Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 07, July -2018

PERFORMANCE STUDY AND EVALUATION OF PHARMACEUTICAL TREATMENT PLANT AT BIDAR

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Abstract—*Pharmaceutical industry produces hazardous, toxic, and high strength Organic liquid wastewater. The bulk drug manufacturing process involves usage of more organic and inorganic salts, which are becoming a major part of high chemical oxygen demand and Total Dissolved Solids. The present paper has been undertaken for the "Performance Study and Evaluation of Pharmaceutical Treatment Plant at Bidar". The pH, Turbidity, Total Suspended Solids, Total Dissolved Solids, COD, DO and Oil And Grease were found to be 6.78, 0.6NTU, Nil, 1800 mg/L, 176mg/L, 0.07 mg/L and Nil, for LTDS waste and 9.31, 204NTU, Nil, 6147 mg/L, 6427mg/L, 0.06 mg/L and Nil, for HTDS waste respectively. The quality of treated waste water is within the Permissible Limits of Karnataka State Pollution Control Board (KSPCB).*

Keywords— *Zero-Liquid Discharge, Thermal Vapour Recompression, Flue Gas Desulfurization, Primary Tube Deck Tank and Bio Tower Sump*

1. INTRODUCTIOIN

The pharmaceutical industry is set with high-value, low volume multiproduct plants on one hand which are mostly batch operations where in the effluent is mixed and treated. These plants use different types of reactants, (homogeneous) catalysts, solvents, solids, and water handled in special equipment. In these types of units, the major cost of the drug depends on the type of impurity rather than on the purity of the drug. Thus, Separation Processes play a very vital role in this industry. Further, ultrapure water is used in the pharmaceutical sector to give multiple washings to the solid cake or to use as an extractant or as a solvent. Moreover this water is not reused due to strict regulations as defined in Drug Master File (DMF)[1], etiquettes approved by the authorities. Of late, management and in-plant control of industrial wastes is becoming a major concern. Due to increasing environmental awareness associated with industrial waste, companies must now incorporate waste management and prevention strategies into industrial process. A wide range of pollution prevention opportunities could be implemented with significant financial advantages for factories, as well as reducing environmental pollution. Pharmaceutical waste water can be treated using different techniques. Activated sludge was used for different therapeutic groups with diverse physicochemical properties; pilot scale membrane bioreactor exhibited enhanced elimination of several pharmaceutical residues poorly removed by the activated sludge system. High pressure driven membranes such as Nano Filtration Membrane and a Reverse Osmosis Membrane are considered to be effective for control and treatment of Pharmaceutical Wastewater**.**

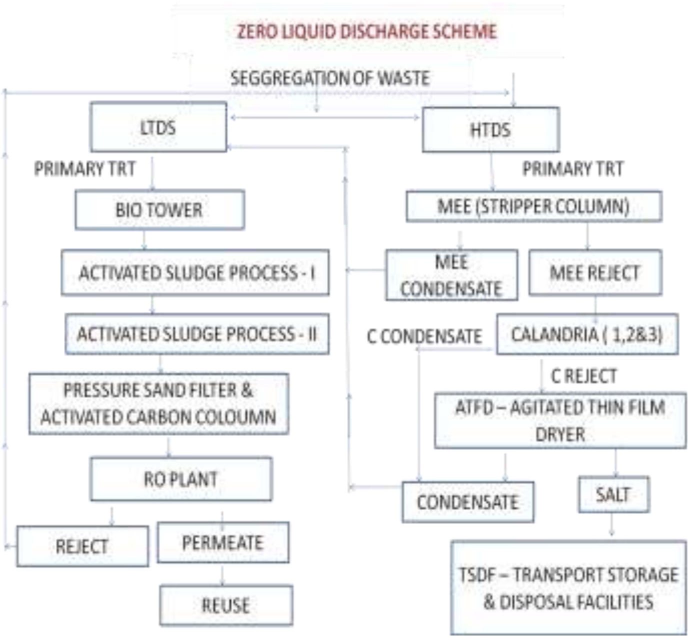

Fig 1: Flowchart Representing Treatment of Waste Water done on the basis of condition 1 and 2 i.e. LTDS and HTDS.

