (HMWSSB) is suggested to construct additional STPs equal to existing capacity (750 MLD) with regular maintenance of STPs and enhanced capacity of methane generation..

General Terms

STP, CETP, Ir.WQHR, PETL, JETL, MEE, TSDF, ATFD, TSDF, ZLD, SOPs, APHA, CPCB, SAR, RSC, MLD.

Keywords

Amberpet STP, Khairatabad STP, Safilguda STP, Nagole STP, Saroornagar STP, Mir Alam STP, PETL.

1. INTRODUCTION

Since its inception in 1591, Hyderabad used to rely on water impounded tanks as well as groundwater tapped shallow dug wells [1]. The growth of the city, educational institutions and the availability of the highly educated and skilled people are leading chemical processing industries to the need of pharmaceutical requirements, formulations and heavy engineering products. The chemical syntheses involve large volumes of strong acid/base, toxic chemicals, and hazardous solvents giving their way to organic as well as toxic pollution to water, air and soil. A sewage treatment plant (STP) was started during the early sixties at Amberpet to solve the contamination problem of the domestic wastewater discharge into River Musi. After 1960, there was a sudden increase in population and industrial complexes, indiscriminate urbanization and lack of planning, which generated both domestic and industrial effluents in the city [2]. The catchments of some Lakes in Hyderabad Metro Development Authority area are being remediated to some extent by diverting their inlet sewage or effluent drains through STPs, ETPs and CETPs, thereby improving the quality of water before joining Lakes /River Musi. The major industries are restricted to discharge their effluents after treating through their own ETPs. To mitigate the pollution problems due to the industrial effluents, Andhra Pradesh Pollution Control Board encouraged construction of CETPs [3].

. Entrepreneurs from Jeedimetla Industrial Estate in 1987, jointly formed a CETP Public Limited Company, M/s. Jeedimetla Effluent Treatment Ltd. (JETL), to address the wastewater treatment problems of small and medium scale industrial units and operational from April 1989. The quantity of effluent received by JETL is about 1000-1200 KLD. The JETL [4] established Multiple Effect Evaporator (MEE) with 5T boiler in 2013 to handle HTDS with membership of TSDF to dispose of solid waste. All the electroplating industries in the unorganized sector are directed to dispose the effluents to CETPs for accountability and treatment. As implementation part, many of the industries installed solvent recovery, MEEs, Spray dryers, sequential RO plants, Solid waste disposal to TSDF, MEE condensate to treatment facility (STP) to minimize effluents discharge and sending treated effluent to CETP with in norms to achieve Zero discharge (ZLD).

In 1994, a CETP was set up at Patancheru under the banner M/s Patancheru Enviro Tech Ltd. (PETL) [4], to treat 7,500 KLD industrial effluents from 108 pollution potential Industries. These are restricted to send their low TDS effluents (less than 5000 mg/L) to the CETP for treatment and disposal. The Outlet of PETL was connected to 18 Km pipeline for transportation of treated effluents (after achieving the prescribed standards) to K&S Main Pipe Line [5], which

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ultimately joins Amberpet STP for further treatment and disposal. The K&S Pipe Line also carries treated effluents from JETL and ETP of M/s. IDPL.

2. EXPERIMENTAL

Typical STP design consist a sequence of process units [6] for effective treatment flow chart is at **Figure 1**. The sequence of operations in a typical modern STP is starting from inlet collection tank, grit screen chamber for separation of plastics and pebbles, oil and grease trap and collection, bar screen chamber for separation of silt and soil, equalization tank for conditioning bacterial activity, Anaerobic digester for heavy organic loads for generation of bio-methane followed clarifier, aeration tanks for aerobic digestion, clarifier for removal of sludge and to recover bacteria to recycle for improved efficiency of digesters and clarified water holding tanks lie in 1st stage operations.

The present stringent norms forced the treatment facilities for further treatment to recycle more than 50% for domestic usage. 2nd stage in **Figure 1** show the possible further treatment passing through sand filter, activated charcoal for removal of organics, ozone/ chlorine treatment, Micron and ultra micron level filtrations and RO purification leads to suitability for domestic use. The tolerance of public acceptance of STP lies with the oxidizing efficiency and maintenance that is reflected in no foul smell and clean environment.

