

Water and Wastewater Management at TNPL

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ABSTRACT

Tamilnadu Newsprint and Papers Limited (TNPL) is India's largest bagasse based Integrated Pulp and Paper mill, having an installed capacity of 245,000 TPY Printing & Writing paper and poised to enhance its capacity to 4,00,000 TPY by middle of Year 2010. It used to consume about 70,000 m³/day water and discharging 55,000 m³/day wastewater where 15,000 m³/day being accounted for evaporation losses. The mill has decided to go for major water saving program along with pollution load reduction. Mill has implemented Superbatch™ pulping in 300 TPD Hardwood Street and modern ECF bleach operations capacities of 300 TPD hardwood and 550 TPD of bagasse pulp streets. TNPL has implemented recycling of Paper Machine Effluent after clarification, close looping Eop filtrate in hardwood fiberline operations, recycling pump sealing water and gland cooling water etc. All the above measures resulted in conserving the fresh water by 30,000 m³/Day and brought the specific water consumption to 51 m³/Ton of Paper during December 2009 with concomitant reduction of 40% pollution load (Phase I). TNPL has drawn ambitious ZLD program to be implemented in 3 phases by 2012. Phase II includes brown loop closure in bagasse pulping operations, close looping the water circuits in gland cooling and pump sealing waters, and implementing ZLD for SRP and Energy islands. The Phase III targets at treating the acidic bleach filtrate using physico-chemical-biological pretreatment followed by membrane separation and recovering 90% of water. The sludge generated in this operation will enter appropriate stage in lime sludge cycle and filtrate to be treated with membrane process to segregate the sulphates and chlorides. The sulphates will be sent to chemical recovery and dilute brine water to be concentrated to marketable level. The evaporator condensate is proposed to be segregated into higher and lower contaminated streams and less contaminated stream to be used as DM water after desirable treatment and highly contaminated stream to be used in SRP operations. After Phase III, it is envisaged to control the treated effluent discharge level to less than 15,000 m³/day having inorganic TDS less than 1200 ppm, hence can be reused appropriately.

Introduction

The pulp and paper industry is water intensive among major chemical process industries. Water is the medium where all the pulp and paper making process are carried out and used as vehicle to transport the pulp in the mills from one unit operations to another. A major fraction of water used becomes contaminated during various processes. The water removes contaminants such as, Colloids, mineral ions, chromophoric groups, wood extractives, organic radicals, slime, stickies etc. This contaminated water (effluent) is treated and discharged later as waste water. In the 80's water consumption per ton of paper produced was as high as 250 m³/MT, and at present it ranges from 100 to 150 m³/MT.

The modern pulping technologies have helped in closing the water circuits to generate less effluent. The concentration of contaminants causes problems in the process by way of erosion, corrosion and scaling etc., as water systems are closed and fresh water consumption minimized. In the

Table - 1: TNPL Road map for water conservation and pollution reduction

1	Phase - I	1. Reuse of paper machine water for bagasse storage, bagasse handling and washing.
		2. Water conservation and pollution reduction under mill development plan (Hard wood brown loop closure)
		3. Mill wide replacement soft water with process water with antiscalants
		4. Recovery and reuse of caustic from caustic boil-outs in papermachine
		5. Eop recycling
		6. Chloride removal in Chemical recovery plant
2	Phase - II	1. Filtration of clear filtrate in paper machine and reuse for high pressure showers.
		2. Chemical bagasse brown loop closing, recycling of gland cooling and pump sealing water
		3. Close looping of SRP island
		4. Close looping of Energy Island
3	Phase -III	1. Segregation of evaporator condensate and treat less contaminated stream to use it as DM system feed.
		2. Bleach plant waste water treatment using physico-chemical-biological process followed by membrane separation.

past decade, considerable efforts were made in both national and international level to develop and operate closed loop configuration in the pulp and paper mills to minimize environmental impact on the surrounding ecosystem. The concept is being accelerated in the recent years due to increasing awareness about environment among the public and consumers (Johnston *et al*, 1996). The concept is accepted within the industry that close looping is

essential for long term sustainable operations (Subhash Chandra, 1994, Senhorest, 1998, Ferguson and Finchem, 1997, Gleadow *et al* 1997). Nonetheless, when water circuit is closed, concentration build-up of contaminants especially chlorides and other non-process elements cause problem in process operation by way of erosion, corrosion and scaling, forcing to purge or develop new systems to remove or reduce contaminants.

