Design and Operational Aspects of Common Effluent Treatment Plant in GIDA Project Area of Gorakhpur (U. P.),

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ABSTRACT: In order to minimize environmental pollution due to the small and medium-scale industries, cleaner production technologies and waste minimization are being encouraged in India. Collective treatment at a centralized facility, known as the CETP, is considered as a viable treatment solution, to overcome the constraints associated with effluent treatment in small to medium enterprises. Ever since the inception of Gorakhpur Industrial Development Authority (GIDA) in 1989, some 159 industries have come up in GIDA Project Area. However, most of the units, being small scale industries, do not have their wastewater treatment units. Besides, there is no satisfactory arrangement of wastewater treatment in large scale industries also, even though they have established their own Effluent Treatment Plants (ETP's). This is a major cause of pollution of Ami River in the region. In this paper, the design and operational aspects of a Common Effluent Treatment Plant (CETP) for large scale industries belonging to textile sector namely, M/s Lari Textiles and Dyeing Ltd., M/s Ambey Processors and M/s Bathwal Udyog Pvt. Ltd. worked out.

The design parameters have been looked into and the quantitative and qualitative aspects of effluent treatment required by CETP are also studied. The analysis of operational cost of various CETP technologies has been carried out and the comparisons are made on the basis of life cycle cost analysis of 30 years. It is revealed that the combination of UASB reactor and Facultative Waste Stabilization Pond ((FPU)) is the least cost feasible treatment technology for CETP. Accordingly, the sizing parameters of UASB reactor and Facultative Waste Stabilization Pond (FPU) are worked out and the annual saving in cost by energy recovery through biogas generation is found out. It is expected that the establishment of CETP in GIDA Project Area will be a step forward towards environmental protection and would go a long way in saving Ami River from the adverse effects of industrial pollution.

Key words: Common Effluent Treatment **(**CETP), Effluent Generating Industries, Design and Operational Aspects, Least Cost Treatment Technology.

1. INTRODUCTION

In order to minimize environmental pollution due to the small and medium-scale industries, clean production technologies and formation of waste minimization circles are being encouraged in India. Besides, collective treatment at a centralized facility, known as common effluent treatment plant (CETP) is considered as a viable treatment solution to overcome the constraints associated with effluent treatment in small to medium enterprises.

It is desired that each industrial unit will provide and operate individual wastewater treatment plant. However, the quantum of pollutants emitted by SSIs clusters may be more than an equivalent large scale industry, since the specific rate of generation of pollutants is generally higher because of the inefficient production technologies adopted by SSIs. Because of operations or lack of space or technical manpower emphasis is being given on the establishment of common effluent treatment plant (CETP) for cluster of such industrial waste loaded in various parts of the country.

1. Present Scenario of CETP's in India

At present, there are about 153 CETP's in India, which have a total capacity of 1190 MLD, and receive effluent from about 15000 industries. Out of these 153 CETP's 39 are in Tamil Nadu followed by Gujarat, which has 34 CETP's. In U.P., there are 4 CETP's. The functional aspect of some CETP's in India is described here.

1. **Jeedimetla (Andhra Pradesh) CETP**: The plant receives coloured and high TDS effluents from different dye and dye intermediate and chemical industries. The quantity of effluent received is about 1000-1200 m^3/D.
2. **Jajmau, Kanpur (Uttar Pradesh)**: The CETP set up at Jajmau receives effluent from 300 tanneries located in the area. The CETP is a 36 MLD Upflow Anaerobic Sludge Blanket (UASB) reactor.
3. **The Pallavaram CETP, Chengulpet District (Tamil Nadu):** This CETP receives effluents from 152 tanneries. The plant receives a wastewater flow of 3000 cu.m/day and also handles effluent from 3 apartment blocks located nearby.

4. Unnao CETP (Uttar Pradesh): The CETP receives an effluent inflow of 2.15 MLD. It receives effluent from mainly 21 tanneries. It is an Activated Sludge Process based CETP.

5. Mathura CETP (Uttar Pradesh): The Activated Sludge Process based Mathura CETP has an inflow capacity of 6.25 MLD. It mainly treats effluents form Textiles (Cotton) dying/printing units. The CETP receives effluents from 30 industries.