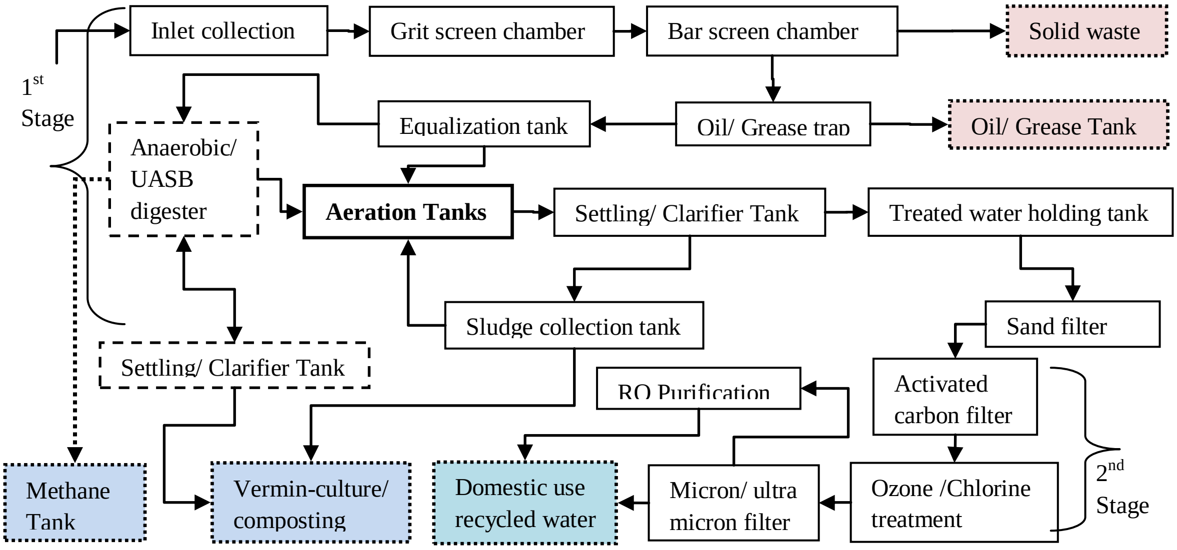

Figure 1: Typical STP design sequence of process units.

The CETPs provide chemical flocculation as primary treatment, storage in buffer tank followed by biological oxidation after mixing with municipal sewage in the ratio of 1:1.6. The imposed restrictions on discharge of High TDS and Hazardous substances (Solid/semisolid/liquid form) facilitated M/s. Ramkee Ltd., Dundigal [7] brought up of Hazardous Waste Disposal Site along with incinerator and toxic solid waste disposal facility (TSDF) for secured landfill resulting in decreased pollution, both toxic solid waste and organic load in the water bodies. In recent years, from the Chemical/ Pharmaceutical Industrial effluents, the load of organic solvent further decreased with the incorporation of Multiple Effect Evaporator (MEE) and Agitated Thin Film Driers (ATFD) for recovery of solvents and their use as co-incineration at cement industry/ power generation based on calorific value. The sequential use of reverse osmosis (RO) system associated with MEE and ATFD to achieve "Zero" discharge generate solids of salts, minerals, toxic substances and poly-organics for secured landfill site at TSDF.

Standard Operating Procedures (SOPs) were prepared and followed based on the methods suggested by i) APHA (American Public Health Association), 16th (1985), 20th (1998) and 21st (2005) Editions: titled "Standard Method for Examination of water and wastewater", ii) "Guide Manual: Water and Wastewater Analysis" published by the Central Pollution Control Board (CPCB), New Delhi, iii) Indian Standard (IS) methods. Methods of Checking Correctness of Analysis [8,9,10] were followed.

Table 1 shows irrigation water quality rating based on EC, SAR, RSC [11,12] and Percent Sodium Classifications in relation to hazardous effects as per IS 11624 (1986). CPCB designated best uses [13] for setting water quality goals fixed for DO ≥ 4.

