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Production, Brightness and Environmental Dynamics in modern Pulp making

Abstract: *The pulp mills are increasingly focused on the rising raw material cost, stringent environmental regulations and improved pulp quality requirements. Accordingly, the industry is focusing to strike a contrasting balance between improving the profitability and meeting their responsibility towards environment and the society. The three factors, production, brightness and environmental dynamics, are interdependent as Venn diagram. In achieving the best of these three important factors, the process is generally tweaked and adjusted to maximize the profitability with an increased production and improved quality while keeping environmental footprint at its lowest. But an outcome from this relationship of these factors is very much dependent on the pulping technology used by the mill. In this article, the author discusses how Amazon Papyrus Chemicals help to bridge technological gaps, which may exist in a particular mill, with their process expertize and specialty chemicals in improving profitability while maintaining corporate social responsibility (CSR) in pulp mills.*

Key Words: *Raw material costs, Brightness, Environment, CSR, Digester additives, Wash Aids, Oxygen Delignification, Bleaching Stages, Water closure, scale control, Lime Mud, Slag Control, Green & White Liquor.*

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Introduction

High raw material costs, increasing awareness of the pollution and water scarcity is likely to cause more stringent environmental norms for the industry in coming years, while the market place keeps looking for better (visually, printable) products. The production increase remains the most obvious way to increase the profits of the organization, however the increasing production complicates the other two aspects (brightness and environment) in any given process.

Hence important job of production and technical teams in the mills focuses to find the new balances and help mill achieve higher profits without affecting the corporate social responsibility of the Industry.

A broad categorization of pulp production, brightness and environment can be explained as three end of a triangle (Pic 1), which delivers a certain profit. The balance is set for a given process and technology of the mill.

A mill with conventional bleaching($CE_pH_1H_2$) and elemental chlorine free bleaching (example- $D_0E_pD_1D_2$) will have very different dynamics.

The three factors ideally being the three end of the triangle, are like venn diagram in real situation (Pic 2), where push in one aspect (Example- Production) affect other two.

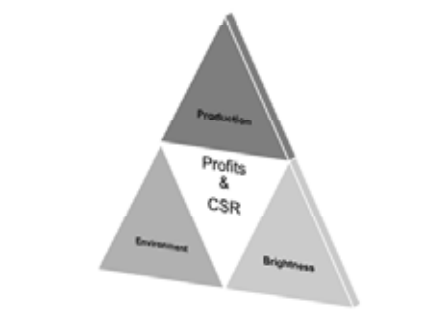


Figure 1- Ideal Dynamics of a Production, Brightness and Environment; for a given set of technology.

Technology and Raw Material

An important part of this dynamics is the given technology, which drives these different aspects. Process optimization and adjustment can help process becomes efficient, but the technology still remains the limiting factor.

A mill with different bleaching sequence like $CE_pH_1H_2$ and DED/P has very different cost economics and environmental load. The overall economics of the mill is not only driven by the production, but also with strength of the fiber, which is processed very differently in the bleaching sections.

The fiber quality in India has also changed rapidly and young and younger wood is coming to pulp mills. The thinner cell walls of fibers are a reality and they respond very differently than a matured wood fiber to same chemistry and reaction time.

Thin fibers are more prone to damage in bleaching and fines generation is detrimental to paper quality and overall economics on machine as well. In the pulp mill also, cellulosic fines consume chemicals in bleaching and also become part of the effluent stream much more easily than the whole fiber

- Increasing the production, tends to drive the brightness down.

- Improving the brightness, increases production cost and environmental burden.

- Environmental limitation restricts the production growth to build up the scale and scale up the profits, or maintain profits to meet the rising cost of production.

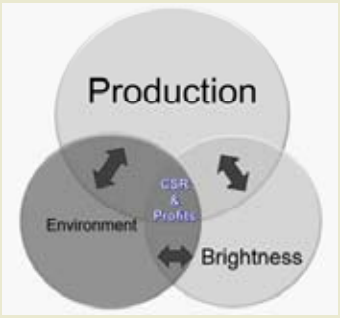


Figure 2- Real Dynamics of a Production, Brightness and Environment; for a given set of technology

PROCESS MODIFICATIONS

Mechanical Options-

The easier but high capital intensive option is to mechanically modify the process. Addition of new digesters, washers and presses, inclusion of oxygen delignification, bleaching expansion and changes, additional bleaching sequences like, (Acidification, Ozone, last peroxide stage) are common steps taken to fix the process bottlenecks.

While these steps are taken, an important aspect of optimization of existing sequence or new sequence continues to challenge the process teams in all Industries.

Process Audit and Optimization-

With any given technology, a good process audit and its optimization helps maximize the potential of technology.

Multiple process factors, contrasting relationships makes the process audit and analysis a specialist job.

