Systematic Approach- Key to Better Environmental Performance

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Abstract

As the performance of Effluent Treatment Plant was found to be below the expected levels even after major modernisation, a systematic approach was taken up which are described in this paper, namely to characterise the individual effluents of each unit to know its pollution potential, which could be useful in evolving a plan to operate the ETP efficiently. Secondly to reduce the effluent volume as much as possible cutting down fresh water use and recycling process waters wherever possible and lastly to evaluate the performance of individual units of ETP, identify the defects and set backs in the system or equipment and take remedial actions.

INTRODUCTION

To operate the effluent treatment plant efficiently, it is essential to have the knowledge of the Pollution loads of the effluents generated by individual modules of a mill as this knowledge will be helpful in evolving strategies for bettcr management of the plant. It is also necessary to evaluate the performance of each unit in ETP and assess its efficiency. This is likely to help in finding ways and means of improving the efficiencies of individual units which also helps in improving the overall performance of the effluent treatment plant. Apart from the above inhouse measures need to be taken to conserve water and reduce effluent volume and to prevent avoidable pollution going to ETP. Effluent treatment, which is the end of the pipe treatment, can operate with better results if such measures are taken.

In 1997 MPM had embarked on an ambitions up-gradation project of its effluent treatment plant, as the environmental pressures started mounting. About Rs.11 crores of money was spent and a number of balancing equipments were added like clarifiers, thickener, new aeration basin, press filters etc. The effluents were segregated into three streams, namely coloured effluents, non coloured effluents and effluents containing only suspended solids but negligible pollution load. Much time was lost in overcoming the teething problems like under performance and failure of equipment etc. When the up-gradation was carried out, the total effluent volume was 80 to 85000 m^3/day for a production of 280 to 300T of newsprint and 80 to 100T WPP.

RESULTS AND DISCUSSION

The flow diagram of the effluent treatment plant is given in Fig. 1.

Characterisation of individual effluents of various modules

Prior to taking up the above study, the performance or ETP used to be unpredictable and hence extremely difficult to control. The problem became more complex as both the primary clarifiers used to receive coloured effluents. Even after the up-gradation, there was no marked improvement in the scenario Due to this reason systematic study on characterisation of the effluents of all the modules was taken up to find the root cause of the trouble so that ways and means could be formulated to improve the performance.

The study revealed that the bagasse yard effluent, which is having low pH and high level of suspended solids, has also got very high COD and BOD load. Also the Brown Stock Washer filtrate of the Cold Soda Refined Mechanical Pulp Mill (CSRMP) though having low solids content has very high pH, colour, COD and BOD loads. Both the plants do not operate round the clock and as a result in the absence of an equalization tank, the influent characteristics to the clarifiers and subsequently to the secondary system used to change drastically giving a shock to the system whenever they start and stop. Due to this reason, the bagasse yard effluent after primary clarification was recycled to the yard. As prolonged recycling was causing solid buildup problem and affecting the chemical consumption and the quality of bagasse pulp, it was decided to purge the bagasse yard effluent after primary

