# Recycling And Reuse of Alkaline Effluent/Filtrate in TNPL

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## ABSTRACT

With the objective of reducing sodium content in the final treated effluent, sodium content generation source was identified corrective measures taken to reduce the sodium content were discussed. Practices followed in Hardwood bleach plant (ECF) replacing the hot water used for washing of ODL pulp by EOP filtrate was given in Case study I. It was also observed that Alkali loss in post oxygen press was not increased by recycling of alkaline filtrate $ClO_2$ consumption remains the same before and after recycling. Procedure was developed to recover maximum caustic after boilout in all the three machines and reuse in SRP causticizing plant was discussed and given in Case study II. Reduction of sodium content and water consumption per boilout was observed.

***Keywords:*** *Boil out, recycling, EOP.*

## Introduction

Mounting environment pressure all over the world has lead to adopting environment system in many industrial units to cope up with the stringent norms formulated by the statutory bodies. Environment issues particularly control of sodium is the major environment challenge before the Indian pulp and paper industry for its sustainability and environment compatibility. If the mill effluent is used for irrigation, the sodium content in the effluent will harm the soil infiltration and hydraulic conductivity of the soil. High Sodium Absorption Ratio (SAR) renders sodium toxicity in land irrigation.

In TNPL up to the year 2009, in Conventional CEH bleaching calcium hardness in the final treated effluent was maintained. Due to change over from conventional CEH bleaching to ECF bleaching in both Hardwood and Chemical bagasse streets, final treated effluent volume, total hardness in bleach effluent and calcium source was reduced and as a consequence, sodium concentration in the final effluent had risen. To mitigate this problem, for the first time in the country, TNPL had implemented recycling of alkaline filtrate (EOP) from Hardwood bleach plant with the main trust on reduction of sodium carryover in the discharge effluent which is going for irrigation (1600 acres of land) in and around TNPL. The aim of this paper in Case study I and II is to highlight the practices followed / adopted in TNPL Hardwood fiber line and paper machines to recycle of alkaline filtrate and recovery of caustic after boilout in all the paper machines.

## Measures Taken at TNPL to Reduce Sodium Content in The Final Treated Effluent

Soft water was used in hardwood fiber line and bagasse street instead of process water due to extremely high hardness in the mill water drawn from river Cauvery. EOP press roll perforation holes were getting plugged with calcium scales due to high hardness of river water and also entry of non-process elements mainly calcium from wood chips, requiring frequent plant stoppages for cleaning the EOP press rolls leading to production loss. To minimize this problem, process water was replaced with soft water. Sodium level in the process circuit and mill effluent is increased significantly due to usage of soft water. To reduce the sodium concentration in the mill effluent, possibility of reducing sodium discharge from the pulp mill effluent, soft water was replaced with process water by adding antiscalant in the process water.

Usage of process water with high hardness, cycle of concentration increases in the cooling tower. Use of this water, scaling increases in condensers, heat exchangers etc. to overcome this problem 4000 $m^3$/day soft water is being used in cooling towers. To reduce the sodium content, soft water was replaced with process water by usage of efficient cooling water treatment chemicals.

To meet the plant process water requirement around 25000 $m^3$ of soft water was produced in water treatment plant. To regenerate this softener 14 –15 tons of sodium chloride was used. Back wash having very high sodium as well as inorganic TDS in softener operation drained to effluent channel. Currently due to replacement of soft water with process water, soft water demand has come down to 2500 $m^3$ / day. Sodium chloride requirement also has come down to 1.5 - 2.0 TPD.

## Case Study I

### Implementation of Alkaline Filtrate Recycling

Clear alkaline filtrate from filter going to the effluent drain is

diverted to an intermediate tank installed for recycling alkaline filtrate. Alkaline filtrate from intermediate tank is pumped and used in post oxygen press for washing of ODL pulp in place of hot water. Dilution factor used in post oxygen press is 2.5 – 3.0. Thereby no alkaline filtrate is going to effluent from hardwood ECF bleaching (as shown in Fig 1). EOP filtrate characteristics are given in Table 1.

