State-of-the-art Technologies and Approach to improve Chemical Recovery Efficiency

Thomas Varghese and Manjunath
Harihar Polyfibers & Grasilene Division, Grasim Industries Ltd., Kumarapatnam 581 123, Karnataka

This paper describes the mill's approach in achieving the global distinction of high chemical recovery efficiency of plus 98% and almost selfsufficiency in energy with implementation of state-of-the-art cleaner technologies. Some of the major cleaner technologies implemented are Black liquor crystallization in evaporator, High dry solids firing in recovery boilers, Continuous up-gradation of recovery boilers combustion technology, Slow motion slaking in causticizing, Modified lime mud clarification, Two stage sedimentation type dregs washing system, Four stage counter current brown stock washing, Closed compact pressure knotter, Micro processor based electro static precipitator for soda recovery boilers and lime kiln, Process automation with DCS and Conductivity controlled recovery pits.

INTRODUCTION

Harihar Polyfibres a unit of Grasim Industries Limited in Karnataka began operations in 1972. The mill produces 72,000 tpa dissolving pulp employing pre-hydrolysis kraft process using Eucalyptus. The dissolving pulp is used in fibre plants for manufacture of Viscose Staple Fibre finding its end use in textile. The mill was set up with indigenous know-how, engineering and process technology. Most of the plant equipments and machinery were manufactured at in-house engineering workshop. The unit has institutionalized the concept of cleaner technology through participation of every employee by minimizing and eliminating the waste generation at source. The state-of-the-art technologies are adopted continuously in each and every section of the mill improving the intrinsic efficiency of process and equipments. With implementation of various cleaner technologies, the mill has achieved a high chemical recovery efficiency, maximized co-generation efficiency, maintained product quality in line with customers requirement, achieved high eco-friendly environment and has centered the business on twin principles of resource conservation and pollution prevention.

Approach to improve chemical recovery efficiency

- The mill with an emphasis on closing the kraft recovery cycle analysed each and every waste stream and started pricing them. Realising that the people are the greatest strength of any organization the mill envisaged maximum participation of practically every employee so as to contribute for realizing the said objective. The work force were trained to have an urge to improve in every possible manner. The response was positive. The employees started investigations to find whether waste could be recycled and reused.. All suggestions were evaluated regularly by the process engineering department specially set up for this purpose.
- The unit has kept pace with latest development through literature survey, operating experience by mills visit worldwide and advice from national and international consultants. Selected the best available technology suitable for the plant and move into actual implementation.
- The manufacturing process were modernized with cleaner production practices to minimize the generation of waste at the source itself.
- The reliability of plant equipments and machinery was improved with installation of latest equipments of higher intrinsic efficiency.
- Stability in the plant operation was established by achieving self sufficiency in energy, improving quality of power supply by co-generation and advanced process automation. This could greatly reduce operation interruption, inaccuracy in measurement thereby reducing chemical losses.

As many as 60 projects were implemented to recover the alkali from the waste streams through innovative solutions, cleaner technologies and improvements in shop floor procedures. The major projects to mention are:

Digester

- Process automation of the digester operations with RS3 DCS have ensured accurate charge of white liquor

based on volume and concentration, reducing the input chemical consumption.

- With floating type preheater the gasket failures were more resulting in contamination of the steam condensate with liquor and the condensate had to be drained frequently to avoid carry over of alkali with the pulp. The digester preheater design changed from floating type to fixed type. Now with new design preheater the gasket failures are eliminated and the steam condensate is free from liquor contaminates and is comparable to boiler feed water.

- Unlike single stage cooking in paper grade mill, dissolving pulp mill uses two stage cooking which is acidic in first stage and alkaline in second stage. The liquor left over in the digester after each blow is recovered and recycled back to the system. This has reduced the alkali carry over during digester wash after each cook.

Washing

- Blow tank is modified with umbrella type internal construction reducing the carry over of black liquor and fibre in the blow heat vapours. The traces of black liquor and fibre, if any, are removed with external cyclone separator. The hot water produced is free from black liquor and fibre. Washing of the pulp in four stage counter current pressure washers with clean hot water in the final stage resulted in minimum alkali carry over.