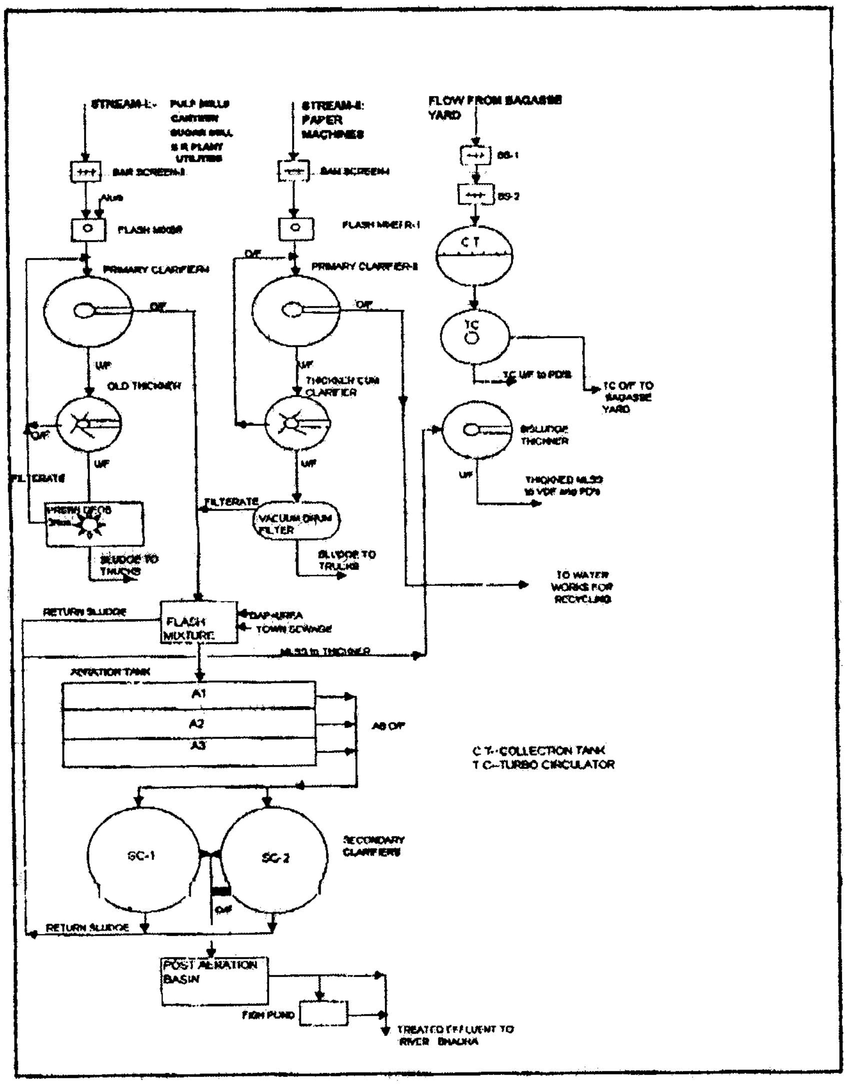

Fig. 1 Effluent treatment plant

clarification into the coloured effluent primary clarifier, whenever CSRMP was stopped. Though this gave some relief, the desired results could not be achieved. Hence the bagasse yard effluent is totally recycled.

The DM Plant effluent used to cause huge pH shocks. Though the volume of effluent is small, the effect is so drastic that the pH shock used to persist for a considerable period of time.

Once the bagasse yard effluent was eliminated from the system, things started to fall in place and after replacing the old pitch blade type aerators with turbine type aerators, the performance of the plant improved considerably. However, the performance used to drop if bagasse yard effluent is taken into the system due to inadequate aeration capacity.

There is hardly any place left to have additional bays for aeration. also the bagasse yard effluent has very high pollution load. Hence it is decided to treat this effluent in an anaerobic digester as this route is not only cheap but also gives methane gas as a byproduct, which can be used as a fuel. Similar anaerobic digester is planned for the treatment of CSRMP effluent also.

Reduction of effluent volume

a) Under the action plan to reduce the effluent volume, several water saving schemes in individual modules were identified and executed. This resulted in effluent volume coming down from 80-85,000 m^3 to nearly 40-45,000 m^3 per day. This reduction in volume has increased the hydraulic retention time in the clarifiers and aeration basins, which was found to be beneficial.

As the degritting unit, installed for the removal of suspended solids did not function well, the effluent volume came down and the grit content in the effluent also came down considerably after the upgradation of stoker fired boilers to AFBC boilers. This effluent was subsequently diverted to coloured effluent stream.

b) After the segregation of coloured and non-coloured effluents, the overflow of the non-coloured effluent i.e. the paper machine backwater is recycled in the process. By this nearly 8,000 m^3/day of water could be recycled bringing down the fresh water consumption to 35-36,000 m^3/day.

e) The Bagasse yard effluent was found to be the most polluting effluent and used to upset the performance of the plant whenever it entered the system. Hence this effluent is recycled to the bagasse yard after clarifying it in a clarifier. This not only reduced the volume of effluent but also helped in reducing the huge shock loads to ETP.

Evaluation of the performance of the individual units in ETP

A) Under this scheme the performance of all the equipments was checked. It is found that there is scope for improvement as the clarity of the overflow is not up to the mark in the clarifiers. The suspended solids removal efficiency is found to vary over a wide range.The corrective measures taken are as under:

Primary Clarifiers

a) Channeling was found to take place in the clarifier. The clarifiers were not provided with serration over the weirs. To distribute the flow evenly over the entire surface of the clarifier and avoid channeling and to improve the solids separation, scrrated plates were fixed for the overflow weirs of clarifliers and thickener.

b) Alum is used for the dual purpose of bringing down the pH of the alkaline coloured stream and also to help coagulation and solid separation. But alum preparation and dosing was found to be labour intensive, cumbersome and consequently reason irregular. It was found that Poly-Aluminium Chloride was not only able to meet the requirement but also there is no problem of preparation of solution for dosing. Hence, by changing over to PAC the dosage could be regulated properly.

c) Foam catching equipment in primary clarifiers: The primary clarifiers are having a foam catching unit through which foam gets collected in a pit. This pit was emptied of its contents by pumping the contents to a storm water drain. This foamy material was found to be highly polluting. Once this was ascertained, this material is discharged to dry beds instead of allowing it to join the treated effluent. The foam catching unit and the baffle in the clarifier to prevent foam entering the launder were repaired and foamy material/ oil entering aeration basin is avoided.

d) The pump house was lowered to avoid the problems with the pumping of solids and other associated problems.

e) Poly-electrolytes usage is regularised to improve clarification and reduce solids carry over to secondary system.