Table 1 Characteristics of EOP filtrate

| S.NO. | PARAMETERS | UOM | HWECF EOP Filtrate |
|---|---|---|---|
| 1 | pH | NO | 9.5 – 10 |
| 2 | Total Hardness as $CaCO_3$ | ppm | 250 – 300 |
| 3 | Chlorides as $Cl^-$ | ppm | 700 – 850 |
| 4 | Color | Pt.Co. | 900 – 1200 |
| 5 | Sodium | ppm | 1600 – 2000 |
| 6 | Potassium | ppm | 40 - 100 |

## Additional Benefits of Alkaline Filtrate Recycling

In new hardwood fiber line, bleach plant alkaline effluent discharge was 1440 $m^3$/day. Hot water of equivalent volume at 80°C used in post oxygen press washing was replaced with alkaline filtrate of 75 -80°C. Alkali loss in PO press was not increased by recycling of alkaline filtrate for dilution factor of 2.5 – 3.0. The same dilution factor was maintained before recycling alkaline filtrate also. Brightness of PO press pulp and chlorine dioxide consumption remains same before and after recycling of alkaline filtrate. Results are shown in Table 2.

## Purging of Non-Process Elements in SRP Cycle

In TNPL about 60-70 tons per day ESP ash is generated which contains 28% chlorides as NaCl and 6.8% as potassium. By purging, ESP ash chloride raise is controlled. Once in two months thorough water wash is being carried out to clean the deposits in the ESP path. TNPL is going to implement dedicated chloride removal system in due course.

## Case Study II

## Caustic Boil-Out Program in TNPL

Caustic boil out is carried out in paper machine for system cleaning once in 45 days. Around 20 – 25 tons of raw caustic is transferred from paper machine storage tank to machine chest, diluted and sent to the approach flow system. Steam and hot water are given in silo to maintain the required concentration and temperature. Dispersing agents 100 kg is used to remove the scales and deposits in machine chest. The concentration of caustic 50 – 60 gpl, pH of 12 and temperature of 50°C are maintained during the boil out. Concentration of caustic, temperature in boil out and effluent is monitored in every 15 minutes. The wire part is kept running and caustic is kept under circulation for effective cleaning of the system for about 2 – 3 hours. The ETP plant is kept informed before draining the boil out. The caustic wash is drained into the effluent channel. Final concentration of the wash is around 15 to 20 gpl. All of these chemicals increase the TDS and sodium content.

## Implementation Cost

Table 2 Results of alkaline filtrate recycling

| S.NO. | Before recycling | | | After recycling | | |
|---|---|---|---|---|---|---|
| | Alkali loss as $Na_2SO_4$ (kg/T) | $ClO_2$ kg/T consumption | Brightness % ISO | Alkali loss as $Na_2SO_4$ (kg/T) | $ClO_2$ kg/T consumption | Brightness % ISO |
| 1 | 12 | 19.7 | 40.4 | 14.0 | 23.1 | 40.0 |
| 2 | 13 | 19.6 | 41.0 | 12.0 | 18.9 | 43.0 |
| 3 | 14 | 22.5 | 40.0 | 11.8 | 20.4 | 42.0 |