1.1 PHARMACEUTICAL PROCESS WASTEWATER

Water is a critical raw material in Pharmaceutical and chemical manufacturing operations, consistent and high-quality water supplies are required for a range of operations including production, material processing, and cooling. The various categories of water which need treatments as part of water management are potable water, process water, feed water for utilities, water recycling, wastewater and water coming from by product treatment. Water is widely used as a raw material, ingredient, and solvent in the processing, formulation, and manufacture of pharmaceutical products, APIs and intermediates, compendia articles, and analytical reagents. Process water quality management is of great importance in manufacturing and is also a mandatory requirement for the sterilization of containers or medical devices in other healthcare applications including water for injection. Process waste waters are a term used to define waste water in any industry coming from the processes occurring in the industry. Process waste waters thus cover any water which at the time of manufacturing or processing comes in contact with the raw materials, products, intermediates, by products, or waste products, which are handled in different unit operations or processes. In fact, the waste water coming out of pharmaceutical units varies in content and concentration, and thus a unique treatment is not attempted since the volumes are small and different products are manufactured from the same battery of reactors and separators. Water reuse provides savings through the reduction of waste disposal costs and feed water requirements, offsetting operational costs associated with the waste reuse process.

1.2 Objectives of the Study

1. To study the Characteristics of raw effluent waste water.
2. To suggest the Recycling and Reuse possibilities for Treated waste water.
3. To suggest any improvement for treatment plant, if needed.

2. LITERATURE REVIEW

Nayana H. Brahmbhatt and Krishna Y. Pandya (Performance evaluation of effluent treatment plant and hazardous waste management of Pharmaceutical Industry)

Various parameters of effluent of this pharmaceutical industry like pH, Ammonical Nitrogen, BOD & COD were analysed. The percentage reduction of 22.33 %, 79.32%, 97.32% and 98.34% reduction was achieved respectively. From the entire study it has been concluded that the effluent discharge was found under the given permissible limits by statutory authority, this was possible only because of wisely formed environmental policy, installation of effective and efficient pollution control technology and equipment, regular monitoring of various environmental parameters, and solid waste management whether they are complying with the given standard or not. On the whole the better and efficient ETP system of the company makes it CLEAN and GREEN.

Ahmad Ashfaq and Amna Khatoon (Evaluating Toxicological Effects, Pollution Control And Waste Water Management In Pharmaceutical Industry)

The performance of the ASP has been found to be more efficient when operating on an extended aeration basis. The design parameters of the process were evaluated for the treatment of pharmaceutical waste. The study revealed that at an extended aeration period of 20 hours.COD and BOD removal efficiency ranges of 89 95% and 88 98% can be achieved. The COD and BOD values of the treated effluent were found to be 74 mg/Land 43 mg/L. respectively. In contrast; the performance of an extended aeration system for the treatment of pharmaceutical wastewater at Lincoln, Nebraska was poor at an organic loading of 30 kg BOD/day and a detention period of 25 hours. The percentage BOD reduction ranged from 30 to 70%. The degree of treatment provided was quite variable and insufficient to produce a satisfactory effluent.

3. MATERIAL AND METHODOLOGY

3.1 Detailed Description about Pharmaceutical Plant

The present study on “PERFORMANCE STUDY AND EVALUATION OF PHARMACEUTICAL TREATMENT PLANT” at M/s Sai Life Sciences Pvt. Ltd is located at kolhar Industrial Area, Bidar district, Karnataka. This company is set up in 10 acres of land. Fresh water is collected through bore wells; total fresh water up to 20KL to 50 KL is consumed per day. This industry has constructed an ETP for a flow rate of 50KLD. The effluent treatment plant at the M/s Sai Life Sciences Pvt. Limited industry is established for treating complex industrial waste water. Also the raw waste water contains high COD, TDS. The Zero Liquid Discharge scheme is adopted for treating waste. It mainly consists of three stages i.e. Primary, Secondary and Tertiary.

Primary treatment comprising of screening, grit removal, oil and grease removal equalisation followed by PH adjustment, chemical coagulation and solid –liquid separation. Secondary treatment comprises of two stage biochemical treatment. Tertiary treatment comprising of filtration and adsorption.

3.2 Parameters COD and TDS

Condition 1:
High TDS (HTDS): If TDS => 8000 mg/l and COD => 15000 mg/l
Treated under Multiple Effect Evaporators (MEE).