TNPL has set to go for major water saving program along with pollution load reduction and developed a road map to achieve Zero Liquid Discharge (ZLD) and same is presented and discussed in this paper. The efforts made in TNPL and its future plans are broadly classified into three phases and presented in Table -1.

Phase I

1. Reuse of paper machine water for bagasse storage, bagasse handling and washing

To reduce fresh water consumption as part of water conservation measure, nearly 9000 m³ treated effluent was used in the bagasse handling and storage area till June 2009. Treated wastewater contains relatively high TDS and enters into pulping and recovery cycle along with bagasse creating adverse impact on recovery process. Paper machine wastewater, which contains relatively low TDS, was identified as an alternate to treated effluent and it was clarified using one of the clarifier separately and pumped to bagasse handling and storage area for use. The comparison of Paper machine wastewater and treated wastewater characteristics are given in the Table 2. Utilization of paper machine wastewater in bagasse storage and handling area has reduced hydraulic load on activated sludge process and reduced 0.87 TPD chlorides entering into process.

Table - 2 Comparison of treated and paper machine wastewater

S. No	Parameter	Unit	Treated effluent water	Paper machine effluent
1	Colour	Pt Co	235	50
2	Total Solids	ppm	1994	800
3	Total Dissolved Solids	ppm	1950	450
4	COD	ppm	194	221
5	BOD	ppm	4	30
6	Chlorides as Cl	ppm	780	150

2. Water conservation and pollution reduction under mill development plan (Hard wood brown loop closure).

TNPL has replaced 120 TPD Hardwood fibreline with 330 TPD Superbatch™ cooking system with oxygen delignification process and complete brown loop closure followed by D_{HT} E_{OP} D medium consistency bleaching sequence. The washing system comprises of twin roll presses. The chemical bagasse line was integrated in to single line 550 TPD ECF (D E_{OP} D) medium consistency bleaching. The oxygen delignification

and brown loop closer is under way in the bagasse line under mill expansion plan. MDP was implemented in the year 2008 and it became fully functional in the year 2009.

Historically, the pulp is transferred by low consistency pumping (2.5 to 3.5%). This means that for each dry ton of pulp, we are also pumping 96 to 97 m³ of water. In this process the water gets several contaminants like, colloids, ions, fines, pitch, chromophoric groups, sand and volatile odorous compounds that enter to other area together with the pulp. Higher consistency washers reduce water and energy consumption for each dry ton of pulp produced. Implementation of medium consistency process using press washing in new hard wood line along with Oxygen delignification and ECF bleaching process is one of the major element, which reduced the water consumption and pollution load in the pulp mill (Pryke *et al*, 1998, Gullichsen, 1991). The average water consumption per day in the pulp mill is reduced from 44,092 m³ in the year 2007 to current quarterly average of 16,080 m³.

3. Mill wide replacement soft water with process water treated with antiscalants:

Process water is replaced with soft water in new fiberlines and cooling tower make-up water to the tune of 25,000 m³/day to avoid the scaling and improve runnability. About 15 TPD of

common salt was used in the softner plant, which ultimately finds its way to the effluent increasing the inorganic TDS and also SAR values. The soft water is currently replaced with process water after treating with antiscalants. The brown stock and decker washers in the bagasse fiberline operations were using softwater, which is replaced with

evaporator condensate. When the brown loop operations in bagasse fiberline are closed under backward integration of MEP, the evaporator condensate will not be required. The evaporator condensate then will be used as DM feed water after suitable treatment.

