

Chemical Recovery - Cost Effective and Efficient Operation in WCPM Limited

Rathi B.H., Rao M.R.C., Mishra Anil & Kulkarni Raju

The West Coast Paper Mills Ltd., Bangur Nagar, Dandeli-581325, Karnataka. (India)

ABSTRACT

The four major operations done in chemical recovery operation are Evaporation of black liquor, firing the concentrated black liquor to extract the chemical in recovery boiler, preparation of cooking white liquor and lime mud reburning in rotary lime kiln. The main objectives of the recovery process are to recover the chemical used in cooking of wood and to beneficially recover the thermal energy from combustion of the organics.

The present paper describes the efficient performance of west coast paper mill recovery operation w.r.t. Environment and Economics. The latest technologically updated Multiple Effect evaporator main features viz burkeite crystallization, sweetening, condensate segregation and efficient operation of recovery boiler and Electro Static Precipitator along with trouble shooting activities are discussed.

The major achievement, which owes to West Cost paper Mill is attaining of highest recovery efficiency among the integrated pulp and paper industries in India. One of the first initiations to the credit of W.C.P.M. is installation of X-filter, which produces very clear green liquor as compared to conventional clarifiers. All these new features with their operation and advantages are covered in detail. The effect of non-process elements and the chemicals used in recovery operation are highlighted. The paper describes the counter steps taken for efficient black liquor management and to improve steam generation and steam economy.

The paper is supported with black liquor properties, trend charts and diagrams of unique features.

The concluding part includes the future vision of recovery operation w.r.t. evaporator, causticiser and boiler ESP capacity management and at the same time to make efforts to contribute in maintaining eco friendly green environment.

Keywords: burkeite crystallization, sweetening, condensate segregation

Introduction

Paper industry has been identified as one of the core industries. The requirements of paper industry have changed and today the consumer preferences and public perceptions have become increasingly important and driving force.

In order to compete in global market and to comply with international requirements of quality, cost and environmental

compatibility the West Coast Paper Mill has dared to take initiative step of Expansion programme called "Mega Project" in 2008-09. More stress is given to adopt latest technology available.

Recovery Plant At a glance

WCPM approach for efficient plant selection and operation

Table-1, Plant supplier and capacity

SECTION	Supplier	Capacity
Evaporator-1	Alfa Laval	Seven effect FFFF Evaporator with mixed flow Water evaporation -100 TPH
Evaporator-2	Alfa Laval	Seven effect FFFF Evaporator with backward flow Water evaporation -230 TPH
Recovery Boiler-1	BHEL	Bi-drum with long economizer Solids firing capacity- 500 T BLds per day
Recovery Boiler-2	Enmas Andritz	Single drum with long economizer Solids firing capacity- 1100 T BLds per day
Causticiser	Enmas Andritz	3500 M ³ /day white liquor production at AA-102 gpl as Na ₂ O
Rotary Lime Kiln-1	FL Smidth	135 TPD, 100% oil firing
Rotary Lime Kiln-2	FL Smidth	230 TPD, 100% oil firing

Evaporator-1

It is old evaporator installed in 1998 and then it is retrofitted in the year 2002 by incorporating auto control system and two additional finisher bodies. The plant is designed to produce HBL at 65% TS concentration. But due to better wood mix and quality, we are able to

achieve HBL concentration up to 72% TS which is directly contributing in efficient operation of recovery boiler. With this evaporator we are supplying liquor to Recovery Boiler-1

Evaporator-2

The new evaporator is commissioned in 2009. This evaporator is thermally designed for 75% TS. To improve the efficiency of recovery boiler, it was necessary to handle higher solid concentration liquor. Frequent fouling of heating surface is the major problem associated with higher solid handling in evaporator. Also due to requirement of less contaminated process condensate for causticising plant operation, it was necessary to segregate the process condensate. Hence we have adopted latest technologies available to overcome these problems.