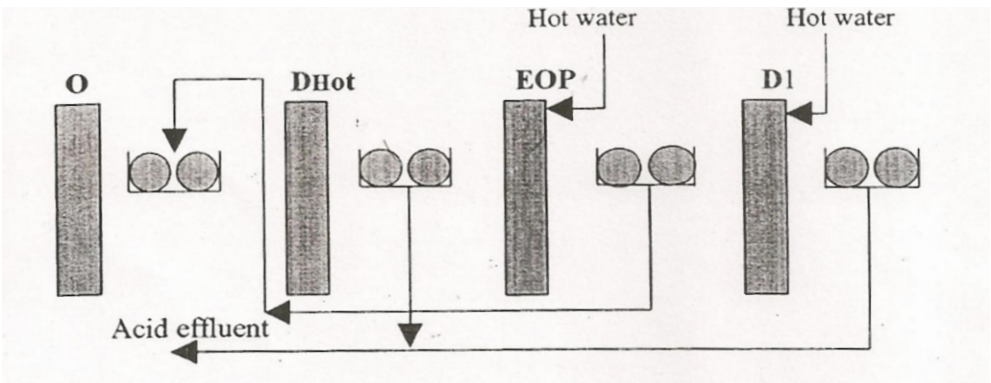


Fig 1. Flow diagram of alkaline filtrate recycling

The project cost had worked out to be around at 35 Lakhs. However, some of the equipments like pumps, vibrating screens, existing pipe line were identified within the premises, which reduced the cost of the project to 20 Lakhs. The project was completed within 6 months time.

## Description of Recovery Process

A sump pit of 100 $m^3$ capacity was constructed in between paper machine 1&2 effluent channels. The flow diagram for reuse of paper machine caustic boil out chemical to SRP is shown in Fig 2. The drains were opened sequentially to collect the maximum quantity of boil out chemical. Drainage from cloudy and clear filtrate chest was isolated to avoid dilution. Two gate valves were provided across the channels to collect the boil out

Table 3 Characteristics of caustic boil-out chemical

| S.NO. | Parameter | UOM | Value |
|---|---|---|---|
| 1 | pH | - | 12 – 13 |
| 2 | TSS | ppm | 200 – 300 |
| 3 | $BOD_5$ | ppm | 350 – 400 |
| 4 | COD | ppm | 1000 – 1400 |
| 5 | NaOH | gpl | 15 – 20 |
| 6 | Volume | Cu.M | 1300 - 1800 |

Table 4 Recovery of caustic after boil-out

| Year | Caustic to PM/C (tons) | Caustic recovered (tons) | Caustic Recovery % |
|---|---|---|---|
| 2004 | 69 | 34 | 49.3 |
| 2005 | 230 | 98 | 42.5 |
| 2006 | 222 | 89 | 40.2 |
| 2007 | 286 | 103 | 36.0 |
| 2008 | 330 | 155 | 47.0 |
| 2009 | 270 | 170 | 63.0 |
| 2010 | 275 | 235 | 85.4 |
| 2011 | 350 | 290 | 82.9 |
| 2012 | 307 | 257 | 83.7 |
| Total | 2339 | 1431 | Average = 58.9 |

Table 5 Environment Benefit: Reduction in Pollution Load

| S.No. | Parameters | Quantity |
|---|---|---|
| 1 | Reduction in water consumption | 1600 $m^3$ / boil out |
| 2 | Reduction in effluent discharge volume | 1600 $m^3$ / boil out |
| 3 | Sodium reduction as Na in final effluent | 148 MT / Annum |
| 4 | BOD reduction | 0.5T / boil out |
| 5 | COD reduction | 1.5 T / boil out |
| 6 | Reduction in HCl dosage | 0.75 T / boil out |

Table 6 Cost economics

| S.No. | Parameters | Quantity |
|---|---|---|
| 1 | Caustic saved during 2004 - 2012 | 1430 T |
| 2 | Cost of caustic lye | Rs. 32,000 / MT |
| 3 | Cost savings during 2004 – 2012 | Rs. 4.6 crores |
| 4 | Investment made for the project | Rs. 20 Lakhs |

chemical into the sump pit. The boil out chemical is then pumped to a storage tank of capacity 550 $m^3$ at SRP. After recirculation, it is transferred to weak white liquor tank through a vibrating screen to remove the fibers and scale particles, at the rate of 50 to 100 $m^3$/day. The suspended solids of boil out chemical is thus reduced appreciably from 500 to 50 ppm. This is further used for dissolving smelt in SRP boiler. There is no change in properties of green liquor and the clarity of white liquor. In ETP only 230 kg of HCl is used to neutralize the non recovered caustic effluent. Caustic send to paper machine recovered quantity and recovered percentage values are given in Table 3. Reduction in pollution load was shown in Table 5 and cost economics of this recovery of spent caustic after boil out economics was shown in Table 6.