Table 1: Irrigation Water Quality Hazard Rating

Hazard Class	**EC** (micro mhos/ cm)	**SAR** (millimole / litre)$^{1/2}$	**RSC** (me/l)	**Percent Sodium** (%Na)
Low	Below 1500	Below 10	Below 1.5	<20
Medium	1500-3000	10-18	1.5-3.0	20-40
High	3000-6000	18-26	3.0-6.0	40-60
Very high	Above 6000	Above 26	Above 6.0	60-80

The CETPs (JETL and PETL) are permitted to send

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treated effluents to Amberpet STP within the limits for TSS: 100, TDIS (Total Dissolved Inorganic Solids): 2100, COD: 500, and Ammonical Nitrogen: 50 mg/L. The quantity of effluent received by JETL is about 1000-1200 KLD. The average effluent and sewage quantities received, discharged and sludge generated by PETL during 2012-2013 were 43193, 26282, 63204 and 103.8 mg/L, respectively, with sewage and sludge percentages 61.61 and 0.24.

Area of Study: This study is conducted with the aid of 430 samples analysis records in the period 2012-2013. It is on six STPs on Lakes inlet drains, three STPs on River inlet drains, and two CETPs [14]. **Table 2** shows details of these sampling points. Gr.1 and Gr.2 shows the grouping representing outlets of treatment facilities T1-T11 and inlet drains to those facilities T12-T22, respectively, for the sampling points detailed at **Table 2** while reference numbers S1-9 referenced the water body [15].

Table 2: STPs and CETPs with capacities and sampling point codes

Ref. No.	Treatment Facility	Sample Code		Capacity MLD		Latitude N	Longitude E
		Outlet	**Inlet**	**CETP**	**STP**		
	STPs on Lake inlets	**(Gr.1)**	**(Gr.2)**				
S1	Langar House STP	T01	T12		1.2	17°22.77'	78°24.83'
S2	Durgam STP	T02	T13		10.0	17°25.97'	78°23.34'
S3	Mir Alam STP	T03	T14		10.0	17°20.17'	78°26.82'
S4	Khairatabad STP	T04	T15		20.0	17°24.86'	78°28.11'
S5	Saroornagar STP	T07	T18		2.5	17°21.22'	78°31.80'
S6	Safilguda Lake STP	T06	T17		0.6	17°27.90'	78°32.31'
	STPs on inlet drains of River Musi						
S7	Amberpet STP	T05	T16		339.0	17°22.50’	78°31.19’
S8	Nagole STP	T08	T19		172.0	17°22.37’	78°33.48’
S9	Nallacheruvu (Uppal) STP	T09	T20		30.0	17°23.86'	78°34.73'
	CETPs (Discharge through K&S pipeline to Amberpet STP)						
C1	PETL (M/s Patancheru Enviro Tech Ltd)	T10	T21	7.5	12.0	17°32.33’	78°14.72’
C2	JETL (M/s. Jeedimetla Effluent Treatment Ltd.)	T11	T22	3.5	5.6	17°31.32’	78°26.54’

S1-6 representing Lakes namely Langar House, Durgam, Mir Alam, Hussain sagar, Saroornagar and Safilguda, respectively, connected with STP outlet T01 - T06 shown in **Table 2**. Water quality characteristics in this study period of these lakes S1, S2 and S4 are moderate pollution [16] and S3, S5 and S6 are polluted [17].

A typical STP view shown at **Figure 2** from Nallacheruvu (Uppal) STP (S9) grit chamber **(a)** Inlet area of S9, **(b)** S9 outlet, **(c)** Khairatabad STP (S4) outlet **(d)** S9 methane holding tank, aeration tanks, and sludge driers arrangement and **(e)** areation tank in Amberpet STP (S7).

