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Pharmaceutical and Bulk Drug Industry Wastewater – Solutions for Water Treatment

Ashok Kumar Popuri*

VFSTR University, Vadlamudi, Guntur (Dist), Andhra Pradesh, India.
S.V.U. College of Engineering, S.V. University, Tirupati, Andhra Pradesh, India.

Abstract : The disposal or treatment of effluents generated in bulk drug industries is the major problem due to its harmful effects on biosphere. As the Effluents from these industries have high pH, floating aerators, oil and grease, suspended solids, dissolved solids, organic matter (BOD & COD), dissolved solids contain inorganic salts like sulphates, chlorides, metal ions and even organic matters like proteins, fats etc. To the posed problems, this approach involves, performing tests in CETP for COD, BOD, TDS, SS, etc. The test results are calculated at input and output of different effluent stages and these properties were compared with the standard norms. Various factor like performance, efficiency, energy requirements and economic factors for different unit operations are calculated and they were compared with the designed data available. This can be used for design of a new plant with similar characteristics with higher capacity.
Keywords : Effluent Treatment, BOD, COD, TDS, SS, CETP.

1. Introduction

Andhra Pradesh contributes to about 40% of the total production of pharmaceuticals in the country. The state is fast emerging as the pharmaceutical capital of India and its pharmaceuticals sector is well known internationally for its skills in chemical synthesis, process engineering and its response to the market[1-2].

Effluent treatment at CETP: Common Effluent Treatment Plant receives effluents from various industries of pharmacity for treatment and disposal. The treatment systems provided are low TDS treatment system, high TDS treatment system, treatment for cyanide bearing effluents and treatment for heavy metal bearing effluents[3-4].

Low TDS effluents treatment system: Low TDS effluent treatment system is designed to treat 4.5 MLD (3.5MLD-LTDS & 1.0MLD-HTDS) of effluents. Pre-treated effluents from industries are collected in sump and treated in the sequence of preliminary treatment of LTDS, primary treatment of LTDS, secondary treatment of LTDS and tertiary treatment of LTDS[5-6].

High TDS effluent treatment system: High TDS effluent treatment system is designed to treat 1.0 MLD of effluents. Pre-treated effluents received from units are treated in thissystem[7-8].

2. Experimental

2.1 pH test

Calibrate the instrument with 4,7and 9.2 buffer solutions and ensure the calibration is completed. Take 100ml of sample into a cleaned beaker place the electrode and temperature probe into the beaker wait until it shows the constant reading on LCD screen[9].

2.2 COD (Chemical Oxygen Demand)

A sample is refluxed in strong acid solution with a known excess of potassium dichromate. After digestion the remaining unreduced $K_2Cr_2O_7$ is titrated with FAS to determine the amount of $K_2Cr_2O_7$consumed and the oxidized matter is calculated in terms of oxygen equivalent[10].

2.3 TDS (Total Dissolved Solids)

Sample is filtered through filter paper and the filtrate is evaporated to dryness in a weighted dish and dried to constant weight at 180^{o}C[11].

2.4 SS (Suspended Solids)

Dry GF/A paper for 1hr at 105 ^{0}C and keep it in silica gel for 30min and measure its weight. Add 50ml sample on the paper, apply vacuum and dry the paper in oven at 105 ^{0}C and ool the paper by keeping it in silica gel and measure its weight[12].

2.5 Ammonical nitrogen

The sample is buffered at pH 9.5 with a borate buffer to decrease hydrolysis of cyanates and organic nitrogen compounds. It is distilled into a boric acid solution and determines ammonia in distillate titrimetric ally with std. H_2SO_4 and mixed indicator[13].

3. Results and Discussion

3.1 Laboratory report

Table 1: Permissible limits for receiving pretreated effluents to CETP

Parameter	Low TDS effluent discharge limits	High TDS effluent discharge limits	Standard methodology code
pH	6.5-8.5	6.5-8.5	APHA-4500
Temperature	<45	<45	APHA-2550 B
Oil and grease	20	20	APHA-5520 B
Total dissolved solids-inorganic	12000	>12000	APHA-2540 C
Total suspended solids	<600	<600	APHA-2540 D
Biological oxygen demand-5 days	3000	<25000	APHA – 5210 B
Chemical oxygen demand	8000	<50000	APHA – 5220 B,C
Chromium hexavalent - Cr+6	2	2	APHA-3500 Cr D
Total chromium – Cr	2	2	APHA-3030-D, 3110
Ammonical nitrogen –NH_3-N	50	50	APHA-4500 NH_3 B,C
Cyanide – CN	0.2	0.2	APHA-4500 CN-c, d
Lead –Pb	1	-	APHA-3030-D, 3110
Nickel – Ni	3	-	APHA-3030-D, 3110
Zinc – Zn	15	-	IS:3025 (Part 49)
Arsenic – As	0.2	-	APHA-3030-D, 3110
Mercury – Hg	0.01	-	APHA-7470 A