Burkeite Crystallization Technology

The experience with black liquor system is that the liquor is having scaling / fouling characteristics, especially at higher concentration effect. It is found that salt precipitation occurs at two points during concentration to 72%. The 1st critical solids i.e. where the first precipitation occurs is in the range of 45-50% concentration of BL solids and the 2nd critical solids where the second precipitation occurs is in the range of 58-62%. Because of this precipitation, scale formation is predominant in the effects operating at above mentioned concentration levels. At the 1st precipitation stage predominantly, the burkeite salt, which is a double salt with composition of $2\text{Na}_2\text{SO}_4 \cdot \text{Na}_2\text{CO}_3$, precipitates out and tends to form scales on the heat transfer surface. Similarly at the 2nd critical solids level, predominantly Na_2CO_3 precipitates out if salt cake is not used.

Since the BL solids concentration is taken up to 72% in our evaporator,

the 1st and 2nd critical solids level falls in effect 2 and effect 1 respectively. Since, the burkeite salts are water-soluble and can be removed by adopting appropriate washing cycles in 2nd and 1st effect, burkeite crystallization technology is adopted to boost double salt formation. Here the concentrated liquor is mixed with ESP ash and salt cake in separate mixing tank in recovery boiler area and then pumped to the inlet of second effect at preset rate. This helps to keep the plant operating for longer duration between washing sequences and minimized fouling of heating surfaces. To facilitate the washing, additional bodies are incorporated in 1st and 2nd effect. With the combination of crystallization technology and appropriate washing cycle for 1st & 2nd effect, frequent water boiling and mechanical cleaning of the evaporator tube are eliminated.

Sweetening

The black liquor received from the pulp mill is stored in storage tank. Depending upon the storage quantity and pulp mill operations, weak black liquor solids may vary. In order to maintain steady performance of the evaporator plant, the inlet solids are controlled by mixing the liquor from 3rd effect with weak black liquor at evaporator inlet.

Figure-2, Condensate Segregation Process

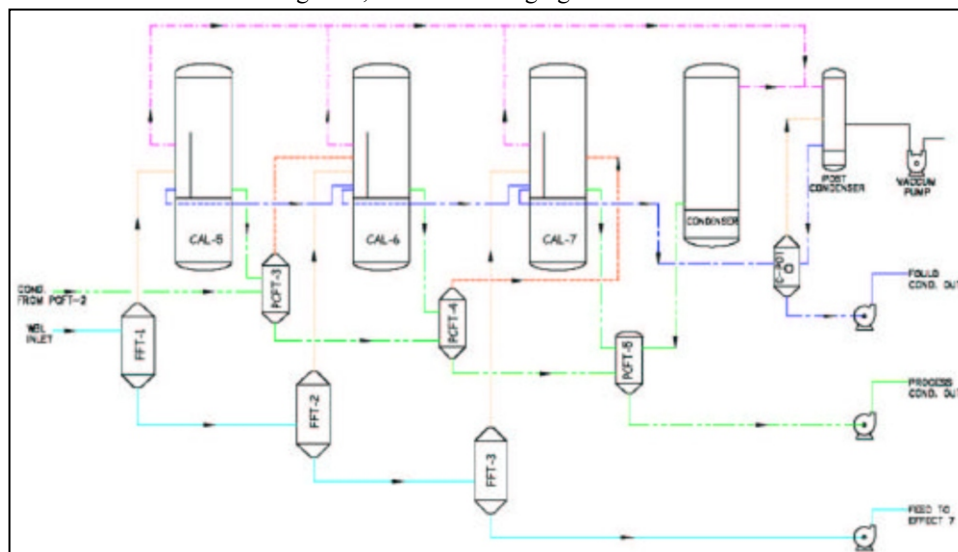
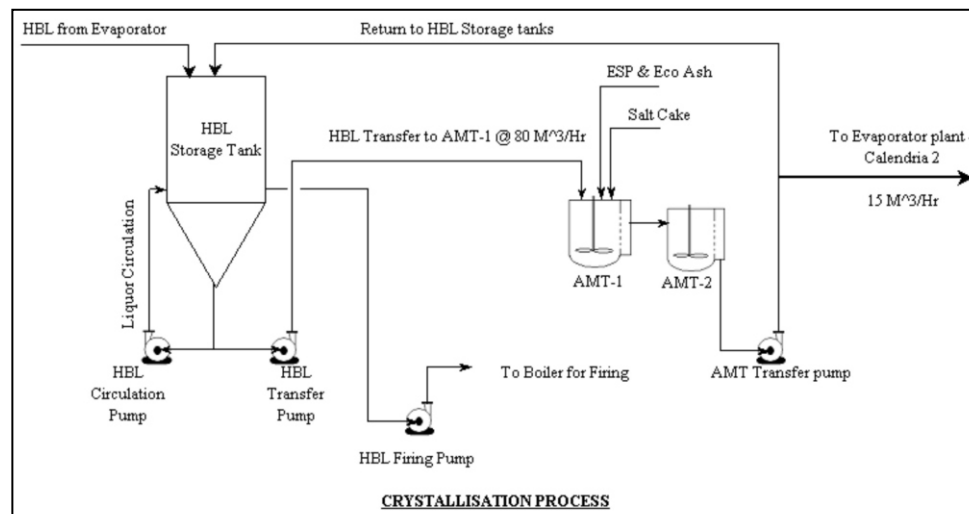