4. Recovery and reuse of caustic from caustic boil-outs in papermachine:

Caustic boilouts are taken up at an interval of 45 days in Papermachine 1 as well as 2 and approximately 25 Tons of caustic lye is used per boilout. After the boilout, the diluted caustic used to be discharged into the ETP. Collection of 95% of used caustic is diverted to a tower and taken to the chemical recovery system. This has helped in recovery of caustic as well as reduction in the sodium content in the final discharge.

5. Eop alkaline filtrate recycling

Replacing conventional CEH with ECF bleaching sequence in both hard wood and chemical bagasse fibreline reduced the contribution of calcium component of the hypo to wastewater resulting in increased percent sodium level in final effluent. Wastewater generated from Eop stage contains relatively high molecular weight organic compounds and sodium (Dence and Reeve, 1996), whereas, acid waste water contains mostly low molecular weight organics and inorganic salts, such as, calcium, magnesium, chlorides and sulphates etc. To reduce percent sodium level, alkaline extraction filtrate (E_{OP}) alone is being recycled in new hardwood fiber line and sent to soda recovery plant via brown-stock washing. Alkaline filtrate contains organic solids removed during extraction process, chromophoric compounds and AOX removed from the pulp. In addition to benefits stated above, reuse of E_{OP} filtrate may reduce organic solids level and colour compounds leaving the bleach plant.

Alkaline filtrate from filter, after recovery of suspended solids, going to the effluent drain is diverted to an intermediate tank installed for

Table - 3 Results of before and after alkaline filtrate recycling

Before Recycling				After Recycling			
Month	Alkali Loss as Na ₂ SO ₄	ClO ₂ kg/T Consumption	Brightness %, ISO	Month	Alkali Loss as Na ₂ SO ₄	ClO ₂ kg/T Consumption	Brightness %, ISO
Dec-08	11.96	19.7	40.4	Mar-09	14.0	23.12	40.0
Jan-08	13.00	19.6	41.0	Apr-09	12.0	18.90	43.0
Feb-08	14.00	22.5	40.0	May-09	11.8	20.40	42.0

recycling alkaline filtrate that is pumped and used in post oxygen press for washing in place of hot water (Dilution factor 2 - 2.5). Use of alkaline filtrate in PO press did not increase the alkali loss, Chlorine dioxide consumption (Table 3) at the same time resulted in saving of hot water (80°C) that was used earlier. Hot water used in the PO press, generated from Superbatch™ cooking process, was diverted to CBP ECF bleaching resulting in saving of 0.3 MT of LP steam per tone of pulp that is used for generating LP steam in CBP ECF. About 60m³/hr of excess hot water is pumped to CBP ECF plant, thereby reducing 1400 m³ of hot water generation using LP steam. Due to that LP steam consumption is reduced by 0.3 t/ton of pulp in bagasse ECF plant.

Incremental impact of recycling:

A key to successful recycling of extraction filtrate is in management of non-process elements and controlled purging of chlorides and potassium. Closing water circuit in pulp mill impact chemical recovery system as it is sensitive to chlorides and potassium and increased concentrations of inorganic cations and anions cause scale formation, deposits, plugging in super heater and corrosion resulting high chemical and steam demand. Therefore, it is necessary to purge chlorides and potassium, directly through ESP ash purging or selective leaching of chlorides in ESP ash and recovery of sodium sulphate present in ESP ash.

6. Chloride removal in Chemical recovery plant

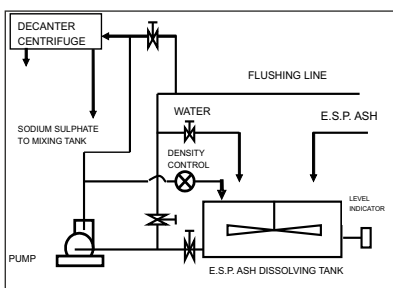
The Sources of Non-process elements (NPEs) in TNPL are mainly from, incoming process water which has a chloride content varying from 100 ppm to 300 ppm, and usage of wood with bark in pulping, entry of treated effluent in pulping street along with washed bagasse and recycling of extraction filtrate. Complete closure of brown loop in pulp mill warrant new systems to remove NPE's to avoid problems arising due to chlorides and potassium (Ferreira *et al*, 2003, www.hpdsystems.com). In TNPL, chlorides in Recovery boiler ESP ash is about 30% as NaCl.