Chemical Options

Chemicals play a large role in overall pulp making. Commodity chemical play the vital role for any given process.

Specialty chemicals have been developed for different part of the process to enhance each section of the process and help mill bridge those gaps between brightness, production and environment dynamics of the modern pulp mill.

Digester additives

Digester additives are often looked only as products to improve impregnation; however, the advantages delivered can be farfetched in the process and many pulp mills have adopted various types of digester additives applications to fix their different objectives (Bottlenecks in several section) Table 1

Table – 1: Digester Additives Applications

Mill problem	Size/ Process	Achievement
Higher Extractive Pitch content	1000-5000TPD TCF bleaching	Final Quality in permissible limits
White Liquor Shortage. Prod^{n} Limitation	60-2400 TPD Conventional TCF bleaching	5-8% reduction in White Liquor demand and increased Prod^{n}
Bleaching Chem. Shortage. Prod^{n} Limitation	50-3500 TPD Conventional TCF Bleaching	3-7% reduction in bleaching demand, or increased Prod^{n}

Various chemistries have been developed in past and more chemistries are being developed to improve the profitability of the mills. Kappa management of the pulp from digester, helps improve the utilization of lignin for energy generation and reduction in environmental burden through bleaching.

Wash Aids (not just Defoamers)

Defoamers are a must have products for any pulp mill, due to excessive foaming in brown stock washing. Knocking down foam is one aspect of defoamers, however modern defoamers are shifting towards better washing efficiency as well.

With the rising efficiency expectations, the value of wash aids is increasing. The requirement also shifts from mill to mill as the bleaching costs between a CEpHH and DEpD/P can be quite different and impact the economics of the process from that individual section.

ODL performance enhancer

One of the best technology enhancement of modern time is oxygen delignification, which is more selective cooking aimed at lignin. Kappa reduction % is impotant aspects of this section. As the removed lignin contributes to power generation, improves organic to Inorganic ratio of black liquor and reduce the environmental load through bleaching section.

While most of the time oxidized white liquor and O2 are adjusted to deliver a good Kappa reduction, more specialty chemicals are generating interest in this section to raise the kappa reduction capacity of the section.

New applications in this sections are

- ODL performance enhancers
- Metal ion management to deliver better fiber and optimize chemicals

Scale Inhibitors

System closure for pulp and paper is an existing challenge and this will continue to be pressed upon industry in future. The biggest

problem of higher system closure is ion accumulations and scales formation. China and India are both “water stress country” (2). Which means, in coming years, lesser fresh water for Industry and more system closure are likely to happen.

China has already led massive changes in last decade and introduction of new and modern technology has helped them meet stringent demand on effluent (Air and water)

Indian Industry is generally limited to vacuum pump scale, shut-down cleaners, but rapidly increasing hardness in surface and underground water and system closure will demand for scale control programs on regular basis in pulp Industry.

Enzymatic bleaching (X Stage)

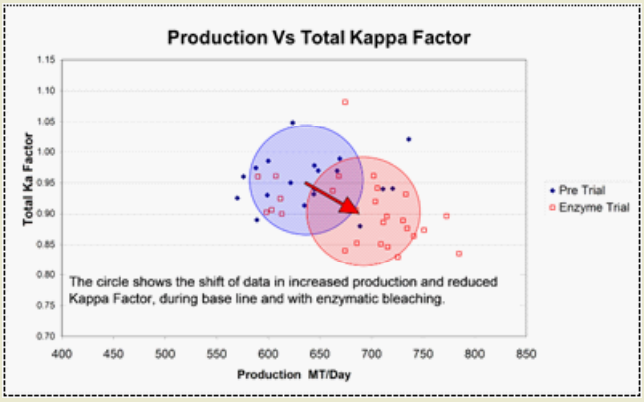
Conversion of unbleached high Density tower has existed as commercial application for over 2.5 decade (1), however most of these applications were driven by environmental constraints. Development of hotter

process and metallurgy issues has also pushed the enzyme development to have higher pH and temperature tolerant products.

Recent development suggest that improvement is biotechnology are able to deliver newer molecules, which can perform in tougher conditions.

The addition of X Stage in bleaching helps mill push through either higher production or reduce environmental burden on the effluent, due to reduced bleaching chemical consumptions. In the days of deteriorating and thinner fiber, such non-hazardous chemistry can help mills achieve better strength of the fiber, along with assisting in production, brightness & environment dynamics. Graph 1 quality of Lime. Many mills test total sodium, soluble sodium and reduced carryover and improved dryness of lime mud into kiln, helps in more uniform Cao Quality and nodule size.