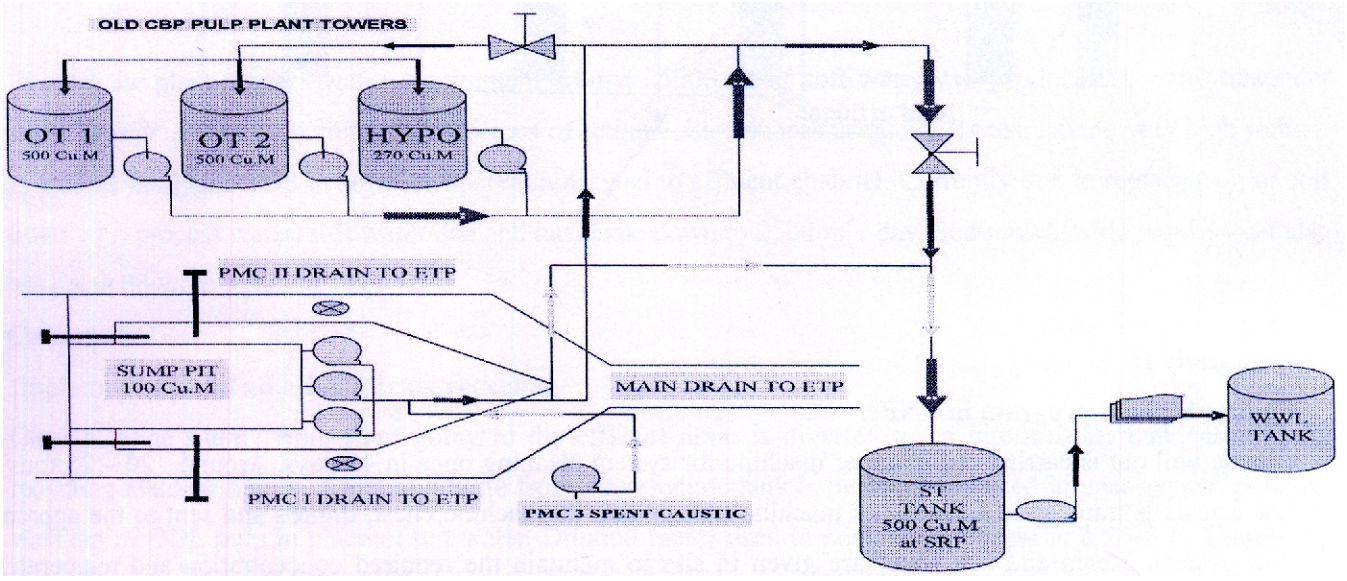


Fig 2. Flow diagram for recover and reuse of PMC spent caustic

## Precautionary Measures Taken During Boil Out Programme in Paper Machine

- Caustic is given to the system after thoroughly cleaning all the chests with water jet.
- All the chest drains are kept closed during the boil out process.
- In the machine chest, caustic is drawn in two installments.
- 50% level is maintained in water storage chest.
- Drains from cloudy and clear filtrate chest were isolated to minimize dilution of used caustic.
- Shower water dilution is controlled to maintain concentration of caustic.
- Cloudy and clear filtrate tanks were maintained at 60% level to avoid over flow and loss of caustic.
- Knock off showers at the wire part is opened intermittently to maintain the concentration level of boil out chemical.
- A butterfly valve was installed across the paper machine effluent channel to avoid passing of effluent to effluent channel during pumping.