Condition 2:
Low TDS (LTDS): If TDS =< 8000 mg/l and COD =< 15000 mg/l
Treated under Biological Treatment Plant.

3.3 Sampling Procedure
Sampling Points:
Samples to be collected at inlet feed and outlet of various Unit Operations, such as Primary Tube Deck Tank (PTD), Bio Tower Sump (BT), Aeration Tank (AT) and Clarifier (CL) of ASP I and ASP II, Reverse Osmosis (RO) system, Oil and Grease, Stripper Column, Calandria's and Agitated Thin Film Drier (ATFD).
The samples collected at this sampling point are denoted by specific sampling number given in Table 1

Sampling Point	Sampling No	Sampling Point	Sampling No
Raw waste	L1	Raw waste	H1
PTD outlet	L2	Oil/grease	H2
BT outlet	L3	PTD outlet	H3
AT I	L4	Stripper outlet	H4
CL 1	L5	MEE Feed	H5
AT 2	L6	MEE Reject	H6
CL 2	L7	Condensate	H7
ACF/PSF	L8		
RO Feed	L9		
RO Reject	L10		
RO Permeate	L11		

Table 1: Notation of Samples at a specific Sampling Point

Physical-Chemical Analysis of waste water is done as Per Standard Methods.

Parameters	Method of Analysis
pH	Electrometric Method
Total suspended Solids	Dried Oven Method
Dissolved Solids	Dried Oven Method
COD	Closed Reflux Method
Oil And Grease	Partition Gravimetric Method
Dissolved Oxygen	The Winkler's Method with Azide Modification

Table 2: Method of Analysis of Wastewater

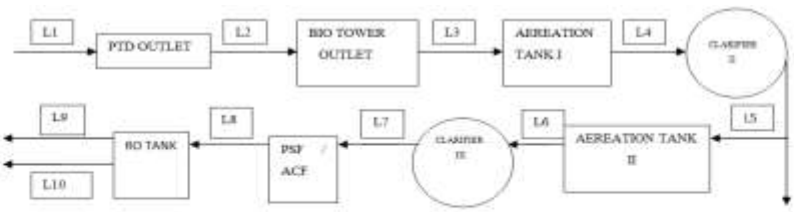

Fig 2: Flowchart for LTDS Waste

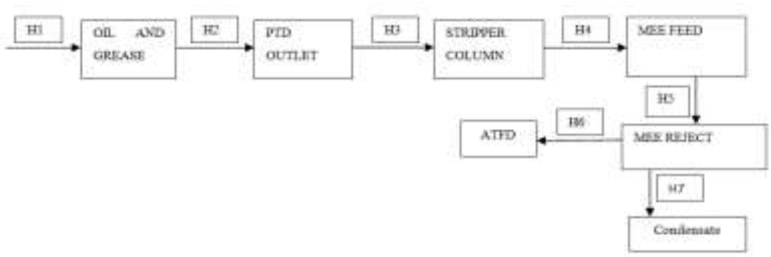

Fig 3: Flowchart for HTDS Wast

4. RESULT AND DISCUSSION

4.1 Characteristics of ETP (Average Values)

Parameter V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
pH	7.11	7.86	7.76	7.70	8.54	8.02	8.19	7.21	7.30	7.23	6.78
TURBIDITY	444	447	422	343	403	297	402	286	217	488	0.6
TSS	757	340	1530	1357	560	1663	610	463	297	510	--
TDS	4277	4288	5083	8420	4555	8792	4423	10477	9395	21633	1800
COD	10853	9827	6587	5680	--	5320	--	5333	5373	12140	176
DO	0.70	0.82	0.11	1.47	--	1.53	--	0.44	0.24	0.13	0.07
O/G	11.62	5.37	0.47	--	--	--	--	--	--	--	--

Table 3(a): Characteristics of ETP (Average Values) for LTDS

Parameter V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
pH	9.69	7.21	7.72	8.26	7.20	7.51	9.31
TURBIDITY	437	424	380	367	388	475	204
TSS	1587	1723	1149	1893	2323	354433	--
TDS	21667	22367	25723	31533	45933	74807	6147
COD	14933	16880	20800	34440	28373	46933	6427
DO	0.04	0.12	0.15	0.08	0.09	0.05	0.06
O/G	33.49	11.64	3.34	--	--	--	--

Table 3(b): Characteristics of ETP (Average Values) for HTDS

4.2 ETP Performance

4.2.1 pH

Weekly Variation of pH at different Sampling Points for LTDS and HTDS waste.