2. Design and Operational Aspects of CETP

Some important factors that influence the design of CETP in industrial areas are:

- Type of industries discharging wastewater
- Characteristics of wastewater discharged
- Qualitative and quantitative fluctuations of effluent discharges
- Pre-treatment by individual industries
- Effluent collection/conveyance system
- Place of disposal for treated waste water

A CETP may receive wastewater with different characteristics. So, the segregation of wastewater with characteristics like high TDS or high COD plays an important role in determining the treatment method. Different forms of treatment exist depending on the quantity and quality of wastewater, which may include:

- **Preliminary Treatment:** This involves a number of unit processes to eliminate undesirable characteristics of wastewater. These include use of screen, grit chambers for removal of sand and large particles, communitors and grinders for coarse solids and pre-aeration for odour control.
- **Primary Treatment:** It includes equalization for wastewaters having varying quantities and quality of flow. Neutralization is applicable for highly acidic and alkaline effluents. Sedimentation is used for separation of suspended particles.
- **Secondary treatment:** In this process purification of wastewater primarily with microbial action takes place. A number of processes are available but mainly used are anaerobic and/or aerobic treatment methods.
- **Tertiary treatment:** This process includes removal of nutrients lick nitrogen and phosphorous treatment using sand filters, activated carbon filters, micro filtration, ultra-filtration, nano filtration, reverse osmosis (RO), ion exchange, evaporation, UV filtration etc.
- **Sludge management:** This refers to the management of different types of sludge generated during wastewater treatment process. They include raw sludge, primary sludge, activated Sludge, tertiary sludge and digested sludge. Technologies in use include filter press, centrifuge, decanters, sludge drying beds etc.

2.1 Advantages and Disadvantages of CETP

The various advantages and disadvantages of a CETP are given below.

Advantages

- Homogenization of wastewater.
- Relatively better hydraulic stability.
- Professional control over treatment can be affordable.
- Facilitates small scale units, which often cannot internalize the externalities due to control of pollution.
- Eliminates multiple discharges in the area, provides opportunity for better enforcement i.e., proper treatment and disposal.
- Provides opportunity to improve the recycling and reuse possibilities.
- Facilitates better organization of treated effluent and sludge disposal etc.

2.2 Disadvantages

- Operating on ‘one-size-fits-all-basis’.
- Lack of access to capital investments, working capitals, specialized technical skills, inconsistent effluent quality from member industries.
- Improper management of treatment units at common facility.
- Varied nature and scale of the industries, along with the addition of industries in a haphazard manner, without proper planning.
- No provision to tackle the fluctuations in the pollution load and quantities, at individual member industries.
- No separate treatment units to deal with hazardous and toxic effluents, etc.

3. Need of CETP in GIDA Project Area

A large quantity of waste water is generated by the industries located in GIDA Project Area that is being discharged into Ami River. This has led to the deterioration in the quality of the river water over the years. In order to control further degradation of river water quality there is a need to setup a CETP so that the wastewater is not directly discharged into Ami River.

3.1. Planning of CETP

Out of 159 industrial units in GIDA Project Area, 154 units are small-scale industries and 5 units are large-scale units. The large scale units are:

1. M/s Ambey Processors
2. M/s Bathwal Udyog Pvt. Ltd.
3. M/s Lari Textiles and Dyeing Industries Pvt. Ltd.
4. M/s India Glycols Ltd.
5. M/s Gallant Steel Ltd.