Figure-1, Crystallisation process

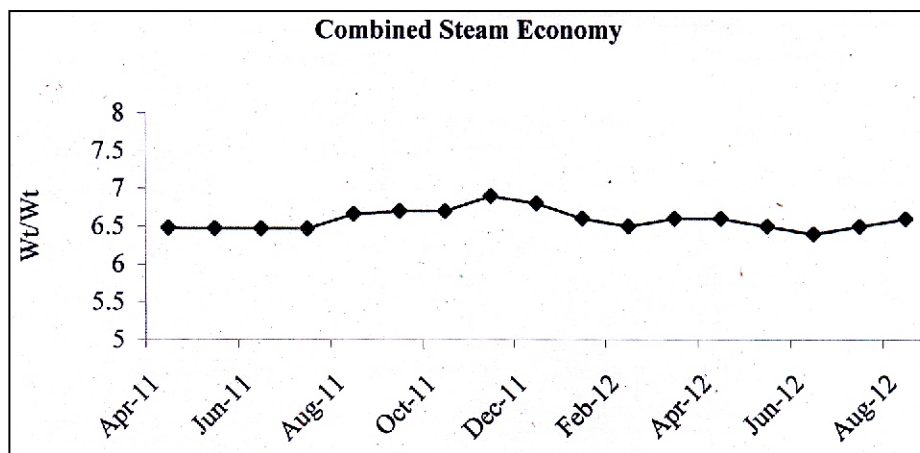


Condensate Segregation

During the flash cooling and evaporation, there is always some evolution of volatile chemical compounds, many of which are more volatile than water. With the incorporation of condensate segregation technology, a system of partial condensation is used, where the main initial condensate is substantially free of volatiles. Separation baffle is provided on the shell side of Effect-6, Effect-7 and surface condenser from where the separate condensate connections are taken to after condenser. Also the top vent from

these effects and condenser is connected to after condenser. This system helps in maintaining good process condensate quality suitable for disc filter operation in causticising plant. The foul condensate, which is not suitable to reuse in the system is drained to ETP.

Graph-1, Combined steam economy for FFE-1 and 2



emission below the norms. Hence ESP is designed to maintain emission below 40 mg/Nm³. Lot of efforts has been done to set the alignment of electrodes.

- MIGI rapping system is adopted and by regular monitoring, it is ensured that all the rappers are operating in sequence.

- Auto power ON/ OFF sequence is adopted in ESP, where out of eight fields, one field gets discharged for 2 minutes at seven minutes interval. This ensures the cleaning of electrodes and enhances ESP performance.

- Optimization of tertiary air really helped in improvement of ESP performance and emission control.

- ESP auxiliary's breakdown brought down to minimum by in-house modification.

Recovery boiler-1

It is bidrum conventional recovery boiler designed to operate at 65% total solids. Due to improved performance of evaporator, the high concentrated liquor of 72% TS is fired in the boiler which has increased the thermal efficiency of boiler.