## Results and discussion

In EOP filtrate, total hardness and chlorides values were in the range of 250 – 300 ppm and 700 – 850 ppm respectively. Color of the effluent was 900 – 1200 Pt.Co. units which is contributing more in the treated effluent. Sodium content in EOP filtrate was 1600 – 2000 ppm. The results are shown in Table 1. Impact of recycling, alkali loss and chlorine dioxide consumption remains same. Recycling has no impact on the brightness of the pulp. Before recycling and after recycling alkaline filtrate results were presented in Table 2.

In paper machine boil out chemical concentration was in the range of 15 – 20 gpl. To increase the concentration of boil out chemical precautionary measures were taken during boil out. Volume generation during boil out was 1300 –1800 $m^3$. Pollution load in terms of BOD and COD were 350 – 400 ppm and 1000 – 1400 ppm respectively. The characteristics of caustic boil out chemical results are given in Table 3. The quantity and the percentage of caustic recovered from 2004 to 2012 are shown in the Table 4. Due to space constraint for storage of recovered caustic, recovery percentage was low (36 to 49 for the year 2004 to 2007). From 2009 onwards by making use of unused towers in old chemical bagasse plant for additional storage recovery (1270 $m^3$) was arranged. Recovery of spent caustic was improved to 85%. Till now 1431 tons of caustic is recovered for reuse.

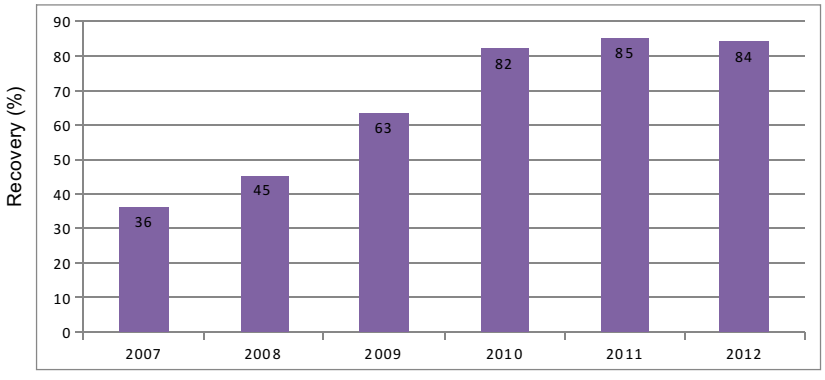


Fig 3. Percentage of recovered caustic during boil out

Due to recycling and reuse of spent caustic significant environmental benefits like reduction in water consumption and effluent discharge volume are 1600 $m^3$ per boil out. Sodium reduction in final effluent is 148 MT per annum. BOD and COD reduction were 0.5 tons and 1.5 tons per boil out respectively. In treated effluent overall total dissolved solids (Inorganics) is reduced. There by minimization of waste by recycling is done. Apart from the Environmental benefits 4.6 crores worth of caustic is recovered from the waste. Due to recycling and reuse reduction in pollution load results are shown in Table 5 & 6.

## Conclusion

State of the art oxygen ECF bleaching of hardwood fiber line in TNPL is sensitive to build of organics and metals in highly closed water recycle circuits. ECF bleaching generates both acid and alkaline filtrates. From March 2009 onwards as entire quantity of alkaline filtrate (EOP) generated is used in PO press, no alkaline filtrate is going to effluent from HWECF fiber line. Due to recycling around 2.3 – 2.8 tons of sodium per day going to the effluent is recycled into the system. New pulping and bleaching process facilitates partial closure of bleach plant effluent. TNPL spares no effort to abate pollution. First time among the Indian pulp and paper industries, TNPL has implemented recovery and reuse of alkaline effluent process in the year 2004. Savings, better quality of effluent with minimum investment, lesser load to ETP plant, reduction in cost of the treatment and other environment benefits such as lesser damage to soil fertility in the irrigated land.

This recycling process also covers the Environment protection act, 1986 Schedule: VI which stresses about "**Minimization of Waste by Recycling and Reuse**".


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