ADEQUACY AND EFFICACY OF EFFLUENT TREATMENT PLANT IN PESTICIDE INDUSTRY

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Abstract:

The present study has been undertaken to evaluate performance efficiency of the effluent treatment plant of pesticide industry located at Nandesari industrial Estate, Vadodara. Performance of ETP is determined by its adequacy and efficacy. The overall performance of the ETP was evaluated considering all the dimensions, actual flow and Hydraulic Retention Time(HRT) of units then find whether the design is adequate for that flow or not. This is known as ETP adequacy. Water samples were collected at each stage of treatment units and analysed for the major water quality parameters, such as pH, Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and Total Dissolved Solids (TDS), Ammonical Nitrogen, Oil & Grease which is being treated in Effluent Treatment Plant of pesticide industry. The performance efficiency of each unit in treating the pollutants was calculated as ETP efficacy. This study will help industry to achieve the desired norms of GPCB. Accordingly recommendations will make for improving the performance of ETP.

Key words: Effluent Treatment Plant, Adequacy, Efficacy, Pesticide Effluent, HRT

1. Introduction

Industrialization is backbone for growth of any country. So many industries are running which are responsible for environmental disturbance. The disturbances are may be untreated waste which generated from process, production, cleaning or washing purpose [1].

Wastewater generated from pesticides manufacturing processes consists of reaction water from chemical processes, process solvent water, process stream wash water, product wash water, spent acid etc. Because of the nature of pesticides and their components, wastewater generated from manufacturing plant is usually toxic. Washing and cleaning operations provide the principal sources of wastewater in formulating and packaging operations because these primary sources are associated with cleanup of spills, leaks, area wash down and storm water runoff.[2]

The quality of such effluent can be analyzed by their physico-chemical analysis. Monitoring of the environmental parameters of the effluent would allow having, at any time, a precise idea on performance evaluation of ETP and if necessary, appropriate measures may be undertaken to prevent adverse impact on environment. The obtained results are very much useful in identification and rectification of operational and maintenance problems and it can be also utilized to establish methods for improved performance of pesticide industry and plant waste minimization strategies.

2. Methodology

2.1 Data collection

Data was collected for water consumption and quantity of wastewater generation in industry.Details of water consumption and wastewater generation are given as table 1 and table 2 respectively.

• Source of water was GIDC water supply.

Table 1 Details of water consumption

Water consumption	Quantity
Total	310 m^3/day

Table 2 Details of wastewater generation

Wastewater Generation	Quantity
Total effluent generated	206 m^3/day
Evaporated in MEE	30 m^3/day
Incinerated after primary treatment	35 m^3/day
Total effluent treated in ETP	141 m^3/day
Domestic	16 m^3/day
Total wastewater generation	222 m^3/day

Domestic Effluent generated is disposed through septic tank & soak pit.

2.2 Detailed data collection of ETP Units

Flow diagram of ETP along with sampling locations are given as fig.1 and dimensions of each units are given as below Table 3

Table 3 dimensions of each unit

Unit	Size(m)		Capacity (m^3)
	No	L x B x (H +Free board)	
Collection tank	1	9.0m x 4.5m x(5.0+0.7FB)	200
Neutralization tank	1	1.8m x 1.8m x(2.65m+0.5mFB)	8.60
Primary clarifier	1	4.8mdia x (3m+0.9mFB)	55
Aeration tank-1	1	14.0m x 9.0m x(6.0m+0.7mFB)	756
Secondary clarifier-1	1	4.6mdia x (3m+0.9mFB)	50
Aeration tank-2	1	14.0m x 9.0m x(6.0m+0.7mFB)	756
Secondary clarifier-2	1	4.6mdia x (3m+0.9mFB)	50
Chlorination tank	1	6.0m x 4.4m x(3.0m+0.5mFB)	79.2
Filter press	1	-	40
Storage tank (treated effluent sump)	1	6.6m x 5m x(3.0mLD+0.5mFB)	115

2.3 Materials and methods

ETP efficacy:

The samples were collected at the inlet and outlet of all the treatment units. Before collection of samples containers were rinsed with the samples being collected. Grab type sampling technique was used to collect the samples. The sampling locations were identified and for which the samples should be analyzed. Sampling location named as S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9 and S_{10} shown in figure1.The samples were analyzed for various parameters like pH, COD, TSS, and TDS, Ammonical Nitrogen, Oil and Grease, depending on the results, performance of each unit was evaluated. Analysis was done in the laboratory by determining various parameters according to "standards methods for examination of water and waste water". [3]

The results obtained from the Efficacy of ETP studies were compared with the effluent standards prescribed in order to assess compliance. The result of sampling and analysis for different treatment units are given in below table 3.

ETP adequacy:

Once the general parameters for the ETP have been checked and deemed to be appropriate, the individual process components must be verified to ensure they have been designed properly.[4] With the help of actual flow of ETP calculate HRT,SOR and MLSS in different units and compare with guideline values for adequacy of ETP.