It is realized that M/s India Glycols Ltd. is required by Central Pollution Control Board, Delhi to follow zero liquid discharge and the onus lies on the part of the industry. M/s Gallant Steel Ltd. is distantly located from the nest of the agglomeration of industrial units in GIDA Project Area as such it has to take up its own treatment mechanism. However, M/s Ambey Processors, M/s Bathwal Udyog Pvt. Ltd. and M/s Lari Textiles and Dyeing Industries Pvt. Ltd. belong to the textile sector only and the performance of their treatment plants has not been found satisfactory earlier. In addition, the effluent from these units is discharged into GIDA drain, which finds its way into Ami river. The reports of Central Pollution Control Board, Delhi have indicated that Ami river is severely victimized by industrial pollution. So, there is an urgent need to put up a CETP in GIDA Project Area. In the present scenario, therefore, it is proposed to provide a CETP for the cluster of these three units, namely, M/s Ambey Processors, M/s Bathwal Udyog Pvt. Ltd. and M/s Lari Textiles and Dyeing Industries Pvt. Ltd. It is also suggested that a detailed survey of waste load generation for the remaining small-scale units may be carried out and, in accordance with the findings, an expansion of the CETP may be subsequently, taken up, for which, enough land is available with GIDA. With this in view, design and operational aspects of a CETP for M/s Ambey Processors, M/s Bathwal Udyog Pvt. Ltd. and M/s Lari Textiles and Dyeing Industries Pvt. Ltd. have been worked out.

The wastewater samples were collected from these industries and were brought to Environmental and Public Health Engineering Laboratory of Civil Engineering Department, Madan Mohan Malaviya Engineering College, Gorakhpur and were analyzed for pH, TSS, BOD and COD.

2. Study Area

Ever since the inception of Gorakhpur Industrial Development Authority (GIDA) in 1989, Common Effluent Treatment Plant could not be set up and the industries had been required to have their own arrangements of effluent treatment. The small-scale industries could not afford to effluent treatment plants and some of them where even ignorant about it. However, M/S Lari Textiles and Dyeing Ltd., Ambey Processors and Bathwal Udyog Pvt Ltd. established their own effluent plants but, as reported by CPCB, their performance was found to be far from satisfactory.

The effluent coming out from the premises of these units appears to be of a kind that could be primary treated only. In view of this fact and their proximity with one another as shown in Fig.1, the setting up of a CETP for these units would be quite relevant.

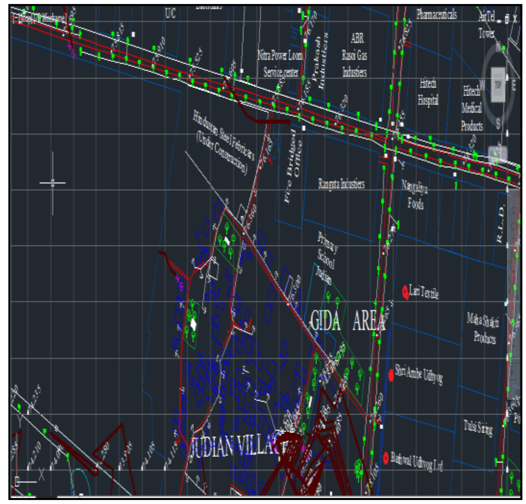

Fig. 1. Map of Study Area

3. Design and Operational Aspects

The design and operational aspects of CETP parameters relating to quality and quality of wastewater, selection of a least cost treatment option and the sizing parameters of the units belonging to secondary treatment of wastewater are discussed here.

4.1. Wastewater Quality

The test results of the samples collected from the three industrial units and analysed during this study are summarized in Table 1.

Table 1: Wastewater Characteristics of Industries Tested in Laboratory

S.No.	Parameters	Lari Textiles and Dyeing Limited	Ambey Processors	Bathwal Udyog Pvt. Ltd.
1.	pH	5.5	6.5	6.0
2.	TSS	324	433	234
3.	BOD	460	550	540
4.	COD	1800	920	1200

The teams of U. P. Pollution Control Board and Central Pollution Control Board have also been inspecting these units from time to time. The findings reported by these agencies are summarized in Table 2 and Table 3 respectively.

Table 2: Summary of Test Reports of Grab Samples of Effluent collected by Regional Officer, U. P. Pollution Control Board, Regional Office, and Gorakhpur in Respect of Effluent Quality of Industrial Units in GIDA Project Area

S.No.	Particulars/ Parameters	Lari Textiles and Dyeing Industries Pvt. Ltd.	Ambey Processors	Bathwal Udyog Pvt. Ltd.
1.	pH	8.68	8.64	8.64
2.	TSS	816	804	794
3.	BOD	580	590	530
4.	COD	2080	1940	1860

Table 3: Analysis Report of Samples Collected from Industrial Units in GIDA Project Area by C.P.C.B. Team

S.No.	Particulars/ Parameters	Lari Textiles and Dyeing Industries Pvt. Ltd.	Ambey Processors	Bathwal Udyog Pvt. Ltd.
1.	pH	7.60	6.69	8.20
2.	TSS	114	857	61
3.	BOD	98.2	263	108
4.	COD	222	618	349

The maximum value of a parameter for the respective industries as given in Tables 1, 2 and 3 is selected as design parameter. The summary of the design parameters is presented in Table 4.