The comparative statement of the performance or primary clarifiers before and after the rectification works is given in Table-1. It can be seen that the solids removal efliciency went up by 3 to 6%.

Aeration system

a) The return sludge gets mixed with the over flow of primary clarifiers at the aeration inlet. To ascertain proper mixing, the addition point is changed to a flash mixer ahead of the aeration basins.

b) Foam is a regular problem. Thick blanket of foam always used to be present in the basins obstructing the oxygen transfer. Use of improved quality defoamer solved this problem.

c) The old pitch blade type aerators, which were inferior in terms of Oxygen transfer efficiency, were replaced with turbine type aerators. After there had been considerable improvement in the dissolved oxygen levels of the effluent and the over all performance of the plant.

d) There were no inverted weirs provided in the two old bays of aeration. Due to this reason foam used to get carried away into secondary clarifiers as well as to post aeration basin. This foam causing material is rich in pollution load and hence used to affect the treated effluent's quality. Installation of baffles in these basins reduced the foam carry over and improved the plant performance. Also foam could be controlled better.

Secondary clarifiers

a) The length of the rake was not long enough to reach below the launder area in these clarifiers. Hence there always used to be sludge bulking and good amount of solids carry over in this area. The rake length is extended to cover this area also.

b) The gap between the rake and the floor of the secondary clarifiers was as high as 8", Due to this reason dead mass always used to be present on the bottom of the clarifier. This used to come to the top with bubbling and used to find its way to the launder. This gap was reduced by installing Teflon blades to the rake for effective sweeping of solids to the center pit for their removal through the under flow pumps.

c) Casuarina trees were present around the secondary clarifiers. The pollen grains and dry leaves of these trees used to fall in the clarifiers, which used to increase the solids content and the pollution load of the effluent. The trees were subsequently cut.

d) Bulking of sludge was a regular problem 1,2 and this sometimes led to the use of chemicals like chlorine and H_2O_2.

After completing the above works, the clarity of the over flow improved, sludge bulking reduced and dead mass carry over problem got minimised.

Post aeration system

a) It is found that higher the fall from the aeration basin weir, higher is the oxygen pick up. The fall could become less due to back up. This is being attended to immediately after noticing it by clearing the debris collected at the discharge gates.

b) Sometimes foam is seen going along with the treated effluent. A curtain is put in the channel to arrest the foam. This is found to be a simple but effective method to arrest foam going with the treated effluent.

Excess biological sludge disposal

Table 1 Comparison of performance of primary clarifiers in ETP

Performance for the period July 01 to Dec- 01, 2003 (Before rectifications)

	P.C. 2 (Coloured Stream)													P.C. 1 (Non Coloured Stream)												
	Inlet					Overflow					Redn.Eff. (%)			Inlet					Overflow					Redn.Eff. (%)		
2001	pH	SS	Color	COD	BOD	pH	SS	Color	COD	BOD	SS	COD	BOD	pH	SS	Coio	COD	BOD	pH	SS	Color	COD	BOD	55	COD	BOD
Jul	7.6	1590	1130	1710	430	7.3	240	900	840	350	84.9	50.9	I8.6	6.	540	250	740	250	6.3	140	250	340	100	74.1	54.1	60.0
Aug	7.6	748	450	1031	296	7.0	158	461	592	213	78.9	42.6	28.0	5.7	549	159	641	179	5.6	115	211	262	79	79.1	59.1	55.9
Sep	7.1	520	347	844	321	6.8	150	349	470	189	71.2	44.3	41.1	5.7	516	187	665	244	5.9	121	227	301	110	76.6	54.7	54.9
Oct	8.0	818	677	1344	489	6.9	233	571	751	358	71.5	44.1	26.8	6.4	614	274	820	289	6.7	93	275	287	131	84.9	65.0	54.7
A\g	7.6	764	592	1194	428	70	195	570	663	277	74.5	44.5	35.3	6.0	555	217	716	240	6.1	117	241	297	105	78.9	58.5	56.3