Recovery boiler-2

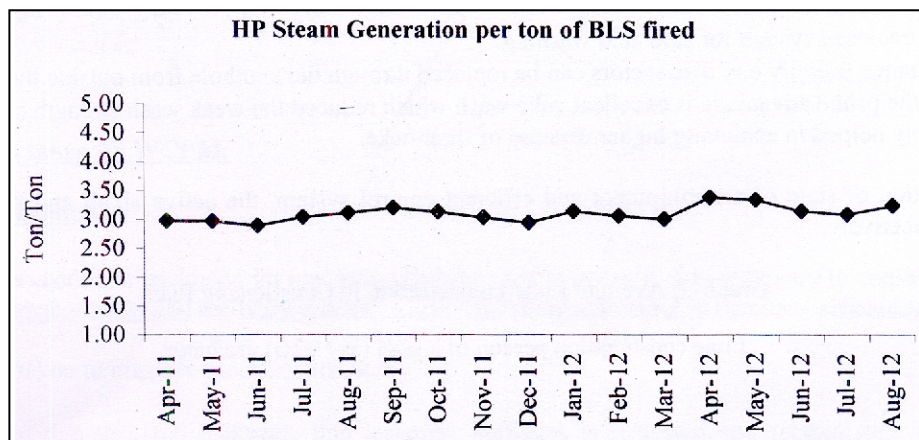
The boiler is single drum, radiant type. The boiler bank is a convective heating surface consisting of vertical tube plates. Compared to conventional bidrum cross flow boiler bank, the arrangement of axial flow panel type boiler bank gives superior performance with regard to plugging behavior and operational safety.

The flue gases leaving the boiler bank enter a two-stage vertical panel type economizer. The economizer panels are axial flow type, which results in the minimum jamming of economizer heating surfaces.

- On line inter changing of GL / WWL lines helped in preventing the fouling of Green Liquor lines.
- Efficient soot blower operation:
 - For super heater and boiler bank area soot blowers with Gemini nozzles provided for improved cleaning of heating surfaces.
 - Based on the experience, the soot blowers of super heater and boiler bank area are repeated in every shift.
- The boiler water washing system helped in reducing boiler passes cleaning period and increased the time gap between two shuts. Due to this plant availability increased.
- The spout cooling system is of vacuum type using demineralised water as cooling medium. This system prevents chances of explosion due to smelt water contact as compared to conventional pressurized cooling system.

Steps taken for efficient operation of Recovery Boiler Graph-2, Average Steam generation in Recovery Boiler 1 and 2

- Maintaining the Furnace stability
 - Firing liquor concentration is maintained >72 %
 - Firing Liquor temperature is maintained in the range of 127 129°C.
 - Adjustment of air as per liquor concentration and proper distribution of air to ensure proper combustion.
- Emission control:
 - Due to stringent environment norms and public aspiration, it was a challenge to maintain



Causticiser Section

To meet upgraded plant capacities a complete new causticising plant with state of the art equipment such as X-filter for GL clarification, slow motion slaker with new set of Causticiser and CD filter for white liquor filtration are installed. These equipments give much better performance like product clarity, very less space. One of the first initiations to the credit of W.C.P.M. is installation of X-filter, which produces very clear green liquor as compared to conventional clarifiers.

Green Liquor filtration by X-filter: (operation and advantages)

In the emerging situation much importance is given to WL clarity to minimize bleach chemical consumption and for higher pulp brightness and for its retention. The good white liquor clarity is achieved by efficient green liquor filtration. X-filter uses cross flow filter technology to remove dregs from green liquor.

Advantages due to installation of Green Liquor X-Filter:

- The performance of X-filter is excellent which gives very clear Green Liquor containing suspended solids of only 20 PPM as against conventional type of operation where suspended solids in GL is very high.
- Less space of installation
- User friendly. Complete system operates with predefined auto sequence including normal operation and washing.
- Large turndown ratio.
- Totally enclosed system for safe acid washing

White Liquor filtration by CD-filter: (operation and advantages)

The white liquor CD filter is a pressurized disc filter, which performs both WL filtration and lime mud washing. The CD-Filter system consists of a horizontal pressurized filter vessel, agitated lime mud slurry vessel, a filtrate vessel, filtration and booster compressors with separators. The CD-Filter contains several filtering discs and each disc consists of several sectors fitted with filter cloths. Filtering sectors are connected to a rotating shaft. Channels, located inside the shaft transfer white liquor from the discs through the shaft and filtrate valve to the filtrate vessel, where gases and white liquor are separated and white liquor is pumped to white liquor storage.