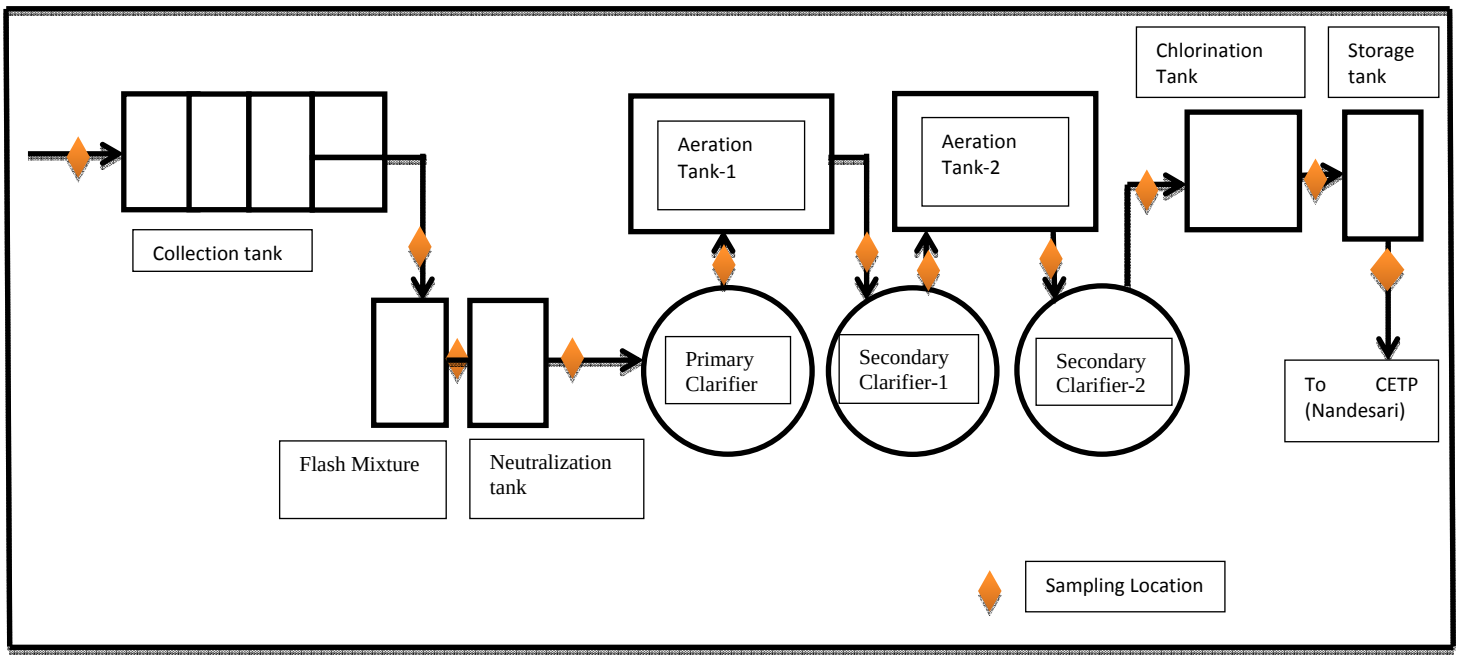

Fig-1: Flow diagram of effluent treatment plant with sampling location

3. Result and Discussion

3.1 ETP efficacy:

The results obtained from the Efficacy of ETP studies were compared with the effluent standards prescribed in order to assess compliance. The result of sampling and analysis for different treatment units are given in below table 4.

Comparison between the findings of the present study & the standards of waste water discharge quality of the treatment plant given as Table 5.

Table-4: Parameters characterised at different sampling location of ETP

Tank/Parameter	Sampling point	pH	COD(mg/l)	TSS(mg/l)	TDS(mg/l)	Ammonical nitrogen(mg/l)	Oil &grease (mg/l)
collection tank (S_1)	Inlet	8.45	20340	6316	52354	82.0	12.3
	Outlet	4.59	18216	6316	52354	82.0	12.3
Flash mixture (S_2)	Inlet	4.59	18216	6316	52354	82.0	12.3
	Outlet	8.73	16982	7048	49642	78.0	10.0
Neutralization tank(S_3)	Inlet	8.73	16982	7048	49642	78.0	10.0
	Outlet	8.45	10856	6100	48945	69.0	9.75
Primary Clarifier-1 (S_4)	Inlet	8.45	10856	6100	48945	69.0	9.75
	Outlet	7.89	6624	4244	45798	65.4	7.9
Aeration tank-1 (S_5)	Inlet	7.89	6624	4244	45798	65.4	7.9
	Outlet	7.56	4048	MLSS:6854	42750	56	6.8
Secondary clarifier-1 (S_6)	Inlet	7.56	4048	-	42750	56	6.8
	Outlet	7.53	3128	1672	39244	52	6.5
Aeration tank-2 (S_7)	Inlet	7.53	3128	1672	39244	52	6.5
	Outlet	7.74	3057	MLSS:5873	35893	49.2	6.3
Secondary clarifier-2(S_8)	Inlet	7.74	3057	-	35893	49.2	6.0
	Outlet	7.78	2944	1054	30512	43.2	6.0
Chlorination tank (S_9)	Inlet	7.78	2944	1054	30512	43.2	5.8
	Outlet	6.88	2392	678	25390	42	5.75
Storage tank(S_{10})	Outlet	7.20	1840	660	24302	41	5.75

