Chemical Recovery in Agro Residue Based Mill

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Wheat Straw, an Agro Residue, is the raw material used for paper manufacture in has been installed based on a conventional Chemical Recovery Unit with 165 TPD of Black Liquor Solids handling capacity in the year 1998, in view of their Corporate commitment for providing a cleaner environment to the society. The efforts were always on to improve continuously the Chemical Recovery operations in tackling the serious technical / operational problems arising out of high Silica, Chlorides and Potassium present in the Wheat Straw Black Liquor. This paper dwells on the issues, remedial actions and best practices implemented to achieve the best Chemical Recovery Efficiency in Wheat Straw based integrated Pulp and Paper Mills.

INTRODUCTION

M/S Abhishek Industries Ltd., (AIL) is an integrated Pulp and Paper mill situated at Dhaula, Barnala, Sangrur district of Punjab. It is a part of Trident Group of companies. The mill produces Eco-friendly Printing and Writing Paper varieties using Wheat Straw, an Agro residue as the Raw material. The mill is a success story following the path of sustainable development and continuous improvement. The Paper division of AIL was established in year 1993 with an installed capacity of 75 TPD of PWP grade with out Soda Recovery Process. The mill could not install a chemical recovery system due to non-availability of technology of processing Black Liquor from Wheat Straw at that time. Subsequently SRP was established with 165 TPD of Black Liquor solids in 1998. Presently AIL produces 120 TPD of PWP grades, which are widely accepted in National and International markets.

With ever increasing awareness towards the Pollution abatement and implementation of stricter Environmental regulations, the Pulp and Paper industry is forced to look for alternatives to meet the standards. The Chemical pulp is produced with Soda Chemical Pulping process and Black liquor so produced are fired in Soda Recovery Boiler.

AIL took the initiative to install the conventional Chemical Recovery Unit supplied by Enmas-Andriz, to treat the black liquor obtained after the pulping of wheat straw. The benefits were two pronged: Economic savings because of the recycling of chemicals and more importantly ensuring a better environment for the society. Technically it is very difficult to handle the black liquor generated from Wheat Straw. The remedial actions taken and the best practices followed by AIL made it possible to design a technologically and financially viable solution to solve the problems. Being the avant-garde in the field of non-wood based chemical pulp producers, AIL is now moving to enter into next generation of chemical recovery in terms of efficiency and operation.

Profile of Process Products

In contrast to wood, wheat straw contains a significant portion of silica. The typical analysis of Black Liquor from different points is given below for reference. The results are expressed on Dry Solids basis only.

In the Soda process, the Wheat Straw is being cooked at a temperature range of 165 to 175 °C under pressure and at 16% alkalinity. Under these conditions, the main portion of non-fibrous matter in the raw material is dissolved into the spent cooking liquor i.e., Black liquor. When compared to conventional Hardwood Black liquor, the Wheat Straw Black liquor contains higher Chlorides (6.5- 7.5%), higher Silica (2.4 2.7%), higher Potassium (5 7%) and lower Swelling Volume Ratio. Mostly Agro Residue pulping is conventionally carried at lower Kappa and higher RAA levels resulting lower Calorific Value (2750 2850 Cal/g). The Viscosity of BL is very high at higher solids i.e., 60% and above concentration levels (3600 4000 mp/sec).

During burning of Black liquor in SRP boiler the main

Parameter	WBL	SCBL	CBL
Total Solids, %w/w	9.5 - 10.5	50-51	65-66
TTA as Na_2O, %w/w	20.5 - 24.5	20.5 - 24.5	21.5 - 25.5
RAA as Na_2O, %w/w	3.5 - 4.5	3.5 - 4.5	3.5 - 4.5
Chlorides as Cl, %w/w	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5
Inorganic as NaOH. %w/w	37.5 - 38.5	37.5 - 38.5	38.5 - 39.5
Silica as SiO_2, %w/w	2.4 - 2.7	2.4 - 2.7	2.4 - 2.7
Inerts as R_2O_3, %w/w	0.1 - 0.15	0.11 - 0.15	0.12 - 0.15
Sulphur as S, %w/w	1.0 - 1.5	1.0 - 1.5	1.25 - 1.65
Calcium as Ca, %w/w	0.1 - 0.12	0.12 - 0.14	0.13 - 0.15
Potassium as K, %w/w	5 - 7	5 - 7	5 - 7
Swelling Volume Ratio, ml/g	7 - 9		
Gross Calorific Value, Cal/g	2750 - 2850	2700 - 2800	2650 - 2750
Viscosity at 80°C mp/sec	1 - 2	28 - 30	3600 - 4000

portion of the Silica reacts with the Hydroxide forming water-soluble Silicate ions. The presence of higher quantities of Silicate ions, Chlorides and Potassium causes serious problems when recovering Sodium and energy from the black liquor.