Table.4. Design Parameters

S.No	Parameters	Lari Textiles and Dyeing Limited	Ambey Processors	Bathwal Udyog Pvt. Ltd.
1.	pH	8.68	7.71	8.20
2.	TSS	816	857	794
3.	BOD	580	590	540
4.	COD	2080	1940	1860

4.2. Wastewater Quantity

The wastewater generation from the three units is given in Table 5.

Table 5: Industrial Wastewater Generation

S.No.	Industries names	Wastewater generation KLD
1.	Lari Textiles and Dyeing Limited	800
2.	Ambey Processors	800
3.	Bathwal Udyog Pvt.Ltd.	800
Total		2,400

From Table 5 it is observed that the daily wastewater generation from the three industries was:

- Lari Textiles - 800 KLD
- Ambey Processors-800 KLD
- Bathwal Udyog-800 KLD

The total wastewater generation is 2,400 KLD. Hence, the Common Effluent Treatment Plant (CETP) may be designed for a discharge of 2.4 MLD.

The total organic load contributed by the industries is given in Table 6.

Table.6. Total Waste Load and Wastewater Discharge from Industries

S.No	Unit	Design Parameters					Organic load (kg BOD/d)	Organic load (kg COD/d)
		Quality				Waste Water generation KLD		
		pH	TSS	BOD	COD			
1	Lari Textiles and Dyeing Limited	8.68	816	580	2080	800	464	1664
2	Ambey Processors	7.71	857	590	1940	800	472	1552
3	Bathwal Udyog Pvt. Ltd.	8.20	794	540	1860	800	432	1488
Total							1368	4704

It is observed that the total organic load CBOD generated per day from the three industries is 1368 kg/d and the total organic load (COD) generated per day is 4704 kg/d.

It is also revealed that a CETP of 2.4 MLD capacity would be designed for influent BOD 570 mg/l and influent COD 1960 mg/l.

4.3. Selection of Least Cost Treatment Option

The unit capital and OMR cost per MLD for different combinations of treatment processes as given in Table 7 are used to work out the capital cost and annual OMR cost for various combinations CETP.

Table: 7 Per MLD cost

Combination	Capital cost of CETP		OMR cost per annum (lakhs)	
	Cost per MLD (lakhs)	Cost (lakhs)	Cost per MLD (lakhs)	Cost (lakhs)
ASP	100	100×2.4 =240	6.59	6.59×2.4= 15.81
TF	70	70×2.4 = 168	5.32	5.32×2.4 = 12.76
UASB+FPU	83	83×2.4 = 199.2	2.99	2.99×2.4 = 7.17
UASB+EAS	84	84 ×2.4 = 201.6	3.68	3.68×2.4 = 8.83
MBBR	90	90×2.4 = 216	10.01	10.01×2.4 = 24.02

However, as capital cost is one time investment only and the OMR cost is to be spent every year for the entire design period of 30 years, the life cycle cost analysis for 30 years is carried out for different CETP technologies and the summary is presented in tables.

A summary of life cycle cost analysis for different CETP technologies is presented in Table 8.

Table.8. Summary of Life Cycle Cost Analysis for Different CETP Technologies

Combination	Total Cost in 30 years (lakhs)
ASP	714.3
TF	550.8
UASB+FPU	414.3
UASB+EAS	466.5
MBBR	936.6

The combination of UASB reactor and facultative waste stabilization pond unit from Table 8 it is evident that (**UASB + FPU**) with an estimated cost of Rs. 414.3 lakhs is the least total life cycle cost for 30 years. Therefore, this technology may be used for the construction of CETP in GIDA Project Area.