(a) (b) (c)

(d) (e)

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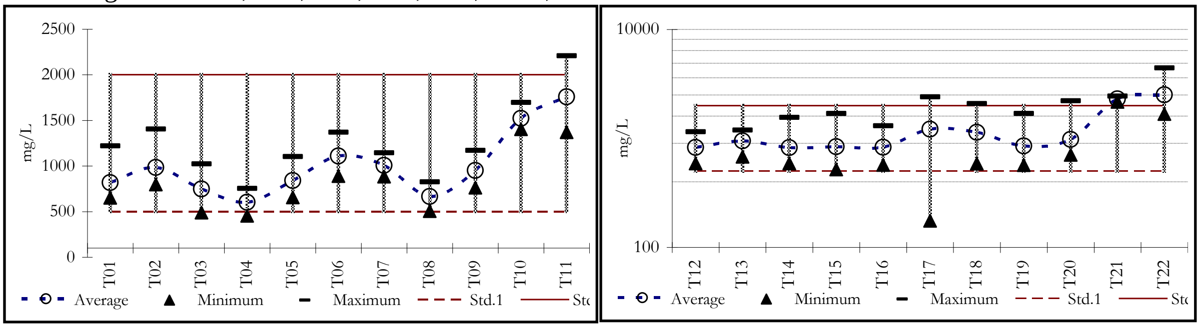
Figure 2: View of S9 (a) Inlet area (b) Outlet (d) methane storage, aeration tank sludge driers, (d) S4 outlet (e) areation tank in S7.

3. RESULTS AND DISCUSSION

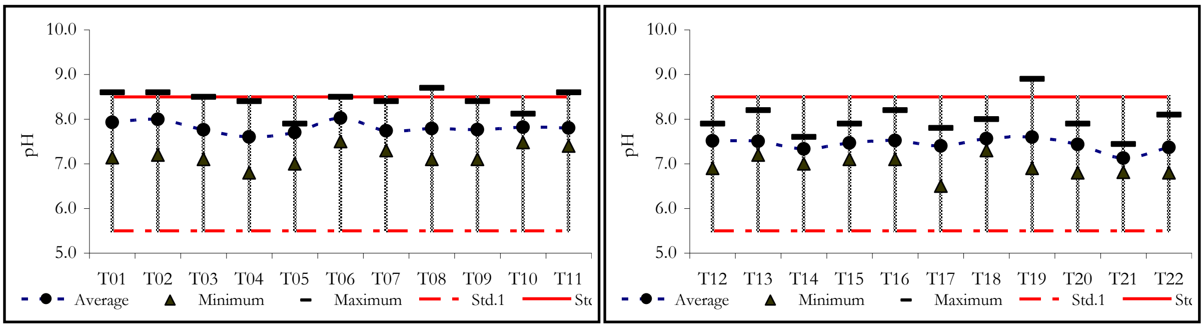
Figure 3 (a) and (b) shows the averages trend of TDS mg/L during 2012-2013 of Gr.1 and Gr.2 points respectively. The TDS of STPs T01-T09 outlets indicate average TDS 817, 984, 748, 603, 841, 1109, 1006, 667, 952 mg/L, respectively, ranging 652-1221, 798-1406, 488-1024, 454-754, 656-1103, 890-1370, 883-1145, 506-826, and 763-1171, not exceeded the standards but influenced TDS of water body it joins.



(a) (b)

Figure 3: TDS trends during 2012 – 2013 of points (a) Gr.1 (b) Gr.2.

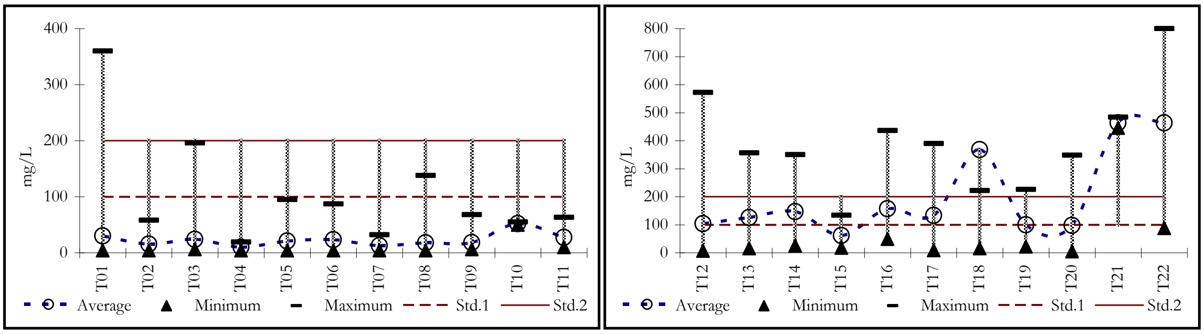
Figure 4 (a) and **(b)** show pH averages of Gr.1 and Gr.2 points, respectively. The pH ranging and averages of T1-T11 are 6.8-8.7 and 7.6-8.0, 7.8, respectively, and T12-T22 are 6.5-8.9, 7.1-7.6.