- Unbleach open vibrating knotters for separating the knots from the pulp prior to washing is replaced with high pressure knotter. Pressure knotter being closed and compact has reduced air infiltration and improved washing efficiency.

- Use of additive in the washer for better drainage could improve the washing efficiency.

- Process automation with latest Delta-V DCS Windows NT based system eliminated process upsets, minimized manual intervention and improved washing efficiency.

- The black liquor over flows, gland leakages from black liquor pumps are routed to a recovery pit with conductivity control loop. The recovered black liquor is recycled back to the system.

Evaporator

- Product liquor concentration raised from 60 % dry solids to 70 % dry solids with installation of Free flow falling Film concentrator. Increase in dry solids content has improved recovery boiler performance in terms of smelt reduction and thermal efficiency.

- Black liquor crystallization introduced to control the formation of crystals in the bulk of liquor before entering the concentrator. Formation of crystals in a controlled fashion has reduced the scaling on the heating surface improving the heat transfer efficiency. This new technology has ensured high availability of dry solids concentration improving the recovery boiler operation.

- Process operations automated with Total Plant Alcont DCS for better operational efficiency.

- Installation of Euroform mist eliminators in all the effects and maintaining optimum liquor levels in the concentrator has reduced the liquor drop lets carry over with the vapour. This has improved the foul condensate quality making it suitable for use as causticizing hot water.

Recovery Boiler

- 70% dry solids firing implemented with suitable modification in recovery boiler pressure parts, combustion system up-gradation with 3 level cold tertiary air system and modification in black liquor firing system . Firing of black liquor at high dry solids dramatically reduced extended combustion & sulphurous emissions to almost nil, increased smelt reduction efficiency, specific steam generation and capacity. With incorporation of black liquor crystallization technology in evaporator the high dry solids availability increased improving the efficiency of the recovery boilers

- Process operations automated with Total Plant Alcont DCS. Uniform Black liquor flow, optimum air to fuel ratio flow based on dry solids content and O_2 level has stabilized boiler operations and reduced the carry over .

- Electrostatic Precipitator with micro processor control is installed for both chemical recovery boilers. ESP ash rich in sodium and sulphur is recovered and recycled back to the furnace. Latest design EPIC-II controller incorporated in ESP has reduced the emission levels. Further replacement of spiral emitting electrodes with rigid multi peak electrodes has reduced the failure and increased availability of ESP.

Causticizing and lime kiln

- Conventional single compartment slaker replaced with new double compartment slow motion slaker. Efficient slaking has reduced excess lime usage controlling lime addition close to stoichiometric ratio, reduced grits generation and eliminated supplement steam in slaker. Advanced controls in the slaker has avoided the boil-outs and spurt of liquor. The formation of big particles due to slow agitation has improved the clarification in the forward stages increasing the lime mud dryness and improved the lime kiln efficiency.

- Modified two stage sedimentation type lime mud clarification system eliminated the running of belt washer. The loss of alkali and lime mud with belt filter filtrate is eliminated resulting in total recycle of lime mud.

- Process automation with Total Plant Alcont DCS and strategically positioned cameras have improved the operations and efficiency.

- Single stage sedimentation dregs washing system replaced with double stage sedimentation clarifier improving the soda recovery efficiency.