Components and process for Chloride removal system:

Solubility of chlorides in water is high

Table - 4 Chemical composition of samples of ESP Ash, Centrifuged cake and filtrates

S. No	Compounds	Composition in %		
		ESP ASH	Centrifuged Cake	Filtrate
1	Sulphates as Na ₂ SO ₄	70.7	90.9	191.3
2	Chlorides as NaCl	22.4	4.50	188.2
3	Potassium compounds as K	5.60	3.0	32.0



compared to sulphates and Sodium chloride dissolved readily in water but suppresses the solubility of sulphates. Based on laboratory results, a system was designed at TNPL to remove the chlorides (Figure) The system consist of a tank with a capacity of 2 m³ with a slow speed agitator, a centrifugal pump, a decanter centrifuge with 2 m³ feed rate, Density control equipments and necessary instrumentation. ESP Ash slurry of 800 gpl to 1000 gpl is fed into a decanter centrifuge which separates undissolved sodium sulphate as a cake from the slurry. The separated sodium sulphate is fed to mixing tank of recovery boiler and the filtrate rich in chlorides and potassium is drained.

The system efficiency for Sulphate recovery from the ash was around 73.4%, while chloride removal from the ash was 90.4% and Potassium removal from the ash was 70.6 % (Table- 4). The filtrate drained contains un-recovered sodium sulphate and chlorides. It is proposed to recover the sodium sulphate by employing sulphate removal nano membrane systems, those are employed in Chlor-alkali plants (Sinclair and

Western,1996, Sanhaber *et al* 2001, Davis and McElhinery, 2002).

Implementation of various water conservation and TDS reduction measures helped in overall water consumption in the mill reduced significantly from 70,851 in the year 2007 to 39,809 m³/day in December 2009 with specific consumption rate of 51 m³/ton of paper and the average discharge for December 2009 was 27,863 m³/day at a specific discharge rate of 36.9 m³/ton of paper (Table 5). Implementation of modern technologies and practices that are stated above have improved the process economics, like, improved yield, quality and reduced energy and water consumption per ton of the product. It also helped in improving the environmental performance of the mill which is evidenced in the present case in TNPL. Commissioning of new 330 TPD hardwood fibre line and 550 TPD chemical bagasse fibre line has improved the overall environmental performance of the mill. The reduced water consumption and pollution load has improved over all performance of ETP and improved the mill final effluent discharge standards with respect to Color, Total solids, Total dissolved solids, COD and BOD. The discharge quality for the year 2009 per ton of product is: Color 9.9 kg, Total suspended solids 2.1 kg, COD 8.9 kg, BOD 0.1 kg and AOX 0.08 kg, which is comparable or even low against the values of one of the European mill (Table 6).

Table - 5 Absolute pollution discharge from the mill

Parameter	Unit	2007	2009 Dec	% Reduction
Process Water	m ³ /Day	71,359	39,809	44
Treated Effluent discharge	m ³ /Day	56,950	27,863	51
Color	T/D	13.1	7.4	44
COD	T/D	12.1	6.1	50
BOD	T/D	0.21	0.12	43
AOX	T/D	0.72	0.08	86

Table - 6 Specific pollution discharge per ton of product

Year	Color, kg/T	COD kg/T	SS kg/T	BOD kg/T	AOX kg/T
2007	18.2	16.8	3.7	0.3	0.72
2008	14.7	13.3	2.9	0.3	0.47
2009	9.9	8.9	2.1	0.1	0.08
Mill in Europe	NA	18.6	1.6	2.2	0.15
Best Available Technology (BAT)	-	8-23	0.6-1.6	0.5-1.5	<0.25

Phase II

1. Filtration of clear filtrate in paper machine and reuse for high pressure showers

Mill is procuring Algas filtration system to filter the clear filtrate to the tune of 5000 m³/day in paper machine I and II. It is proposed to reuse this filtered water in high pressure showers that would reduce the fresh water consumption of similar quantity.