(a) (b)

Figure 4: pH trends during 2012 – 2013 of points (a) Gr.1 (b) Gr.2.

Figure 5 (a) and **(b)** show TSS averages of Gr.1 and Gr.2 points, respectively. The TSS ranging and averages of T1-T11 are 4-138 and 13-55, respectively, and T12-T22 are 5-800.



(a) (b)

Figure 5: TSS trends during 2012 – 2013 of points (a) Gr.1 (b) Gr.2.

The T10 ranging and averages of TDS, TSS, Chloride, Sulphate and COD are 1403-1697, 1522; 50-55, 52; 495-690, 613; 82-120, 102; and 178-214, 190, respectively, and the same of T11 are 1370-2208, 1759; 10-63, 27; 364-534, 443; 97-186, 142; and 61-344, and 197 mg/L. The T21 ranging and averages of TDS, TSS, Chloride, Sulphate and COD are 2164-2442, 2300; 446-484, 464; 873-1218, 1119; 79-117, 96 2925-3387, 3180 and 1202-1414, 1302 mg/L, respectively, and the same of T22 are 1674-4430, 2513; 88-800, 464; 571-3080, 952; 125-648, 314, 696-5483, 3565 and 260-4320, 1816.

Figure 6 shows the trends of COD ranging of STPs T1-9 outlets are 10-192, 12-188, 30-218, 29-124, 43-176, 13-165, 22-204, 8-260, 37-365, respectively, averages 61, 74, 71, 63, 89, 70, 85, 79 and 102 mg/L, and exceeded standards in October 2012 at T09. COD of CETP C1 and C2 inlet and outlet T10 and 11, T21 and

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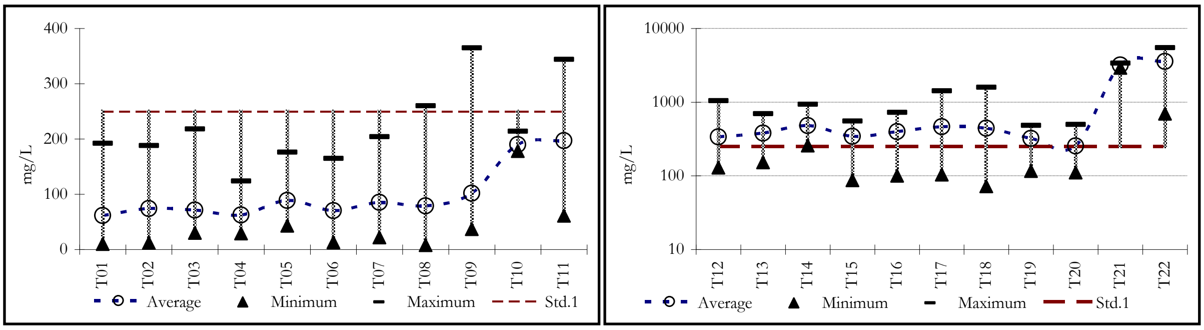
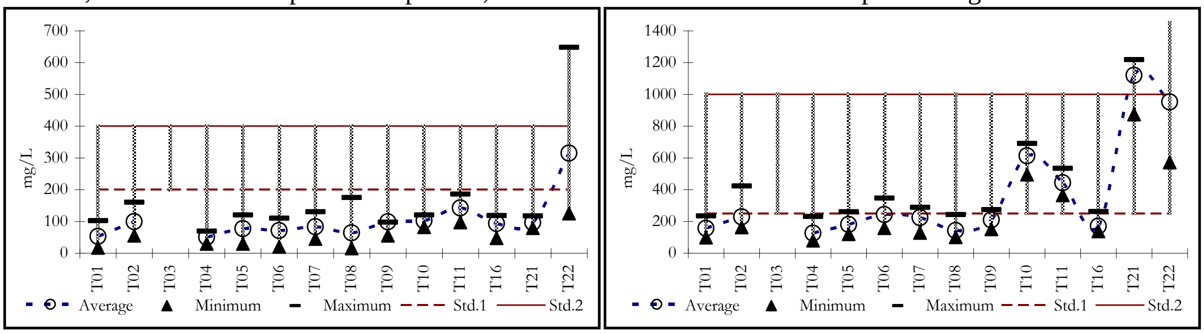
22, respectively, ranging 178-218 and 61-344, 2925-3387 and 696-5483.



