

Energy Savings in Chemical Recovery through Process Modifications

Presentation by

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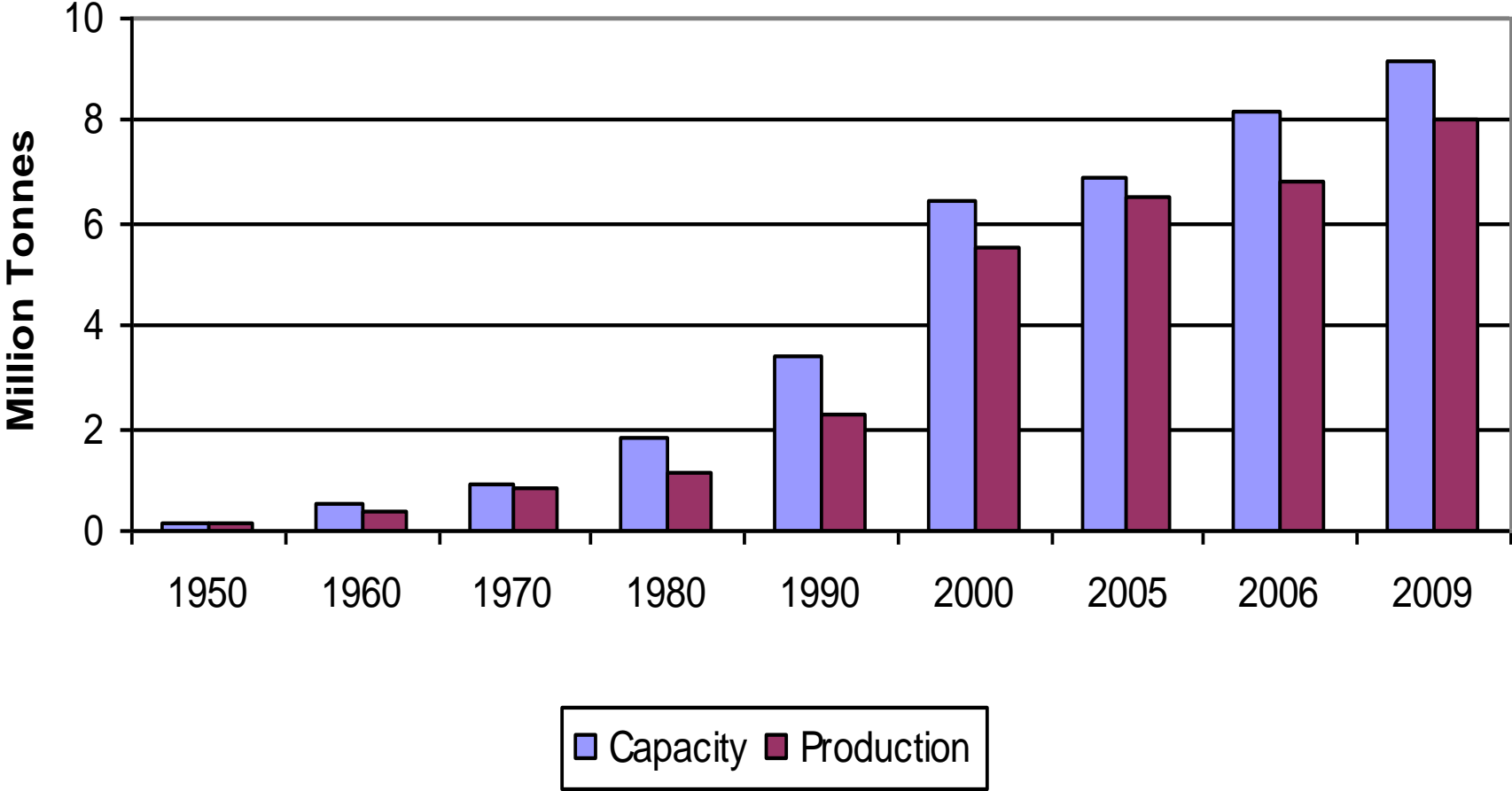
PAPER INDUSTRY AT A GLANCE