Table 5 Comparison between the findings of the present study & the standards of waste water discharge quality of the treatment plant

Parameter	Acceptable limit of CETP Nandesari	Present findings of the treated effluent plant
pH	5-9	7.20
COD	2000	1840
TSS	600	660
TDS	-	24302
Ammonical nitrogen	50	41
Oil and Grease	20	5.75

3.2 Overall Efficiency of the Effluent treatment plant:

Removal efficiency of different parameters in different units is given as below table 6 and removal efficiency of primary treatment and secondary treatment is given in below Table 7.

Table 6 Removal Efficiency (%) of different parameters in different units

Parameter	Neutralization tank (S2-S3) (%)	Primary clarifier (S3-S4) (%)	Secondary clarifier-1 (S4-S6) (%)	Secondary clarifier-2 (S6-S8) (%)	Chlorination tank (S8-S9) (%)	Total removal Efficiency (%)
COD	36.07	38.98	52.77	5.88	18.75	89.89
TSS	13.45	30.42	60.60	36.96	35.67	89.55
Ammonical nitrogen	11.53	5.22	20.48	16.92	2.77	50
Oil and grease	2.5	18.97	17.72	10.76	3.33	43.90

Table 7 Removal efficiency (%) of Primary and secondary treatments

Parameter	Primary treatment (S_2-S_4) (%)	secondary treatment (S_5-S_9) (%)
COD	63.64	63.88
TSS	32.80	84.02
Ammonical nitrogen	16.6	35.77
Oil and grease	35.77	27.21

3.3 ETP adequacy:

Design flow of ETP = 200 m^3/d
Actual flow of ETP =141 m^3/d

Design Flow Rate for ETP[4]

a) Calculate the average flow rate (Qav) for the design of the ETP using the following formula.

$$Q_{avg}\,(m^3/hr) = \frac{\text{Total volume of effluent to be treated } (m^3/d)}{\text{Total hr of ETP Operation (hr/d)}}$$

$$= \frac{141}{8}$$

$$= 17.625\ m^3/hr$$

b) Calculate Hydraulic Retention Time (HRT) as follows:

$$\text{HRT (hours)} = \frac{\text{Total Volume } (m^3)}{\text{Flow rate of Effluent } (m^3/hr)}$$

c) Check surface overflow rate (SOR) using the following equation:

$$\text{SOR (m/h)} = \frac{\text{Flow } (m^3/hr)}{\text{Surface area of clarifier } (m^2)}$$

Where: Surface Area = $0.785 \times D^2$ (m^2)

d) Calculated HRT, SOR and MLSS given in below Table 8

Table 8 Check HRT and SOR of treatment Units

Treatment unit	HRT (hours)	Check HRT falls within guidelines (hours)	SOR ($m^3/hr/m^2$)	Check SOR falls within guidelines ($m^3/hr/m^2$)	MLSS	Check MLSS Falls within guideline	Remark
Collection tank	11.30	8-10	-	-	-	-	Adequate
Flash Mixture	0.70	0.8-0.13	-	-	-	-	Adequate
Primary clarifier	3.12	2	0.97	0.9 - 1.2	-	-	Adequate
Aeration tank-1	42.89 hr	36 – 48	-	-	6854	3000-5000	MLSS more than limit
Secondary clarifier-1	2.83	2 - 2.5	1	0.75 - 1.0	-	-	Adequate
Aeration tank-2	42.89 hr	36 – 48	-	-	5873	3000-5000	MLSS more than limit
Secondary clarifier-2	2.83	2 - 2.5	1	0.75 - 1.0	-	-	Adequate
Chlorination tank	4.49	2	-	-	-	-	Adequate

4. Conclusion:

The removal efficiency of overall treatment units are 89.89% of COD, 89.55 % of TSS, 53.58 % TDS,50 % Ammonical Nitrogen, 43.90% Oil and grease. The overall performance of the effluent treatment plant was satisfactory except TSS in final effluent 660 mg/l which is above the permissible limit 600 mg/l.

The design of effluent treatment plant is adequate for Actual flow 141 m^3/d. The HRT and SOR fall within guidelines of Effluent treatment plant [3].

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