Performance for the period July 03 to Dec- 03 (Before rectifications)

	P.C. 1 (Coloured Stream)													P.C. 2 (Non Coloured Stream)												
	Inlet					Overflow					Redn.Eff. (%)			Inlet					Overflow					Redn.Eff. (%)		
2003	pH	SS	Co1	COD	BOD	pHl	SS	color	COD	BOD	SS	COD	BOD	pH	SS	Color	COD	BOD	pH	SS	Color	COD	BOD	SS	COD	BOD
Jul	7.8	926	1240	1526	529	7.5	192	1203	839	341	79.3	45.0	35.5	6.8	855	70	606	119	6.8	95	70	145	34	88.9	76.1	71.4
Aug	8.4	861	1429	1344	487	7.5	164	1383	802	331	81.0	40.3	32.0	6.0	786	70	563	146	6.7	100	70	144	34	87.3	74.3	76.6
Sep	8.1	526	1485	1201	462	7.4	153	1371	801.1	326	70.9	33.3	29.4	6.4	522	70	432	103	6.3	89	70	162	38	83.0	62.4	63.1
Oct	8.10	503	1609	1218	477	7.1	131	1246	751	335	74.0	38.3	29.8	7.0	647	99	482	105	6.9	98	112	173	30	84.9	64.1	71.4
Nov	7.9	674.8	1655	1408	557	6.8	108	1500	851	373	84.0	39.6	33.0	7.5	607	85	56O	170	6.6	95	70	178	50	84.3	68.2	70.9
Dee.	8.4	764	1621	1521	555	7.1	182	1339	897	3%	76.2	41.0	28.3	8.4	557	185	524	141	7.4	84	78	160	50	84.9	69.5	64.3
Avg.	8.1	709	1507	1370	511	7.2	155	1340	824	351	77.5	39.6	31.4	7.0	662	80	528	131	6.8	93	78	160	39	85.5	69.1	69.6

Table - 2 Characteristics of CSRMP-brown stock washer filtrate & bagasse yard effluent

Parameter	CSRMP - BSW Filtrate	Bagasse Yard Effluent
pH	10.9	4.6
Color, PCU	8000 to 10000	Turbid
COD, ppm	4000	8260
BOD, ppm	1800	7800
TS, ppm	4300	6630
DS, ppm	4130	5800
SS, ppm	170	830

1) It was mixed with primary solids, after thickening in a separate thickener and was processed either in VDF or Press Deg. The filtrate was earlier going to primary clarifiers and used to become septic. The filtrate of VDP was subsequently segregated and taken to aeration basin to avoid such problems. The filtrates of press degs, which are not clear enough to be taken to aeration basin were taken to primary Clarifiers only but biological sludge is not processed in them later.

2) The sludge is disposed off in tankers.

Nutrients preparation and dosing

Earlier both urea and DAP were added at the flash mixer ahead of the aeration basin. At present urea solution is prepared separately in a tank and dosed at the aeration in let by gravity. DAP is being added at the flash mixer.

AOX was never a problem for the mill as the major product is newsprint and its major constituent namely CSRMP is bleached with Hydrogen peroxide. More over one third of the chemical produced in the mill is from sugar cane bagasse which is cooked to a low Kappa No.

After completing all the above the performance of the plant improved considerably as can be seen from the reduction in the BOD load and colour load on river Bhadra (Fig.2).

Constraints and future plans

MPM has a large mechanical pulp mill of 240 TPD capacity but it operates for only 2 shifts in a day. The effluent of this unit is not only highly coloured but also has high pollution load. The intensity of the colour would be much more when Eucalyptus is used as a raw material for pulping in the event of short supply of the regular Acacia Auriculiformis. Also the limitation in back liquor evaporator unit makes the bagasse pulp mill to run intermittently. The mill does not have an equalisation tank in ETP. The clarifiers, which are large, are not large enouth to honogenise and even out the peaks and valleys in the characteristics of the overflow, which are related to the starts and stops of these pulp plants. Hence, it is planned to go in for an equalisation tank. The mechanical pulp mill effluent gives shocks not only in terms of COD and BOD but also in pH and colour.

The bagasse yard effluent is not only acidic in nature but also has great pollution load and anaerobic treatment is the best option for its treatment. Hence, MPM has gone for an anaerobic digester for this effluent and the gas generated will be used for power generation. This plant is expected to come on stream by mid 2004. The characteristics of the bagasse yard effluent is given in Table-2.