2. Chemical bagasse brown loop closing, recycling of gland cooling and pump sealing water

TNPL is currently executing Mill Expansion Plan (MEP) involving reduction of the pollution load further by backward integration of ECF bleach plant of Chemical Bagasse Pulp. The current brown pulp operations in Bagasse fibreline are open and use drum washing system having brown stock washers followed by Decker washing. The Decker washer is currently integrated with ECF bleach line through Pre-thickener filter to increase the pulp consistency before it enters bleaching process. In backward integration, the drum washers will be replaced with press washers and Oxygen delignification will be introduced and close the brown loop. Current fresh water consumption in bagasse pulping and bleaching operations is about 30 m³/ton of pulp that is expected to come down to about 18 m³/ton after backward integration. Introduction of press washing, closing brown loop, introduction of ODL stage and recycling of extraction filtrate will reduce water consumption and pollution loads especially the colour and TDS. A dedicated system is being implemented for bagasse washing, wastewater reuse and recycling along with sludge handling system. Increasing the recycle ratio in the bagasse handling process will improve biogas generation due to increased COD concentration in the wastewater and reduced hydraulic loading in the reactors.

3. Close looping of SRP Island

In Chemical recovery plant, nearly 70 m³/hr of mill water is used for pump cooling and vacuum pump sealing and another 20m³/hr for lime kiln bearing cooling details are presented in Table 7. The used water is let in to the drain. It is proposed to recover water and reuse for the process again. The pump sealing

Table - 7 Fresh water use in SRP

S. No	Equipment	Consumption m ³ /hr.
1	Alfa Evaporator-1 Pumps cooling water	15
2	Alfa Evaporator-1 Vacuum pump sealing water	10
3	Alfa Evaporator-2 Pumps cooling water	20
4	Alfa Evaporator-2 Vacuum Pump sealing water	20
5	Recovery Boiler Pumps cooling water	5
6	Lime kiln bearing cooling water	20
7	Total discharge to drain	70

Table - 8 Treated wastewater use in SRP

S. No	Equipment	Consumption m ³ /hr.
1	Dregs filter vacuum pump and condenser	50
2	Mud filter vacuum pump and condenser	100
3	LMCD vacuum pump and condenser	70
4	WLCD heat exchanger	80
5	Total discharge to drain	300

water used in the Alfa Evaporator will be pumped to old causticizer hot water tank and from Alfa evaporator -2 and Recovery boiler, water will be pumped to dissolver tank and then to lime kiln hot water tank. The water used for lime kiln bearing cooling will be diverted to lime kiln hot water tank. The vacuum pump sealing water contains some odour and further studies are underway to identify the appropriate point to use. Around 300 m³/hr treated effluent is used in WLCD heat exchanger; Dregs filter vacuum pump & condenser, Mud filter vacuum pump & condenser and LMCD vacuum pump & condenser and let into drain Table 8. In the proposed new system all the water after use will be collected in separate collection pit and will pumped to proposed dedicated new mini cooling tower and recycled in the system and will not be allowed to drain. The excess effluent from paper machine will be used for make-up in new cooling tower and will eliminate around 300 m³/hr treated effluent use.

4. Close looping of Energy Island

Around 1000 m³ of treated wastewater is used in Boiler # 1, 2 & 3 for ash quenching and Vacuum Pump sealing and let into drain. It is planned to draw

clarified papermachine waste water for pump sealing and ash quenching. And after filtering to remove coarse and fine materials the used water will be sent to clarifier along with papermachine effluent. Nearly 1000 m³ of water is currently drained from cooling tower as blow down water. Instead of draining from the cooling towers, the water will be drained from evaporator and used for vacuum sealing. Close looping in SRP and Energy Island will eliminate the burden on effluent treatment system and ultimately facilitate ZLD.