The major problems are:

- Scaling on the heat transfer surfaces in the Evaporator in which the black liquor is concentrated and the Silica in scales varies from 25 52 % from different bodies.
- High viscosity of the Concentrated Black Liquor, which impedes both with evaporation and combustion of the liquor,
- Problems in Causticizing, i.e. in converting Sodium Carbonate to Sodium Hydroxide and also settling problem.

The following table gives the results of ESP Ash:

The above results indicate the very high Chloride levels, which will create process problems in SRP boiler operations. This is the area of concern and needs Research to be done. The emission of mercaptons

Parameters	Results
Moisture, %w/w	1.0 - 1.5
Loss on Ignition, %w/w	10.0 - 12.0
Water Insoluble, %w/w	0.13 - 0.15
Carbonates as Na_2CO_3, %w/w	8.0 - 11.0
Chloride as NaCl, %w/w	30.0 - 40.0
Sulphate as Na_2SO_4, %w/w	32.0 - 40.0

The following are the results of different liquors obtained during Soda Recovery process.

Parameters	GL	WL	WWL
TTA as Na2O, gpl	110.0 115.0	90.0 92.0	35.0 38.0
NaOH as Na2O, gpl	28.0 35.0	72.0 74.0	27.0 32.0
Na2S as Na2O, gpl	6.2 6.5	6.2 6.5	3.0 4.3
Na2CO3 as Na2O, gpl	73.0 76.0	11.5 12.5	3.0 4.0
TAA as Na2O, gpl	34.0 38.0	77.0 79.0	31.0 35
Sulphate as Na2SO4, gpl	3.0 4.5	4.0 5.0	1.5 1.8
Silica on Dry basis, %	0.75 0.95	0.6 0.8	0.3 0.4
Mixed Oxides, gpl	0.75 0.90	0.5 0.6	0.35 0.45
Calcium as CaO, ppm	0.5 0.8	1.0 2.0	2.0 3.0

emission is almost nil and the Flue gas emission is around 100 to 150 mg/N M^3 only.

Due to these problems, the pulp mills using Wheat Straw as raw material have difficulties to recover the cooking chemical and utilize the black liquor as fuel.

The results indicate that the Active Alkali level of White liquor (WL) is around 77 to 79 gpl and the Causticizing efficiency maintained are around 84 to 86%.All the operating parameters of Causticizing section are similar to any other Sulphate process. The Burnt Lime purity at the Table Feeder is around 68 70 % with MgO around 1.2 1.5% only. The settling problems are high because of Silica build up in the entire process resulting Sodium Silicate formation. The typical results of Filter Cake and Classifier Grit is given below for reference.

Improvements and Modification Jobs Carried out in Pulp Mill

The present year saw a number of small and major modifications in the pulp mill. These adaptations helped reduce Chloride, Carbonates, and Sulphates from the system. These modifications also had a major impact on the pulp mill efficiency, which increased significantly from 82.8% in January'04 to 96.7% in Dec'04. The improvements and modifications are summarized below with the achieved gains.

Parameters	Filter Cake	Classifier Grit
Moisture %	52.0 - 53.0	19 20
Sodium as Na20. %w/w	0.9 1.1	0.7 0.9
Free Calcium as Ca(OH)2, %w/w	1.5 2.0	1.4 1.6
Loss on Ignition, %w/w	35 37	31 33
Acid Insoluble, %w/w	8 9	16 18
Silica, %w/w	7 8	13 15
Mixed Oxides, %w/w	0.35 0.45	0.4 0.6
Total Calcium, %w/w	87 89	78 81
Total Magnesium, %w/w	1.2 1.4	0.8 1.0

1. **White liquor addition during extraction :** In normal course, during Extraction stage, Sodium Hydroxide is used to remove the residual Lignin from pulp. Earlier purchased Caustic Soda was used for this purpose. After modification White liquor addition was started at this point, so that Chloride purging is carried out through WL. This way the dead load (Chlorides, Sulfates) purging with minimum chemical loss could be done and non-process elements (N.P.E.) were reduced from the system.