3.2 LTDS samples test

Table 2: LTDS sample-1 test

Sample-1	pH	TDS	COD	SS	AN	SV
Decant composite	8.0	5020	659	184	157	-
Feed composite	7.2	4940	3505	208	185	-
HTDS sump	8.4	99050	71155	1130	-	-
LTDS sump	7.4	1500	1360	-	-	-
Storm water	7.5	-	580	-	-	-
1B tank	7.2	4680	7795	189	-	-
MHRSCC	7.1	5090	7691	196	-	-
C-tech	-	-	-	3880	-	380

Table 3: LTDS sample-2 test

Sample-2	pH	TDS	COD	SS	AN	SV
Decant composite	8.1	5560	771	146	246	-
Feed composite	7.0	4960	3608	154	179	-
HTDS sump	6.1	62420	80360	2350	-	-
LTDS sump	6.9	4360	5357	-	-	-
Storm water	7.7	-	437	-	-	-
1B tank	7.3	3710	9348	176	-	-
MHRSCC	7.3	3560	9457	172	-	-
C-tech	-	-	-	3370	-	380

3.3 HTDS samples test

Table 4: HTDS sample-1 test

Sample-1	pH	TDS	COD	Hardness	SS	Density	AN
MEE feed	7.4	123860	73771	-	990	1.035	-
Conc. 145	6.2	194570	86328	-	-	-	-
Scrubber composite	12.9	39470	-	-	-	-	-
Cooling	8.7	1310	6017	-	-	-	-
Stripping inlet	9.8	810	23544	-	-	-	448
Stripping out	9.7	780	19097	-	-	-	358
Online	7.5	11	-	2	-	-	-
Storage tank	8.5	13	-	2	-	-	-
Raw water	7.6	183	-	80	-	-	-
Feed water	8.6	19	-	2	-	-	-
Blow water	10.5	348	-	3	-	-	-

Table 5: HTDS sample-2 test

Sample-2	pH	TDS	COD	Hardness	SS	Density	AN
MEE feed	7.6	116670	68539	-	1660	1.039	-
Conc. 145	6.2	201510	94176	-	-	-	-
Scrubber composite	12.1	44480	-	-	-	-	-
Cooling	8.7	1710	5860	-	-	-	-
Stripping inlet	9.8	1010	23021	-	-	-	487
Stripping out	9.9	840	17266	-	-	-	392
Online	9.8	22	-	2	-	-	-
Storage tank	7.6	180	-	82	-	-	-
Raw water	9.2	15	-	2	-	-	-
Feed water	9.2	19	-	2	-	-	-
Blow water	10.6	330	-	4	-	-	-

Table 6: Composition of effluent after treatment

Parameter	Effluent limits	After biological	After sand and carbon filter
pH	6.5-8.5	7.0-8.5	7.0-8.5
Temperature	<45	28	28
Oil and grease	20	-	-
Total dissolved solids-inorganic	5000-12000	3500-5000	3500-5000
Total suspended solids	200-600	30- 20	20-50
Biological oxygen demand-5 days	2500-3000	50-75	25-50
Chemical oxygen demand	5000-8000	400-500	160-250
Chromium hexavalent - Cr+6	1.0-2 0	0.5- 1.0	0.0- 0.5
Total chromium – Cr	1.0- .0	0.5-1.0	0.0-0.5
Ammonicalnitrogen – NH_3-N	25-50	45-70	25-40
Cyanide – CN	0.2	< 0.2	< 0.2
Lead – Pb	1	< 1.0	< 1.0
Nickel – Ni	3	< 3.0	< 3.0
Zinc – Zn	15	< 5.0	< 5.0
Arsenic – As	0.2	< 0.2	< 0.2
Mercury – Hg	0.01	< 0.01	< 0.01

All parameter values are in mg/l except pH and temperature (^{0}C).The comparative studybetween the input and output effluent is done using chemical analysis at different stages.The results are falling under the range of pollution control board norms.