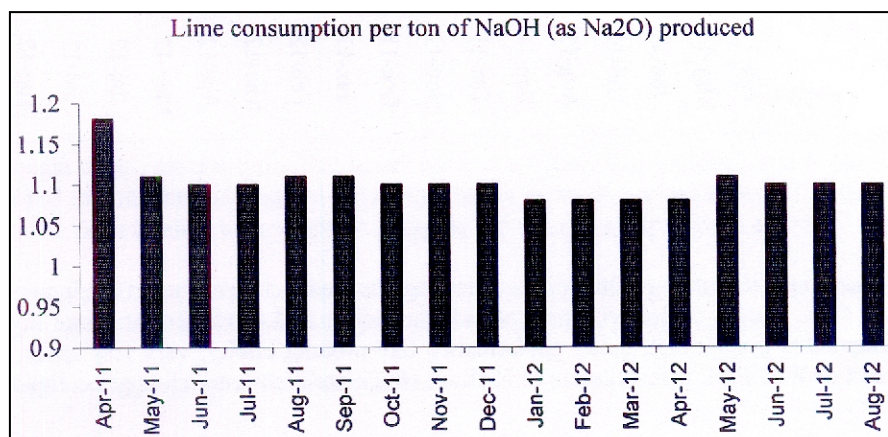
Advantages due to installation of White Liquor CD Filter:

- Single unit system for white liquor separation and lime mud pre-washing.
- Clean hot white liquor for cooking contains less than 20 ppm solids.
- Automatic “short blow-off” feature enables the filter to continuously produce white liquor during process upsets and start-up conditions.
- Fully automatic operation.

- Low wash water requirement provides flexibility for mill water balance.
- “Air” agitators maintain lime mud in suspension at all filter production rates.
- Large turndown ratio.
- Totally enclosed system for safe acid washing.
- Maintenance friendly e.g. disc sectors can be replaced through the manhole from outside the filter.
- One of the prime advantage is excellent cake wash which reduced the weak wash strength considerably and ultimately helped in achieving higher dryness of filter cake.

Due to adoption of state of art equipment and efficient control system, the active alkali and lime consumption is controlled effectively.

Graph-3, Average Lime consumption in Causticising Plant



Rotary Lime Kiln-1

Rotary limekiln 1 is commissioned successfully in May 2003 and running smoothly. Pre coat type vacuum filter is used for mud washing.

Rotary Lime Kiln-1I

New rotary limekiln design objective is to wash and dewater efficiently the lime sludge with Lime Mud Clari Disc filter, resulting in high dryness, good recovery of alkali and proper oxidation. Kiln is designed for 100% sludge feeding. Good performance of kiln resulted in stable kiln operation and low stack emission. The active CaO in the lime is also considerably at higher level.

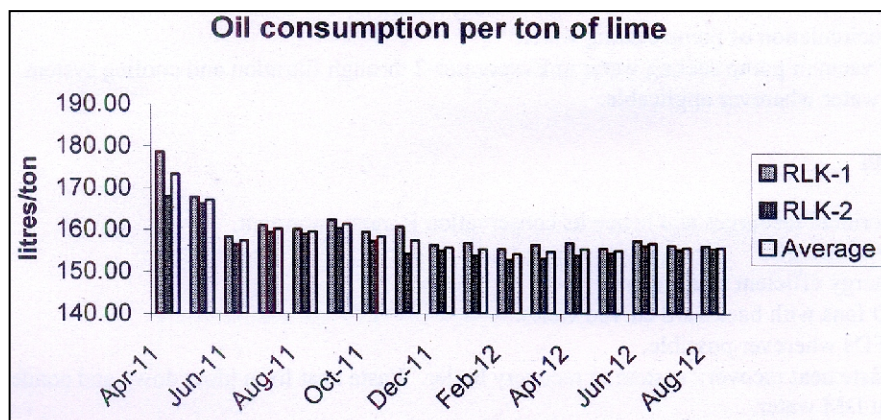
Whenever required, make up lime stone is added. Imported crushed lime stone which is having very high CaCO₃ content i.e. 96-97% is being used for the purpose to improve kiln efficiency and to reduce entering of NPE such as silica in to the system.