Phase III

1. Segregation of evaporator condensate and treat less contaminated stream:

Results of SRP condensate from various stages are presented in the Table 9. The evaporator condensate from 2, 3, 4 and 5 effects are less contaminated and it is proposed to use this water after desired treatment, preferably as DM feed water. It is proposed to condensate from 6,7 effect for lime mud washing. The membrane treatment rejects as well as surface condensate which are mostly volatile and have high organic matter can be used in the biomethanation system.

Table 9 Quality of evaporator condensate generated in various effects

	pH	Cond. Umhos /cm	Colour Pt.Co	COD ppm	TDS ppm	Ca as CaCO ₃ ppm	Mg ppm	Na ppm	Cl as Cl ppm	K ppm	M alk Ca CO ₃	BOD
Effect 2	7.9	161	0	434	70	0	0	6	14	1	80	209
Effect 3	7.5	129	94	296	66	8	4	8	14	1	90	116
Effect 4	7.2	121	114	327	86	0	0	21	34	3	60	150
Effect 5	9.2	436	187	786	94	8	4	24	42	3	220	602
Effect 6	9.0	444	240	1665	80	12	4	21	56	3	220	1007
Effect 7	8.9	371	177	1852	64	8	4	24	42	3	150	1127
Surface condensate	9.2	871	377	5019	274	8	4	77	93	3	370	3951
Process condensate	8.9	412	227	1696	96	8	4	30	40	4	150	1063
Foul condensate	8.9	1290	107	6070	94	8	4	21	104	7	620	4293

Table -10 Effluent treatability studies in FACCO pilot plant

S. No	Parameter	units	Raw effluent	Lime -Soda treated	FACCO outlet	Reduction %
1	pH		2.1	11.5	6.5	-
2	COLOR	ppm	540	250	200	63
3	TDS	ppm	7740	8760	6780	12.4
4	COD	ppm	1807	1502	760	58.4
5	Total Hardness as CaCO ₃	ppm	2200	200	200	91
6	Calcium as CaCO ₃	ppm	1800	40	40	97.8
7	Magnesium as CaCO ₃	ppm	400	0	0	100

Note: The FACCO outlet has to be passed through Membrane unit to remove the COD and TDS

Table - 11 Results of Membrane filtration studies

S. No	Parameter	Units	Nano			RO	
			Feed	Rejects	Permeate	Rejects	Permeate
1	pH		6.9	7.1	6.5	7.3	5.8
2	COLOR	Pt Co	790	1880	ND	254	ND
3	TDS	ppm	8756	23354	2784	8984	70
4	COD	ppm	1094	3203	332	703	133
5	Total Hardness as CaCO ₃	ppm	600	1760	40	280	10
6	Calcium as CaCO ₃	ppm	520	1660	20	240	ND
7	Magnesium as CaCO ₃	ppm	80	100	20	40	ND
8	Sodium as Na	ppm	2900	7800	850	3150	52
9	Sulphates	ppm	1166	4479	12	494	ND
10	Chlorides as Cl	ppm	3006	7090	1078	3658	28

Current Water consumption	:	+39000 m ³
Additional Water consumption in PM 3	:	+5000 m ³
Water savings in Bagasse line (MEP)	:	-5000 m ³
Water savings in PM 1& 2	:	-5000 m ³
Water savings with condensate treatment	:	-5000 m ³
Water recovery in Bleach filtrate treatment	:	-9000 m ³
Total Water requirement	:	+20000 m ³
Total Effluent discharge	:	+15000 m ³

2. Treatment of Acidic effluent from Bleach plant (HW & CB ECF)

Pilot plant studies:

The D_{HT} filtrate from HW ECF plant was treated with lime followed by soda ash and sent to a clarifier to precipitate Magnesium and Calcium salts, colloidal silica and some of the organics. Lime addition increased the pH to 11.0 to 11.5. The precipitated clarified sludge contains 50 to 55% organics, 5 to 7 % silica, 30 to 40 % calcium as CaO and 4 % MgO that is found to be suitable for use in Cement plant along with lime sludge.