2. **System closure :** Several points were identified from where chemical loss was taking place. The system was modified to get a closed configuration. The modification includes digester degassing cyclone redesigning and provision of pits to succor recovery of liquor coming out of system due to leakages and cleaning works. The closure of system means direct increase in pulp mill efficiency, which was the resulted in this year.

3. **Use of Wash Aid :** After several laboratory trials, the same was extended to the plant trials and then addition of a suitable commercial Wash Aid was started on a continuous basis. It reduced the foam generation and also better washing resulting Alkali Loss in final stage of BSW pulp significantly. Finally this resulted in reduction of consumption of Chlorine in Bleach plant.

4. **Increased amount of wash water on BSW No 2 & No3 :** This has been done by providing extra shower pipe on washer and using dedicated shower water supply pump for each stage giving improved pulp washing and less carry over of chemicals with pulp.

5. **Optimized Caustic dosing for cooking :** To meet the requirement of better pulp for paper production caustic dosing was optimized and increased. More caustic dose means softer pulp after cooking with lesser Lignin content. This resulted reducing the bleaching chemicals, increased Organic solids in WBL which means increased Calorific Value.

Improvements and Modifications Jobs Carried out in soda Recovery Plant

During this period, the Recovery section envisaged a number of improvements and modifications. These modifications had a major impact in SRP, resulting a tremendous improvement in Causticizing efficiency and Recovery efficiency. Also this has helped in reducing the Soda loss and Free Lime losses from the system. Given below the improvement and modification done in all three plants i.e. Causticizing plant, Evaporator plant and Recovery Boiler, are summarized with the benefits achieved.

Causticizing Plant

1. **Weak White Liquor usage for Caustic Soda dilution in pulp mill for cooking :**

The decision was taken to take excess WWL for Caustic Soda dilution in Starw Cooking and dilution in Lime Mud Washers was increased to get the desired volume of WWL. This has resulted better washing and hence reduction in Soda and Calcium losses from LMWs with increase of dilution factor.

2. Causticizer steam pipe repositioning :

The steam pipe was adjusted such a way that maximum heat transfer was achieved. This small change helped a lot in terms of gains An increase of 5°C temperature of green liquor / slurry was realized after the modification. It helped in reduction of dead load from the system. The Causticizing efficiency also improved more than 2% after the modification during the period.

3. Green liquor dosing started in Recausticizer :

To reduce the free Lime loss additional requirement of Sodium Carbonate in recausticizer was observed. After detailed calculations, addition of a quantity of 2 lpm of Green Liquor was started in recausticizers. This helped in reduction of Free Lime in Filter Cake from 2.5% in Jan'04 to 1.5% in Dec.'04.

EVAPORATORS

1. Scheduled cleaning :

Earlier the bodies were cleaned after observing the scale formation with help of T of a particular body. The new approach was a shift from reactive to proactive paradigm. A preplanned schedule was made and cleaning was done according to the schedule. The new practice resulted in a stable and predictable operational process.

2. Regular Caustic boiling of the system :

Schedule of regular Caustic boiling of the Evaporator bodies is being followed religiously to avoid building up of scale on the heating surfaces and now are able to run the Evaporator plant at the maximum capacity . With this modification Recovery plant, we are able to handle extra amount of Weak Black liquor received from pulp Mill due to improved washing of the pulp giving us more chemical recovery.

RECOVERY BOILER

1. Tertiary air fan installed :

Earlier the Secondary air Fan was serving two purposes. It was providing air both for Secondary and Tertiary airports. New modification catered to following two purposes i.e., first, amount of air in Tertiary airports increased and it reduced the carry over going with flue gas and the second, the amount of air entering through Secondary airports was also increased, leading to better combustion of Black Liquor. More steam generation was