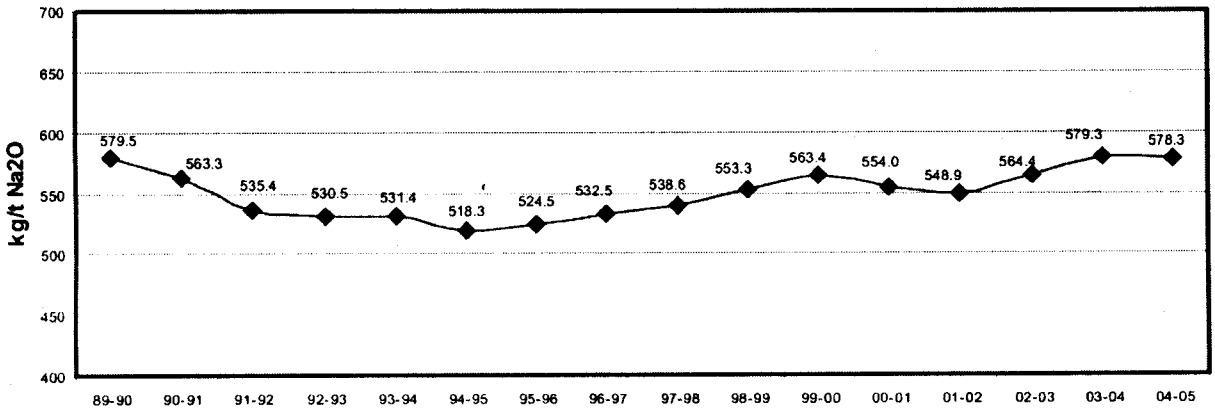

Fig. 1 : Input White Liquor Charge to Digester

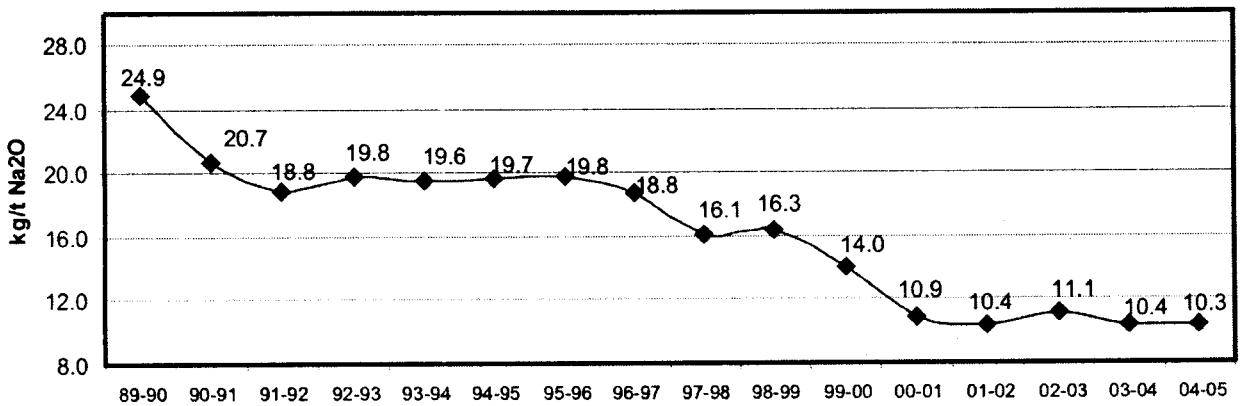

Fig. 2 : Make Up Salt Cake

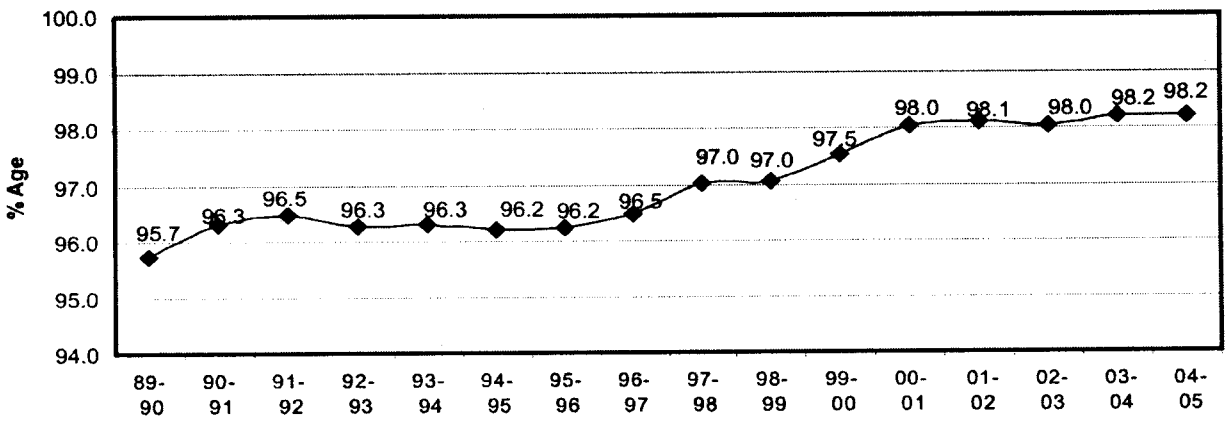

Fig. 3 : Chemical Recovery Efficiency

- Electrostatic Precipitator with micro processor control is installed. ESP ash is recovered and recycled back to the kiln.
- Lime kiln dust chamber ash is recovered and recycled back to lime kiln.
- Overflows, gland leakages from the pumps etc. are routed to a recovery pit and recycled back to the system.

Measurement and Controls

Mill has day to day measuring, monitoring and control of each stream carrying residual alkali. Chemical recovery efficiency is calculated every week by process engineering department taking net stock of the process liquor tanks with make up salt cake and white liquor charge to the digester.

Regular analysis of the black liquor is carried out to monitor the build up of non presence elements like potassium and chlorides in the system due to highly closed kraft cycle.

In addition to achieving high chemical recovery efficiency the mill has increased the lime mud recovery efficiency from 78.7% in 1989-90 to 94.1%, increased the smelt reduction efficiency from 89.9% in 1989-90 to 92.4%, increased the recovery boiler specific steam generation from 3.4 t/t of solids in 1989-90 to 4.1 t/t of solids and meets 90% of energy requirement from black liquor.

RESULTS AND DISCUSSION

- Chemical recovery efficiency increased from 95.7 % in 1989-90 to 98.2% in 2004-05. The details of white liquor charge, make up salt cake and chemical recovery efficiency from 1989-90 to 2004-05 is depicted.