3.4MEE design parameters

Table 7: MEE design parameters

Calandria	Feed (L)	Evaporate (L)	Conc. (%)	Vacuum pressure (mm Hg)	Absolute pressure (bar)	Area of tubes (m^2)	U ($W/m^2.K$)	Q (W)
	25000		8%		(AP-VP)			Q=UA ΔT
C-1	16666	8333.3	12	50	710	271.2	98.039	281935
C-2	14285	2380.9	14	200	560	266.5	98.039	130679
C-3	12499	1785.7	16	350	410	203.4	98.039	199482
C-4	9090	3409.0	22	550	210	142.2	98.039	223124
C-5	4999	4090.9	40	630	130	375.8	98.039	515883
-	-	-	-	-	760	-	-	-
-	-	19999	-	1780	2780	1259	490.1	13511

3.5 MEE calculations based on operation

Table 8: MEE design outputs

Calandria	Feed (L)	Evaporate (L)	Concentration (%)	Vacuum pressure (mm Hg)	Area of tubes (m^2)	Pressure of evaporation (mm Hg)	Temp. of evaporation (deg C)
	25000		8%				
C-1	16666	8333.3	12%	50	271.2	710	94.7
C-2	14285	2380.9	14%	200	266.5	560	97.5
C-3	12499	1785.7	16%	350	203.4	410	90
C-4	9090	3409.0	22%	550	142.2	210	77
C-5	4999	4090.9	40%	630	250.5	130	62
-	-	-	-	760	-	-	-
Total	4999.9	19999.9	-	1780	1134	2020	-

4. Conclusion

Experimental results for COD, BOD, TDS, SS, ammonical nitrogen etc., fall under the norms of Pollution Control Broad. Aspects like performance, efficiency, energyre quirement and economic factor for different unit operations of CETP were studied and results are compared with standard design data. The comparative study between the input and output effluent was made using chemical analysis at different stages in the process and the results were falling under the range of Pollution Control Broad norms.

SBR:In order to increase the efficiency of SBR above 75%, the sludge age must be monitored regularly, sludge must be removed from SBR from time to time depending on the MLSS present in the effluent, maintain an effective growth of heterotrophic bacteria by providing necessary supplementary and maintain the perfect anoxic conditions in baffle tank.

MEE:From the initial study of MEE it is known that, for the treatment of 25KL of effluent 3799 kg of steam is required. After detailed study based on the operating conditions, only 3655kg of steam is required to treat the same quantity of effluent stream.

Spray dryer and coal hag:In order to convert 40% slurry of solids into 100% solids, 15tons of coal per day and 10.8 tons of air per hour are required to maintain 600^{o}C inside the dryer.

Cooling Tower: From initial study, the present capacity of cooling tower is 750TR. Detailed analysis of MEE energy balance shows that 585 TR is required and by considering 10% losses 643 TR is required for optimum operation. From this result, around 107 TR is reduced of worth Rs. 247371/- per annum.

References

1. Gohary EI, Abou-Eleha FA, Aly HI. Evaluation of biological technologies for wastewater treatment in the pharmaceutical industry. Water Science and Technology, 1995, 32(11): 13-20.
2. Garcia A,Rivas HM, FigueroaJL, Monroe AL. Case history: Pharmaceutical wastewater treatment plant upgrade, Smith Kline Beecham Pharmaceuticals Company. Desalination,1995, 102(1-3): 255-263.
3. Hashmi Imran. Wastewater monitoring of pharmaceutical industry: Treatment and reuse options. Electron. J. Environ. Agric. Food Chem., 2005, 4 (4):994-1004.
4. Junico M,Shelef G. Design operation and performance of stabilization reservoir for waste water irrigation in Israel. Wat. Res.,1994, 28:175-186.
5. Khan MA, Ahmad SI. Performance evaluation of pilot waste stabilization ponds in subtropical region, Wat. Sci. Tech., 1992, 26:1717-1728.

6. NgMiranda WJ, Yap GS,Sivadas M. Biological treatment of a pharmaceutical wastewater. Biological Wastes, 1989, 29(4):299-311.
7. Puskas K, Essen II, Banat I, Al-Daher R. Performance of an integrated ponding system operated in arid zones. Wat. Sci. Tech.,1991, 23:1543-1542.
8. Rosen M, Welander T, Lofqvist A, Holmgren J. Development of a new process for treatment of a pharmaceutical wastewater. Water Science and Technology, 1998, 37(9): 251-258.
9. Ashok Kumar Popuri, PrashantiGuttikonda. Zero liquid discharge (ZLD) industrial wastewater treatment system. International Journal of ChemTech Research, 2016, 9(11): 80-86.
10. Uwadiae SE, Yerima Y, Azike RU. Enzymatic biodegradation of pharmaceutical wastewater. International journal of energy and environment, 2011, 2(4):683-690.
11. Heberer T. Occurrence, fate, and removal of pharmaceuticalresidues in the aquatic environment: A review of recent researchdata.ToxicolLett., 2002, 131:5–17.
12. Williams RT, Cook JC. Exposure to pharmaceuticalspresent in the environment.Drug Inf J., 2007, 41:133–141.
13. Larsson DGJ, De Pedro C, Paxeus N. Effluent from drugmanufactures contains extremely high levels of pharmaceuticals.JHazard Mater,2007, 148:751–755.

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