Other Initiatives taken by WCPM

Chemical Conservation

Since recovery is economic backbone for any integrated pulp and paper mill, it is necessary to conserve chemical at each and

Graph-4, Furnace Oil consumption in Rotary Lime Kiln

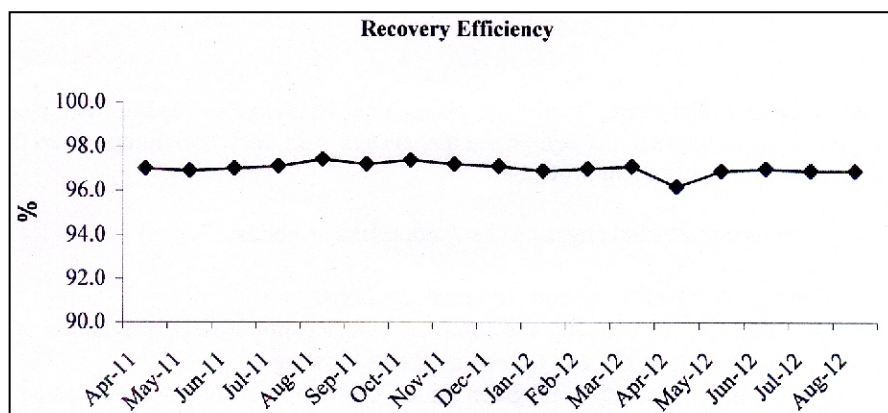


every stage of pulp and recovery process. These efforts are reflecting in recovery efficiency and also in effluent quality.

Following steps taken to improve recovery efficiency.

- Waste liquor due to gland leakages, line leakages, spillages is collected and recirculated in to the system through chemical collection pits, installed in evaporator, boiler and causticising section
- In evaporator tube-cleaning water is collected and recirculated in to the system to conserve chemicals.

Graph-5, Chemical Recovery Efficiency



Water Conservation

Water is one precious natural resource and in present scenario, it is compulsory to conserve water.

Steps taken to conserve water:

- Recirculation of surface condenser water through cooling tower.
- Collection and recirculation of pump sealing water.
- Recirculation of vacuum pump sealing water in Evaporator-2 through filtration and cooling system.
- Reutilization of water wherever applicable.

Energy Conservation

Energy is one of the critical resources and hence its conservation is most important.

Steps taken to conserve energy:

- Installation of energy efficient equipments.
- Installation of ID fans with backward curved vanes.
- Utilization of VFDs wherever possible.
- Installation of waste heat recovery system in recovery boiler. Waste heat from blow down and condensate tank is used to preheat DM water.
- Regular monitoring of steam traps and leakages to save steam.
- Utilization of fuel additive in furnace oil to reduce oil consumption in rotary limekiln by 3.5-4.0%.
- Collection of NCG and incineration in rotary limekiln.

Challenges before WCPM

Since continual improvement is our culture and also we feel responsible for environment protection, we are preparing our self for following challenges.

- Elimination and minimization of effluent at source by strengthening of chemical and water conservation system.
- Maintaining emission level always at lower level without affecting production. Installation of 3rd ESP chamber for recovery boiler-2 is planned to use this ESP during breakdown of any one of the present ESPs.
- Capacity management by installation of 100 TPD water evaporation plant and installation of stand by for critical equipments like WL filter and GL filter.
- With increased chemical recovery efficiency, enrichment of NPEs such as Potassium and Chloride is a major concern for recovery boiler operation. Hence, it planned to set up suitable system for removal of these non-process elements.

Conclusion

Being one of the top paper manufactures in India, it was a big challenge to cope up with changing market demand. For this it was necessary to upgrade the equipment and system with latest technology from time to time and also to fulfill the requirement for environment protection.

The measures taken to face these challenges can be summerised as below.

- Installation of energy efficient evaporator and recovery boiler.
- Adoption of crystallization, sweetening and condensate

segregation system in evaporator-2.

- Strict adherence to proper and efficient operation of soot blowing.
- Installation of white liquor CD-filter and green liquor X-filter to get comparatively clean white liquor and green liquor.
- Intensive measures for water and energy conservation.
- System adopted for collection and recirculation of spill liquor, which is reflecting in recovery efficiency.

The systematic operation of DCS enabled to glance the plant operating parameters and control the operation efficiently. With the vision of environment protection along with continual

improvement w.r.t. to productivity and quality, at WCPM we have successfully installed and commissioned the new plant and now looking forward for further progress.

Acknowledgement

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