(a) **(b)**

Figure 6: COD trends during 2012 – 2013 of points (a) Gr.1 (b) Gr.2.

Figure 7 reveal that no remarkable deviations in inlet and outlet water characteristics of these STPs in respect of TDS, Chloride and Sulphate except TSS, BOD and COD, which are reduced to acceptable limits after treatment. The concentrations of Chloride and Sulphate are within acceptable range.



(a) (b)

Figure 7: Shows trends of some points during 2012 – 2013 (a) Sulphate (b) Chloride.

Figure 8 shows averages of DO, F, B, Al, Nitrate, and Phosphate at T01, T02, T04 – T09 are in between 1.4-2.8, 0.9-1.6, 0.4-0.9, 1.5-19.8, 2.5-16.4 and 1.4-3.2, respectively, representing insignificant concentrations in mg/L.

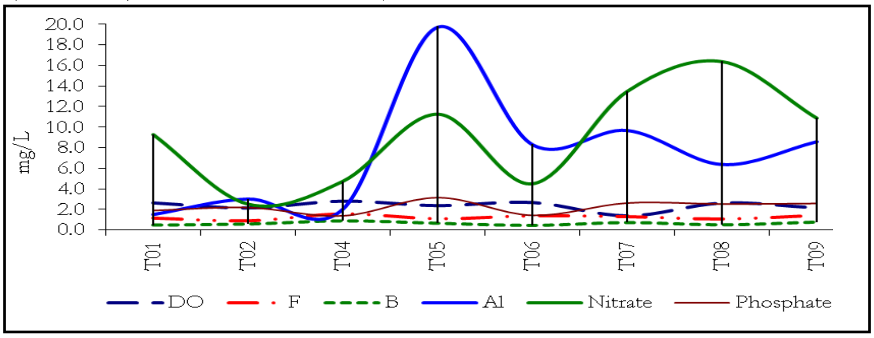
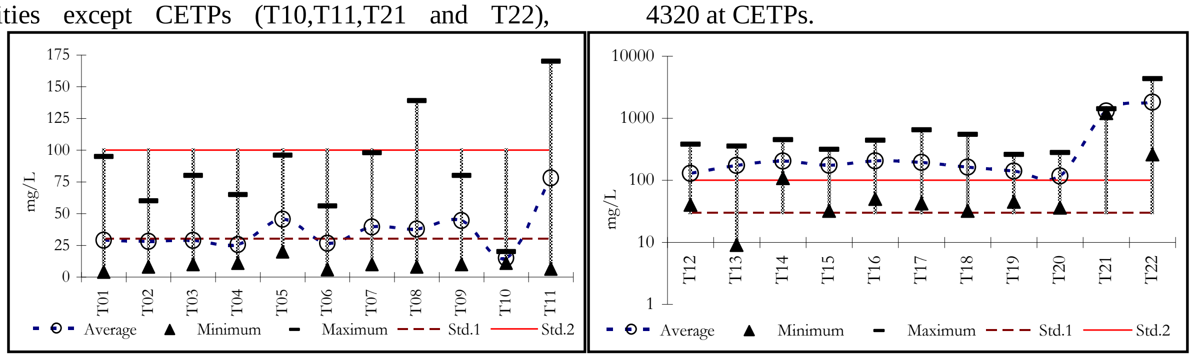


Figure 8: Insignificant parameters in some treatment facilities during 2012–2013.