4.4. Design details of CETP in GIDA Project Area

The UASB reactor proposed for CETP in GIDA Project Area as shown in Fig. 2 will have reactor size 8.9 m × 7.5 m, with a depth of 10.8 m and a free board of 0.5 m.

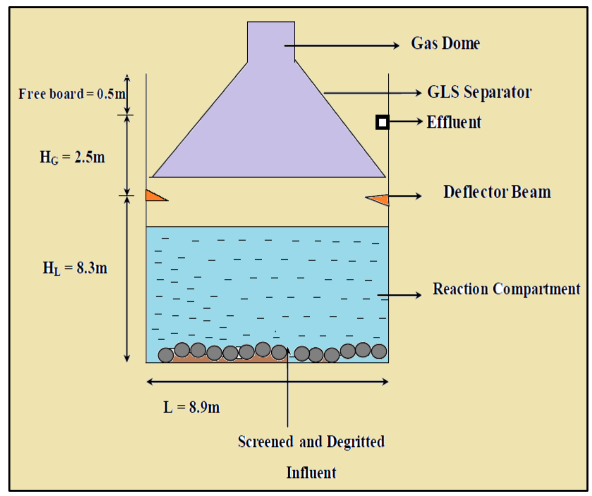

Fig. 2 Design details of the UASB reactor

It is found that the electricity generated annually from the reactor would be 174729.15 kWh while the annual saving in OMR cost is calculated to be Rs. 10.48 lakhs. In this combination, the facultative waste stabilization of size 424 m × 53 m, with a depth of 1.5 m and a free board of 0.5 m is to be used as post treatment unit. Sizing Parameters of Facultative Waste Stabilization Pond are shown in Fig. 3.

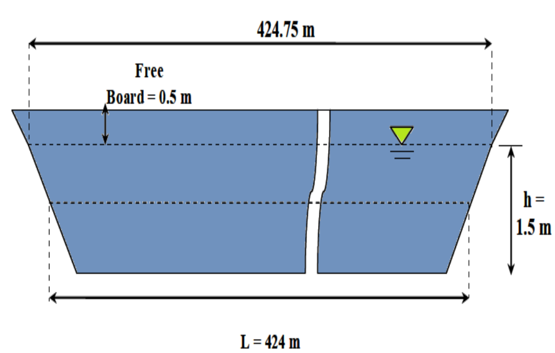

Fig. 3 Design Details of Facultative Pond

5. CONCLUSION AND RECOMMENDATIONS

After the study carried out in GIDA Project Area relating to design and operational aspects of CETP, it is found that:

1. Due to the delay in establishment of the CETP partially treated or untreated effluent from industries in GIDA Project Area is being discharged directly in Ami River, a tributary of Rapti river, which is deteriorating the quality of the river and the aquatic life present in it.

2. There are 5 large and 154 small scale industries in the GIDA Project area. All of these industries discharge their effluents into the river.
3. It is found that most of the industries do not have any effluent treatment units so far. However, some large industrial units have their own wastewater treatment plants but their performance is not satisfactory.

4. The present study has revealed that for the cluster of textile units a combination of UASB reactor along with Facultative Waste Stabilization Pond is the least cost and most feasible treatment option. So the CETP for this cluster may suitably be located, constructed and operated.

5. The capital cost of CETP is found to be Rs. 199.2 lakhs and the OMR cost is calculated as 7.17 lakhs per annum.

6. The energy recovery through biogas production from CETP will result in annual saving of Rs. 10.48 lakhs.

It is recommended that a survey should be taken up for the determination of waste load from other industrial units located in GIDA Project Area and there should be a provision for the expansion of CETP as per need.

In order to manage the CETP, there should be a Special Purpose Vehicle (SPV) registered under an appropriate statute. A legal arrangement between the SPV and its member units clearly delineating their relationship and mutual obligations should be executed and implemented. The cost recovery formula developed for the CETP project should be ratified by all the members in order to prevent any conflict in future.

It is expected that the establishment of CETP in GIDA Project Area will be a step forward towards environmental protection and would go a long way in saving Ami River from the adverse effects of industrial pollution.

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Characterize all effluents produced on-si