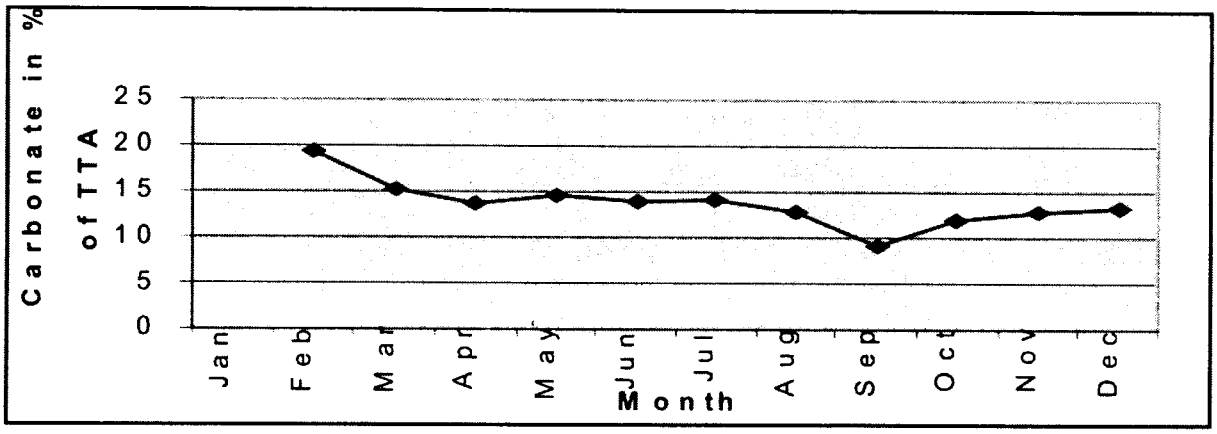

Fig. 1 : Carbonate in White Liquor Jan'o4-Dec'04

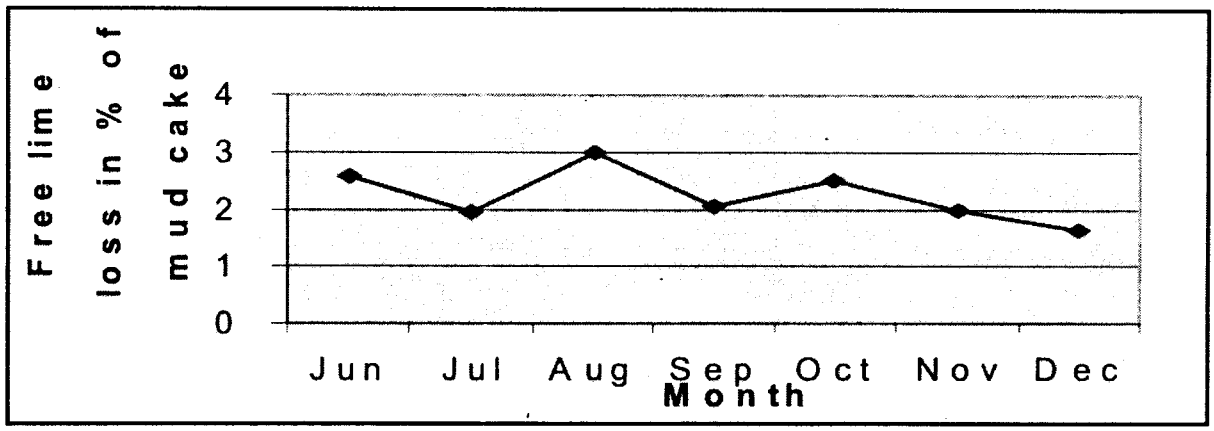

Fig. 2 : Free lime loss June' 04-Dec'04

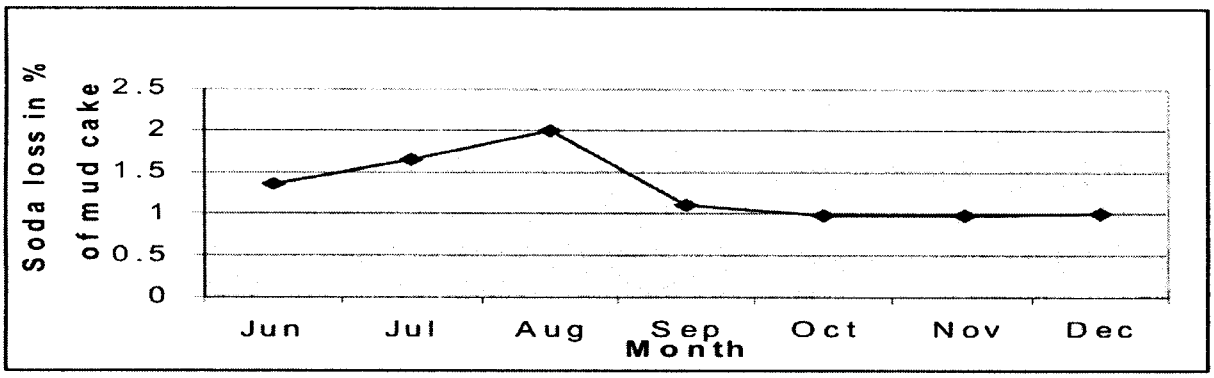

Fig. 3 :Soda Loss Jun'04-Dec'04

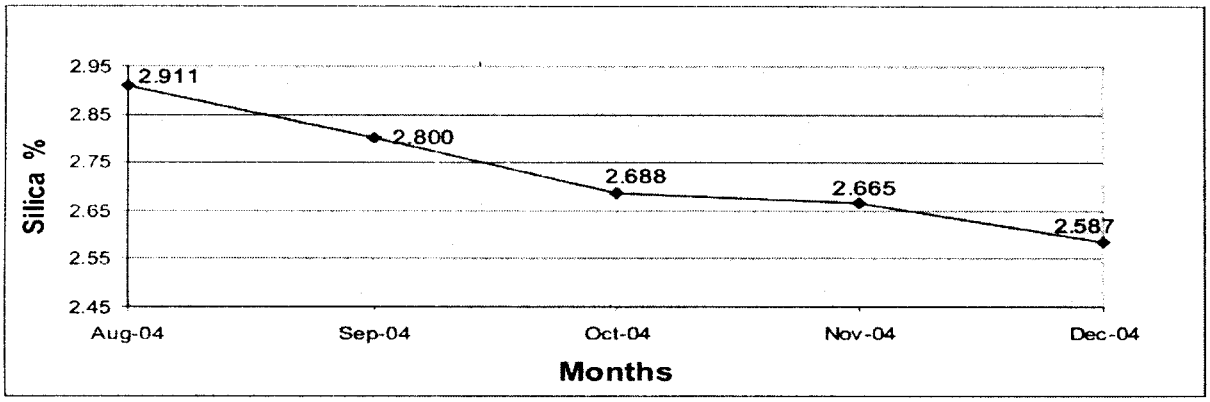

Fig. 4 :Silica in WBL

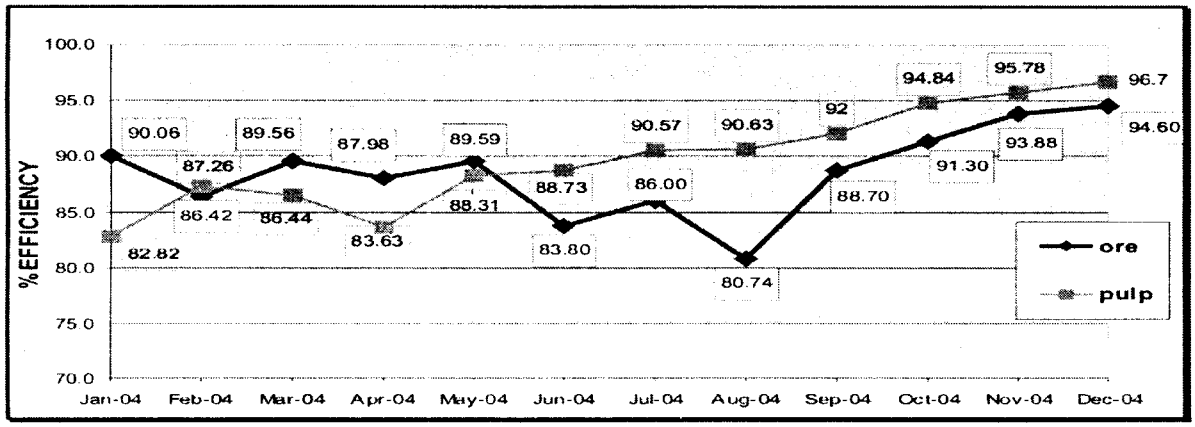

Fig. 5 :Plant Efficiency

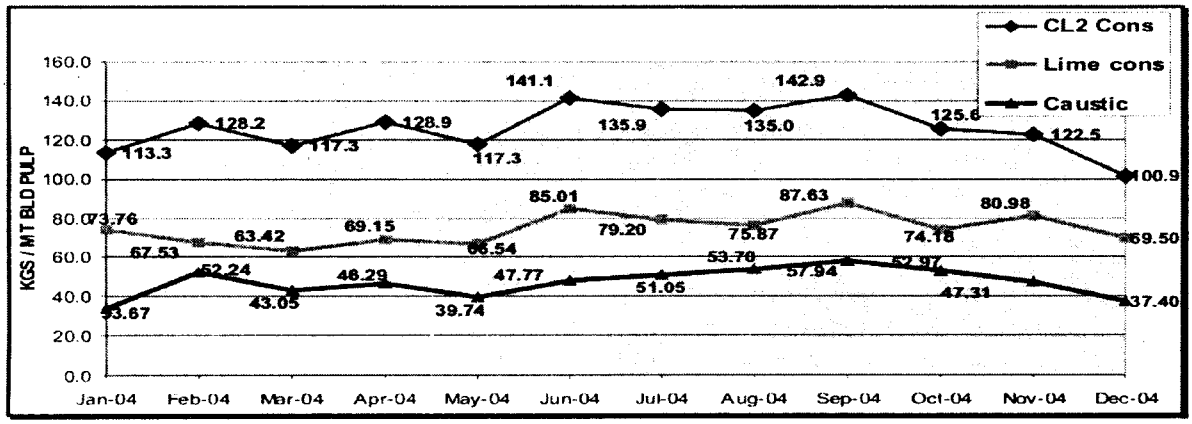

Fig. 6 : Chemical Consumption / MT BLD PULP

Proposals for Pulp Mill	
Description	**Advantages**
Replacement of Chlorine washer.	Old one is not performing efficiently, causing high Beach chemical consumptions.
Use of Alkali washer as BSW (Brown stock washer)	To get better washing, higher Recovery Efficiency and lesser bleach chemicals consumptions.
Drop leg of Chlorine washer to be increased.	To increase vacuum in washer.
High-pressure pump for washers wire cleaning to be installed.	Better performance of washers.
Providing of Bubble buster in remaining Centricleaners pumps.	To reduce breakdown in pumps and reducing power consumption.

Proposals of Recovery Plant	
Description	**Advantages**
DESCRIPTION	ADVANTAGES