Graph 1



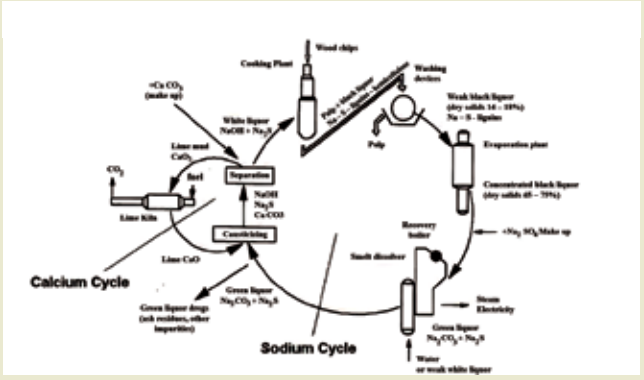


Figure 3- Ca and Sodium Cycle in Recovery plant Adapted from European Commission IPPC 2001

Figure 4- Nodules larger than 25 mm have a dark, uncalcined grey core, surrounded by a white calcined shell (3)

Figure 5- Cross Section of nodules from a lime Kiln (3)

Impurities carryover increases the dead load in process and drives down the overall efficiency of the Calcium cycle and impacts the Sodium cycle of the chemical recovery.

Peroxide Stabilizers

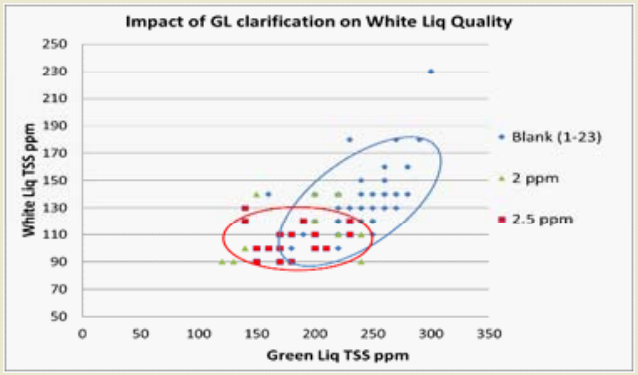
While Ca ions cause deposits, many other like Mn, Fe & Cu cause Peroxide (H_2O_2) degradation. This results in poorer H_2O_2 performance. Stabilizers have attained more attention in mechanical pulp (TCF pulp) due to higher usage. However, with more closed system, deteriorating wood the ion buildup in system is pushing Industry to look for ways to control metal ions in bleaching sections. While Calcium is mainly looked as an entry from fresh water and wood, an important addition is from the calcium loop of the recovery cycle (Pic 3). Focus in recovery helps pulp mill largely, however cost in one department and benefits in different department often causes lost attention.

Green & White Liquor Clarification

The impact of carryover from these section is cooking liquor quality and the Calcium carryover to pulp mill, which affects considerably in pulp section. These

applications are amongst the smallest pulp mill chemical applications, but their indirect returns are substantial. Inter departmental cost, benefits conflict and lack of expensive equipment, often causes neglect of these chemical applications. Graph 2

Graph 2



Lime Mud Dewatering Aids

An important part of Calcium cycle in recovery is lime kiln. In Addition to NPE, Sodium carry over in this cycle causes negative impact to the

Slag Control in Recovery Boiler:

To extend running period of recovery boiler between water wash.

Summary

Specialty chemicals in process can help build the technology gap, to increase profits with a responsible behavior towards environment. Figure 6

A great deal of research and experience is going into developing new and innovative chemistries and it's a fast pace ongoing process. Indian Industry can easily prepare itself for the forthcoming changes likely to take place on environmental and raw material front and chemical supplier can play a role of technology partner more emphatically.

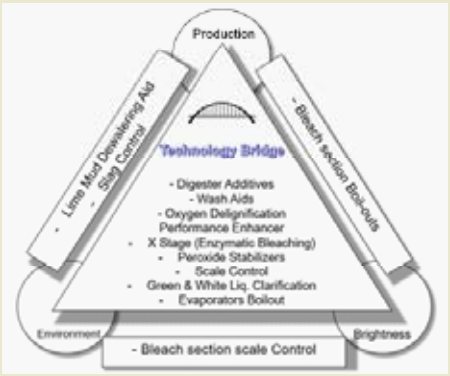


Figure 6- Production, Brightness and Environment dynamics and technology bridge

Evaporator Boil-Outs

Evaporators are a crucial part of part of the recovery system. The organic and inorganic ratio, the lignin polymer complexities, the scaling tendency on heating up, makes its operation even more critical.

While continuous scale program is not very popular yet, due to long justification period, an effective way to improve efficiency of the entire system it to have improved cleaning.

Boilout additives increases the deposits removal, thus reducing the wash frequencies. This helps in keeping the high steam economy and stable production rate in evaporators for longer period. Several mills have increased their wash cycle from few days to weeks, with a meager cost, to get good return on Investment.

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