Figure 9 shows BOD at (a) inlet (b) outlet of treatment facilities except CETPs (T10,T11,T21 and T22), ranging 5-139 and 9-650, respectively, 6-170 and 260-4320 at CETPs.



(a) **(b)**

Figure 9: BOD trends during 2012 – 2013 of points (a) Gr.1 (b) Gr.2.

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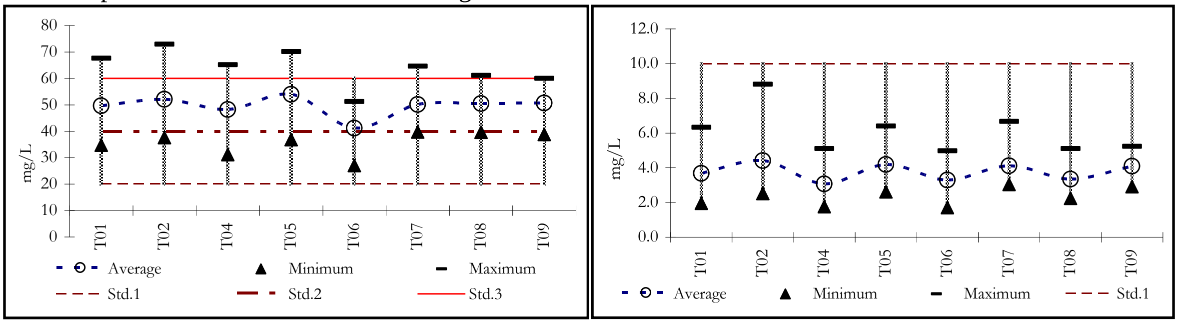
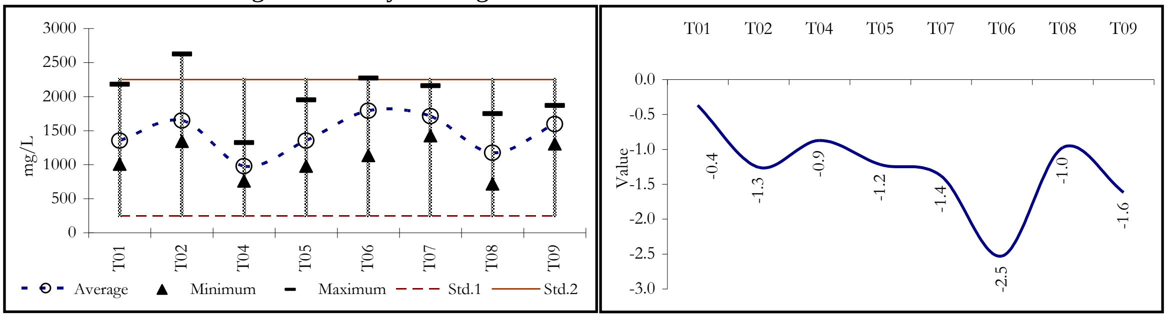
Figure 10 show **(a)** Percent Sodium (b) SAR trends of some outlet points. Percent Sodium averages lie between 40-60 indicating High Hazard Class. SAR shows Low Hazard Class with SAR value less than 10.



(a) (b)

Figure 10: Trends of some outlet points during 2012 – 2013 (a) percent sodium (b) SAR.

Figure 11 (a) and (b) shows EC and RSC. EC represents Low Hazard Class. The RSC [18] shows negative value which indicates the reducing efficiency in toxicity. The TDS values are not reduced by the treatment facilities but brought down by mixing the sewage having low TDS and some extent COD at C1 and C2. **Figures 10 and 11** show Ir.WQHR on EC, SAR, RSC and Percent Sodium at outlet of STPs (T01, T02 and T04 – T09).