The industry is fragmented with capacities ranging from 10 to 800 tonnes per day

➤ Total number of Pulp & Paper Mills	715
Wood Based	25
Agro Based	139
Recycled Fiber Based Mills	551
➤ Installed Capacity of Mills	9.2 million tonnes
➤ Per-capita consumption (Paper & Paperboard)	7.0 kg
➤ Production	8.0 million tonnes P&B and Newsprint
➤ Turnover	Rs. 17000 crore
➤ Exchequer	Rs. 2500 crore
➤ Employment	Direct-3 Lakh / Indirect-10 Lakh



GROWTH OF PAPER INDUSTRY



Paper capacity and production in India 1950-2009

Issues – Pulp & Paper Industry

- Nearly 99 mills (with a capacity of 1.20 million tonnes) is closed.

Reasons for Closed Capacities

- Technological obsolescence
- Environmental issues

- Technological obsolescence

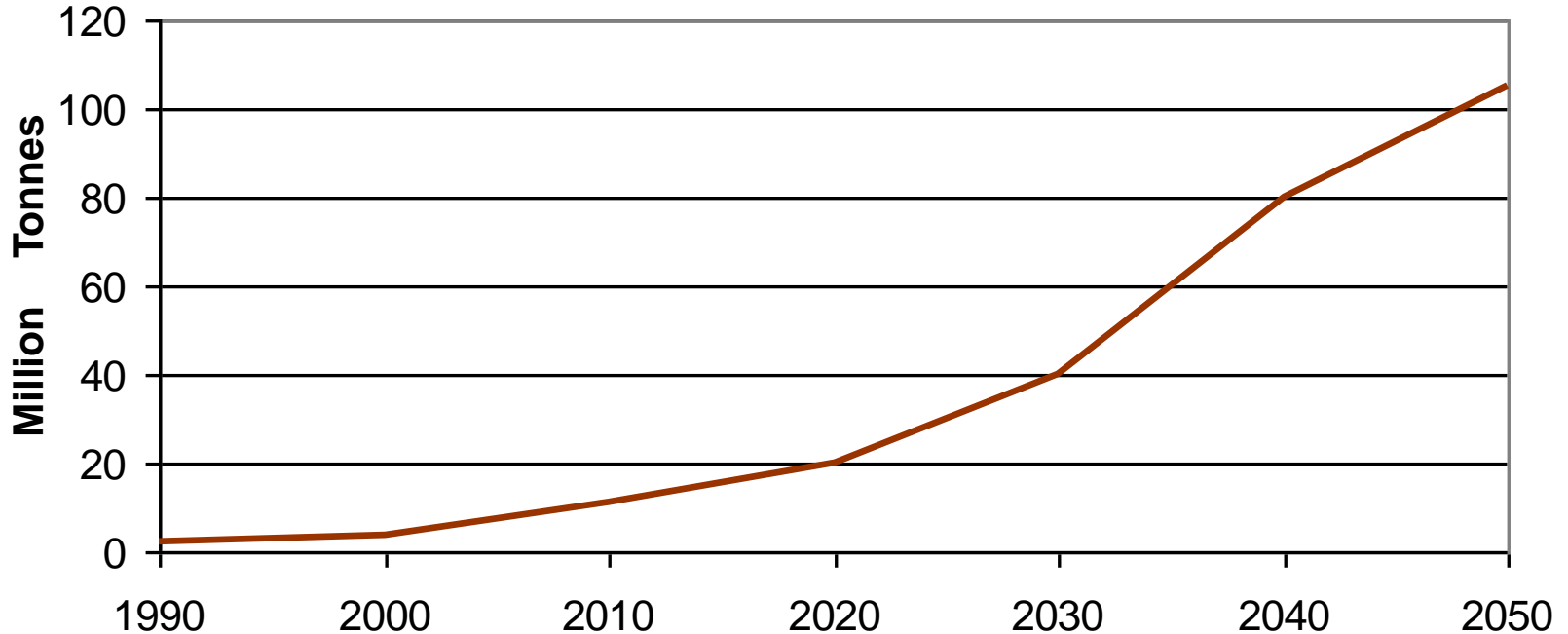
- Lack of eco friendly state of the art processing technologies.
- Uneconomic scale of operation.
- For adoption of new papermaking technology quality of raw material and mill size are the major limitations.