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	11.90	7.93	7.75	7.69	8.6	7.96	7.60	7.41	7.80	7.25	7.10
17-7-17	3.24	7.81	8.22	8.16	8.62	8.28	8.76	7.11	6.48	6.53	6.01
24-7-17	6.20	7.83	7.32	7.25	8.40	7.83	8.20	7.11	7.62	7.91	7.23
Average	7.11	7.86	7.76	7.70	8.54	8.02	8.19	7.21	7.30	7.23	6.78

Table 4(a): pH values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	9.20	7.21	7.81	8.11	7.24	7.62	9.30
17-7-17	10.9	7.31	7.72	8.34	7.14	7.25	9.23
24-7-17	8.96	7.11	7.63	8.32	7.22	7.65	9.41
Average	9.69	7.21	7.72	8.26	7.20	7.51	9.31

Table 4(b): pH values for HTDS waste

4.2.2 Turbidity

Weekly Variation of Turbidity at different Sampling Points for LTDS and HTDS waste

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	460	468	502	360	480	352	495	301	210	520	0.10
17-7-17	398	401	294	280	320	260	378	244	198	482	1.60
24-7-17	474	473	470	389	410	280	332	312	242	462	0.10
Average	444	447	422	343	403	297	402	286	217	488	0.60

Table 5(a) : Turbidity values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	550	541	490	510	580	610	120
17-7-17	381	411	363	385	348	382	298
24-7-17	381	320	286	207	237	432	194
Average	437	424	380	367	388	475	204

Table 5(b) : Turbidity values for HTDS waste

4.2.3 Total Suspended Solids

Weekly Variation of Total Suspended Solids at different sampling point for LTDS and HTDS waste.

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	762	330	1550	1300	550	1650	610	460	290	510	-----
17-7-17	760	350	1560	1450	580	1680	620	480	320	530	-----
24-7-17	750	340	1480	1320	550	1660	600	450	280	490	-----
Average	757	340	1530	1357	560	1663	610	463	297	510	-----

Table 6(a) : Total Suspended Solids values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	1810	1970	1286	1870	2250	348300	-----
17-7-17	1830	1920	1280	1850	2290	349700	-----
24-7-17	1120	1280	880	1960	2430	365300	-----
Average	1587	1723	1149	1893	2323	354433	-----

Table 6(b) : Total Suspended Solids values for HTDS waste

4.2.4 Total Dissolved Solids

Weekly Variation of Total Dissolved Solids at different sampling point for LTDS and HTDS waste.

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	4570	4483	5180	8420	4671	8870	4210	10040	9200	21300	1900
17-7-17	3680	3890	4810	8530	4530	8915	4490	9870	9120	21000	1700
24-7-17	4580	4492	5260	8310	4463	8590	4570	11520	9865	22600	1800
Average	4277	4288	5083	8420	4555	8792	4423	10477	9395	21633	1800

Table 7(a): Total Dissolved Solids values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	22800	23000	26300	31500	45200	76000	5840
17-7-17	18800	20020	23670	29800	46500	73820	6500
24-7-17	23400	24080	27200	33300	46100	74600	6100
Average	21667	22367	25723	31533	45933	74807	6147

Table 7(b): Total Dissolved Solids values for HTDS waste

4.2.5 Chemical Oxygen Demand (COD)

Weekly Variation of Chemical Oxygen Demand at different sampling point for LTDS and HTDS waste

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	10720	9720	6800	5680	---	5480	---	5320	5200	11700	168
17-7-17	10960	9920	6640	5600	---	5320	---	5600	5920	12240	192
24-7-17	10880	9840	6320	5760	---	5160	---	5080	5000	12480	168
Average	10853	9827	6587	5680	---	5320	---	5333	5373	12140	176

Table 8(a): Chemical Oxygen Demand values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	15040	17520	20160	35160	27200	46000	5840
17-7-17	14720	16240	22560	33920	28800	47600	6880
24-7-17	15040	16880	19680	34240	29120	47200	6560
Average	14933	16880	20800	34440	28373	46933	6427

Table 8(b): Chemical Oxygen Demand values for HTDS waste

4.2.6 Dissolved Oxygen (DO)

Weekly Variation of Dissolved Oxygen at different sampling point for LTDS and HTDS waste