CONCLUSION

With implementation of the various cleaner technologies the mill has almost closed the kraft cycle. With this the mill has achieved the global distinction of high chemical recovery efficiency of 98.2% and is almost self sufficient in energy.

References :

1. K. K. Chaturvedi, Manjunath - Emerging Tech. for Sustained Development - A Continuous Process at Harihar Polyfibers, IPPTA Convention Issue, 1997.
2. K. K. Chaturvedi, Mnjunath, B. Syamsundar, R. K. Nair - High Dry Solids Firing of Black Liquor at Harihar Polyfibers, International Conference on Pulp & Paper Industry, Paperex 1997.
3. K. K. Chaturvedi, Manjunath - Emerging Trends in Energy Management at Harihar Polyfibers, IPPTA V(12) N.2 June 2000.
4. B. Syamsundar, K. K. Chaturvedi - High Dry Solids Firing - Experience at Harihar Polyfibers, IPPTA V(9)N.3, Sep. 1997.
5. Thomas M. Grace & E. W. Malcolm - Pulp & Paper Manufacture V(5) Alkaline Pulping, TAPPI.
6. R. K. Narang, Kapil Kumar Narula, Suneel Pandey, Atreyi Paul - Cleaner is Cheaper Case studies of corporate environmental excellence V.2 TERI publication.

Table 1 : Alkali Loss Distribution

A. Alkali Loss

Section	Streams		kg/t Na_2O
Digester	Chips wash		1.04
	Vent vapours and blow vapours		0.87
Washing	Alkali in final stage wash pulp		2.05
Evaporator	Foul condensate		0.14
	Pit condensate		0.23
Causticizing	Grits		0.02
	Dregs		0.33
	Mud filter		3.07
	Green liquor dissolver, Slaker vent vapours		0.10
Rec.Boiler	Flue gas in stack and others		2.45
		Total	10.30
B. White Liquor charge to digester			**578.3**
C. Chemical Recovery efficiency			**98.2 %**