(a) (b)

Figure 11: Trends of some inlet points during 2012 – 2013 (a) EC (b) RSC.

The sewage and effluents cause enrichment of nutrients in terms of Magnesium, Calcium, Ammonium, Phosphate, Sulphate, Potassium and micro-nutrients. The TSS and organic carbon content support micro-organisms and chlorophyll of the plant kingdom. The forced aeration supports aerobic organism in consumption of organic matter. In this process, urea/ ammonia generated, pH is regulated to slightly basic. Major part of organic load is removed as TSS through the grit chambers and then sludge separators by these STPs. The aeration further decreases COD by oxidizing organic matter and stripping Ammonia. Due to enhanced nutrients with TDS from the outlet of STP, joining the Lake / river supports rich growth of algae and fish.

4. CONCLUSION

Fig.21 shows the average percentage reduction efficiency for BOD, COD, TDS, pH and TSS by treatment facilities. The average percentage ranging in these parameters of treatment facilities are 62-86, 57-90, (–2)-32, (–1.3)-(-9.5) and 81-95, respectively, indicating higher efficiency in removal of TSS followed BOD, COD, TDS and finally pH.

COD is a marker for organic load in water bodies. Properly designed and managed STPs and CETPs are capable to reduce COD by removing TSS and oxidizing organic matter. The TDS, Percent Sodium and SAR are the deep markers for quality assessment. The developed organisms in the sewage / treatment plants are capable to change many of dissolved heavy metal ions to non-soluble suspension and act as substrate to microorganisms. EC is not appropriate measurement as it provides tentative value suitable to track the correctness of the analysis, which is based on mobility of ions, varying with the composition of ions, in practice KCl ionic mobility is taken as standard. The response with measuring equipment is a logarithmic scale applicable for dilute solutions.

The projections of demand-supply-deficit bar graph from 2006 till year 2031 with 5 year intervals [19] prepared by Hyderabad Metro Water Supply and Sewerage Board (HMWSSB) estimates the total capacity of existing sewerage treatment facilities is 750 MLD. The Amberpet STP (S7) and Nagole STP (S8) are generating methane through digesters (Modified UASB Digesters) which are connected to in-house power generator. These sections are low capacities with improper operations and require attention for improvement and capacity enhancement. It is found the capacity and operation of the HMWSSB is suggested to construct STPs, additionally, equal to existing capacity with regular maintenance of STPs and enhance capacity

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of methane generation with anaerobic digesters. The latest trends of RO followed with MEE are to be adapted to reduce the TDS to desirable limit which in turn reduce TSS for water recycle and reuse. Further Studies supported for the conversion sludge to energy.

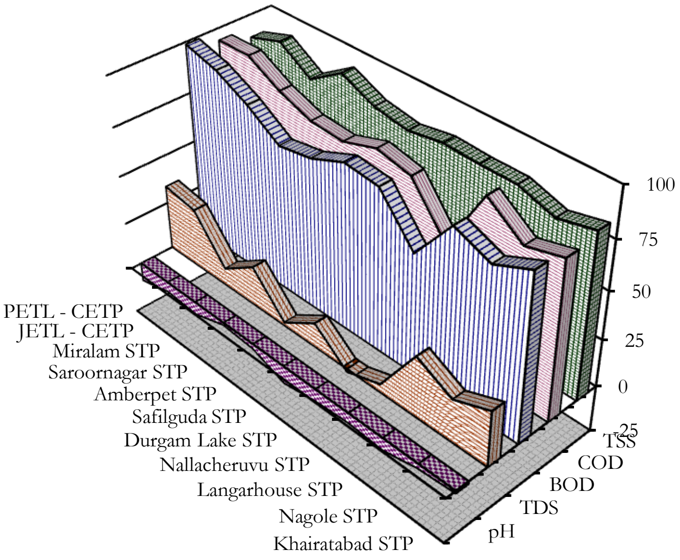

Fig. 21: STPs/CETPs removal efficiency of some parameters during 2012 – 2013.

5. ACKNOLEDGMENTS

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