Installation of spare 2nd body in Evaporator Plant	With the availability of extra body, Evaporator plant will be always running as I+5 effects to give better Steam economy and less consumption of LP steam
Provision of additional inter stage BL preheaters in parallel to 2nd and 3rd Evaporator body to increase the heating area	To increase the throughput and evaporation capacity of the plant
Increasing the Secondary air heater area to facilitate use of LP steam instead of MP steam for air heating	To reduce consumption of MP steam in boiler and to use excess LP steam available
Installation of Demister in Dissolver tank vent line to reduce carry over of chemicals	To reduce chemical losses in the plant

among other gains.

The above-discussed modifications were chosen meticulously to achieve the following objectives :

- Improvement in Overall Chemical Recovery Efficiency (Includes both Pulp Mill efficiency and Chemical Recovery efficiency)
- Reduction in dead load (i.e. the Chloride, Sulphate present in the system)
- Increase in Causticizing efficiency ,
- Reduction in Free Lime and Soda losses.

The following graphs show how these parameters were improved during the period (Jan 2004 Dec. 2004).

Future Proposals

For further improvements in the system and to achieve the target Overall Recovery Efficiency of 96%, a detailed proposal has been made both in Pulp Mill and the Recovery sections. These are expected to help getting not only a higher ORE but also an improved operations.

CONCULSION

AIL has always strived to be the pioneer in Chemical Recovery from Agro Residue waste based Chemical Pulping manufacturers. It is constantly trying to innovate to make the process economically and technically viable and to benchmark us against the best in the industry. Today we are the leaders in Agro residue based paper mills in India with an Overall Rrecovery Efficiency of 94.6% (achieved by AIL during December '04).

But this is not end of the road, AIL has many proposals in store for further improvement in the system. Successful implementation of these proposals would mean achievement of targeted sustainable 96 % Overall Recovery Efficiency. AIL is all set to move Non-wood base Pulp & Paper industry to Twenty First century by adopting new technologies and more importantly by continuous improvement in existing processes.

ACKNOWLEDGEMENTS

The authors sincerely thank AIL management for giving permission to present the technical paper in Annual IPPTA seminar, 2004.