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	0.74	0.85	0.10	1.5	---	1.6	---	1.12	0.54	0.21	0.09
17-7-17	0.70	0.81	0.10	1.3	---	1.1	---	0.05	0.05	0.09	0.06
24-7-17	0.65	0.80	0.12	1.6	---	1.9	---	0.15	0.12	0.08	0.05
Average	0.70	0.82	0.11	1.47	--	1.53	--	0.44	0.24	0.13	0.07

Table 9(a): Dissolved Oxygen values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	0.06	0.10	0.16	0.08	0.09	0.05	0.05
17-7-17	0.05	0.12	0.15	0.08	0.10	0.03	0.05
24-7-17	0.02	0.13	0.14	0.09	0.09	0.07	0.07
Average	0.04	0.12	0.15	0.08	0.09	0.05	0.06

Table 9(b): Dissolved Oxygen values for HTDS waste

4.2.7 Oil and Grease

Weekly Variation of Oil and Grease at different sampling point for LTDS and HTDS waste

Days V/s Sampling Point	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
10-7-17	12.51	6.42	1.4	---	---	---	---	---	---	---	---
17-7-17	12.59	5.2	0.1	---	---	---	---	---	---	---	---
24-7-17	9.76	4.5	0.15	---	---	---	---	---	---	---	---
Average	11.62	5.37	0.47	---	---	---	---	---	---	---	---

Table 10(a): Oil and Grease values for LTDS waste

Days V/s Sampling Point	H1	H2	H3	H4	H5	H6	H7
10-7-17	33.4	12.92	4.54	---	---	---	---
17-7-17	35.8	11.26	2.91	---	---	---	---
24-7-17	31.26	10.75	2.58	---	---	---	---
Average	33.49	11.64	3.34	---	---	---	---

Table 10(b): Oil and Grease values for HTDS waste

The performance of ETP in terms of Removal Efficiency (%) in the pollution parameters is given in Table11(a)

Parameters	Units	Overall Efficiency
COD @ LTDS	mg/L	98%
COD @ HTDS	mg/L	57%
Total dissolved solids @ LTDS	mg/L	58%
Total dissolved solids @ HTDS	mg/L	71%

Table 11(a): Performance of ETP in terms of Removal Efficiency

4.3 Use of Treated Waste Water

Waste water from ETP is treated to meet the KSPCB standards, which can be used for gardening and cooling blow down purposes. Comparison of wastewater quality parameters with their prescribed values by the Karnataka State Pollution Control Board (KSPCB) are listed in Table 12

Sl. No	Parameters	Units	Treated wastewater	Permissible limit
1	pH	---	6.78	6.5-8.5
2	Turbidity	NTU	0.6	<10
2	Total suspended solids	mg/L	nil	<200
3	Total dissolved solids	mg/L	1800	<2100
4	COD	mg/L	176	250
5	Oil and Grease	mg/L	nil	10

Table 12: Comparison of wastewater quality parameters with their prescribed values by the Karnataka State Pollution Control Board (KSPCB)

(Source: The Karnataka State Pollution Control Board, Bangalore**)**

I. CONCLUSION

Based on the characteristics study of the performance evaluation of pharmaceutical treatment plant at Bidar, the following conclusions can be drawn.

- The pH, Turbidity, Total Suspended Solids, Total Dissolved Solids, COD, DO and Oil and Grease were found to be 6.98, 0.6NTU, Nil, 1800 mg/L, 176mg/L, 0.07 mg/L and Nil, respectively. (Average Values of LTDS waste)
- The pH, Turbidity, Total Suspended Solids, Total Dissolved Solids, COD, DO and Oil and Grease were found to be 9.31, 204NTU, Nil, 6147 mg/L, 6427mg/L, 0.06 mg/L and Nil, respectively. (Average Values of HTDS waste)
- The quality of treated waste water is within the permissible limits of KSPCB. This treated water (RO permeate) with addition of a minimum percentage of pure water may be used for cooling tower blow down.
- The industry adopts ZLD scheme which results in generation of the huge amount of hazardous solid wastes (particularly waste mixed with salt) causing disposal challenges. Presently the Hazardous solid waste (salt) is stored in the premises of the treatment plant itself which has to be disposed off in a secured landfill site at a later stage.

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