The clarified water is free from hardness. This treatment reduces the COD to a level of 30 %, but TDS and Sodium level increase marginally. The pH is then adjusted to 3.5 to 4.0 using CO₂ or Hydrochloric acid to neutralise pH. The effluent is then passed through a 5 micron bag filter and treated with 100 ppm of FeSO₄, H₂O₂ (60 ppm) and Ammonium persulphate (90 ppm) and fed to a FACCO (Fenton activated carbon catalytic oxidation) reactor.

This reactor consists of Stone pebbles, 0.3 to 3 mm in the bottom layer and catalyst impregnated activated carbon in the top layer. The effluent is allowed to pass downwards with air distribution at the bottom. The COD reduced from 1807 to 760 ppm and colour from 540 to 200 ppm (Table 10).

The lime-soda treated effluent was taken for Membrane filtration and RO studies. The effluent is passed through a pre-filter to remove suspended solids and taken to a Membrane filtration unit, to remove dissolved organics (lignin compounds) and inorganic salts. The permeate COD was reduced from 1094 to 332 ppm (69.7 %) and TDS from 8756 to 2784 ppm (68.2 %). Colour gets reduced totally in this stage. The rejects can be concentrated to get Sodium chloride, Sodium sulphate and other inorganic salts. The Organics, after concentration can be sent to Chemical recovery plant for incineration. Permeate from the above stage is further processed through RO system. RO accepts was found to contain negligible level of COD and lower TDS and hardness. (Table 11).

The pilot studies indicated the

feasibility of the process. Keeping the practical issues in consideration, it is proposed to go for elaborate pretreatment which includes lime-soda softening followed by biological treatment to remove all the hardness and organic components of the effluent, then segregate the sulphates and chlorides using membrane and/or physico-chemical process. This process is projected to yield 90% clean water, lime-sludge, sodium sulphate and sodium chloride. The treatment plant will have a capacity of 10, 000 m³/day that is proposed to accommodate the acidic effluent from bleach plant (HW & CB ECF) and proposed 300 TPD DiP. Based on the measures implemented in three phases, the water scenario at TNPL is projected as follows:

Conclusions:

TNPL took many environmental initiatives to conserve the water and reduce the pollution load to surrounding environment in the past one decade that include:

- SuperBatch™ pulping process followed by two-stage Oxygen DeLignification (ODL) for Hardwood Pulp line replaced the conventional batch digesters, thereby closing the brown pulp operations.
- The brown stock washing is based on the TwinRoll Press technology for achieving low alkali loss at minimum dilution factor resulting in substantial reduction in water consumption.
- The malodorous gases (Non Condensable Gases) are captured and burnt in the Lime Kiln of 170TPD commissioned under MDP.
- The Elemental Chlorine Free/Chlorine-dioxide (ECF) bleaching process replaces the conventional Elemental Chlorine Hypo bleaching process bringing down the pollutants like color, COD and AOX significantly.
- By adopting the advanced pulping and bleaching processes in hardwood pulp processing, the water consumption is reduced from 60 m³/ton of pulp to 15 m³/ton of pulp.
- TNPL is first mill in India to implement recycling of Extraction filtrate (highly colored with high TDS Eop effluent) in the hardwood fibreline that minimises the pollution load significantly at source.
- The conventional Elemental

Chlorine Hypo bleaching process in bagasse line also is replaced with the Chlorine-dioxide bleaching to reduce the Color, Chloro-organics and COD generation at source.

- Other measures like reuse of paper machine wastewater, chloride removal also contributed to improve the environmental performance of the mill..
- TNPL is currently undertaking many measures like close looping of chemical bagasse brown loop, recycling of gland cooling and pump sealing in pulp mill, energy & SRP.
- Treatment for bleach plant acidic wastewater using physico-chemical process followed by the membrane technology to reduce the pollution load to the barest minimum.
- Treatment of about 15000 m³/day having low TDS with Ozone making it superior quality irrigation water to meet the obligatory supply of irrigation water to TEWLIS farmers.

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