The brown stock washer filtrate of the Mechanical Pulp Mill i.e. CSRMP (Cold Soda Refined Mechanical Pulp) is another major pollutant in the mill. The anaerobic digestion of this effluent was studied by a consultant, who reported that

Table-3 Trials of anaerobic digestion of CSRMP BSW filtrate in STP

CSRMP BSW filtrate characteristic						Collection tank outlet					UASB reactor outlet				
Sl.	pH	Colour	SS	COD	BOD	pH	Colour	SS	COD	BOD	pH	Colour	SS	COD	BOD
1	10.6	7500	170	4720	3000	7.5	500	120	440	160	7.3	250	85	145	60
2.	11.3	7500	180	4260	1800	7.5	700	210	600	260	7.6	700	30	300	130
3	11.1	8750	180	3617	1900	7.2	1000	100	800	310	7.1	750	110	585	185
4	11.0	6250	170	3404	1200	7.5	750	110	560	200	7.3	900	100	450	140
5	11.6	10000	90	3980	1500			135	600	232			81	370	129
6	10.4	10000	120	3570	2000									38%	444%
7	10,5	10000	250	4030	1700										
8	10.7	8750	210	3724	1850										
Avg	10.9	8590	171	3910	1870										

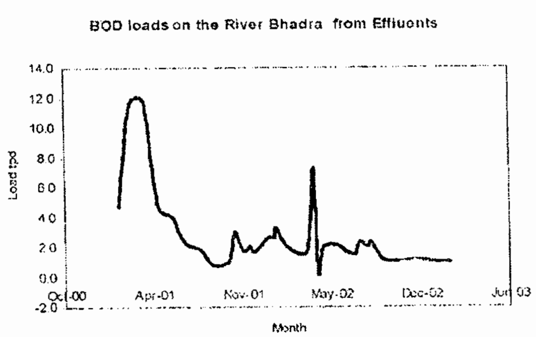

Fig. 2 BOD Load on River Bhadra

it is possible to anaerobically digest this effluent. This effluent was taken to Sewage Treatment Plant on experimental basis for a few weeks and it could be established that anaerobic treatment of this effluent is possible. The generated gas could be flared continuously. Hence an anaerobic digester is planned to treat this effluent. The characteristics of the CSRMP filtrate and the characteristics of the inlet and overflow to the UASB reactor is furnished in Table-3.

Once the above projects are implemented, MPM would be doing better than the norms. MPM plans also to pump this treated coloured effluent for land discharge in its captive forests about 10 KM away for forestation. National Institute of Technology, Suratkal, is the consultants for the execution of this project. It is estimated that by 2005, this project would be competed. Initial study on Environmental Impact and soil conservation study has been carried out by The Energy Resource Institute, Bangalore, and the findings are favourable.

CONCLUSION

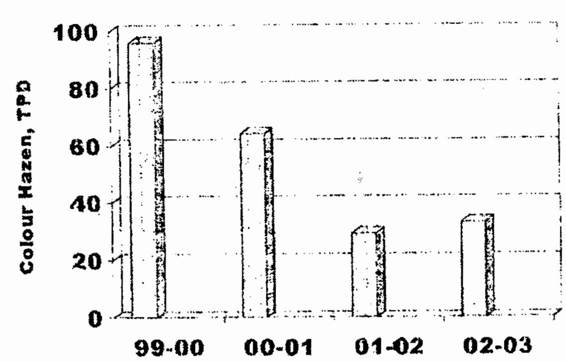

Fig. 3 Relative Colour load on River Bhadra

MPM is unique in the sense that it is an integrated mill of writing and printing paper, Newsprint and sugar. The sugar cane bagasse from the sugar mill is used as a raw material for paper mill. The sugar mill is seasonal. All these things make it a herculian task to manage its ETP efficiently. To bring the ETP to a level of reasonably good performance became possible by:

Gaining the knowledge about the pollution load of the effluents generated by individual modules helped MPM to evolve systems to operate ETP in a better way as like all other units ETP also has limitations in handling thc effluents.

In house measures are the primary requisite as they helped MPM in not only implementing recycling and reuse of water and thus reduce fresh water consumption but also in reducing the hydraulic and pollution load going to ETP.

Evaluating the operating efficiencies of different equipment in ETP, helped MPM in identifying certain defects and deficiencies in the system and correcting them subsequently. This helped in not only improving the efficiencies of individual units but also the overall plant efficiency.

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REFERENCES

1. "The causes and control of Activated sludge bulking and foaming" P. 9 and 77, EPA summary report, July (1987).

2. "Simon J. Binyon page 61, Paper Technology, Effluent Treatment in the Paper Industry-Where are the savings," May (1999).