Demand for paper and paper board

- The demand for P&B may be higher than projected
- The production will be mainly due to increase in recovered paper use as raw material

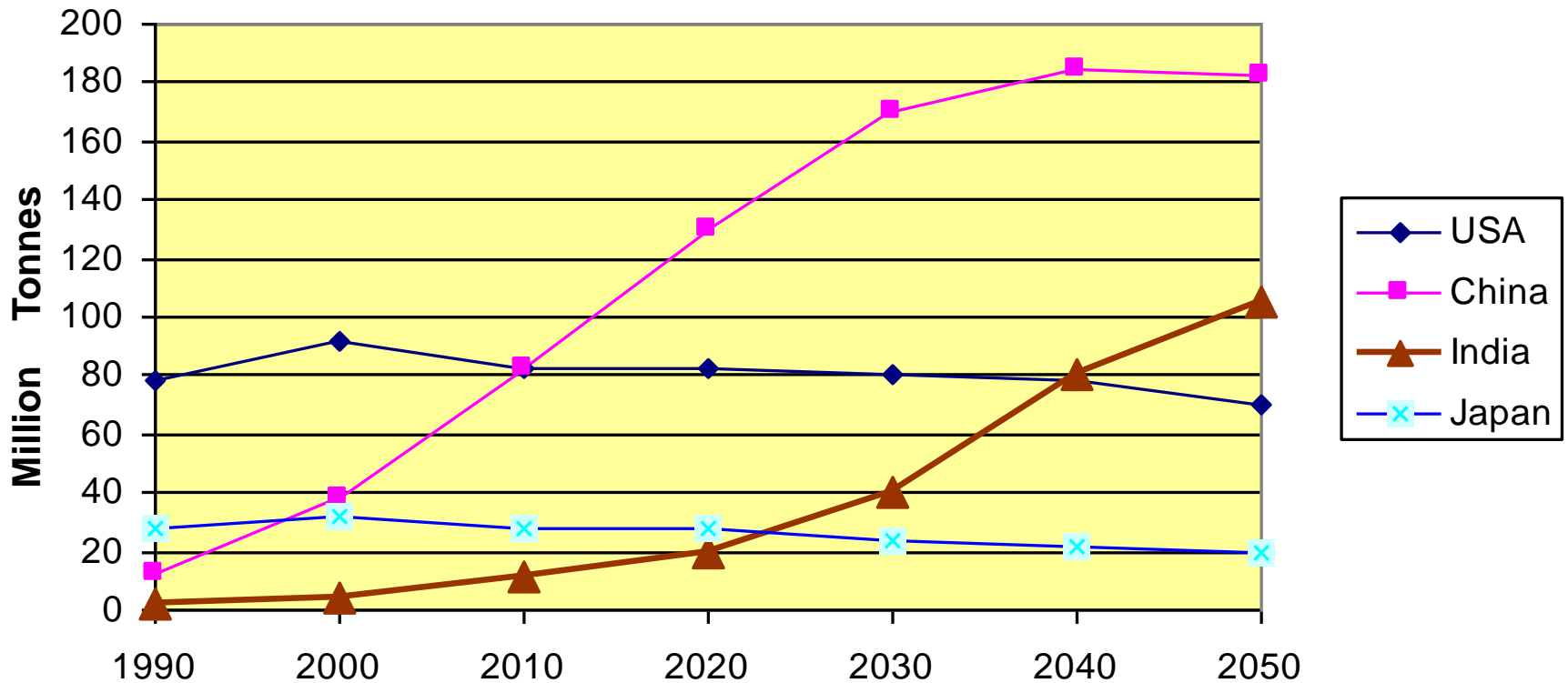
India - Projected P&B demand in 2050



Source: Study by Finnish Expert - Paperex 2009

Demand for paper and paper board

- According to Finnish Expert India will be second largest consumer of P&B in 2050 after China



Energy Consumption

- **Predicted value of Energy Consumption in the year 2050 will change accordingly.**
- **Indian mills lag behind the mills in developed countries by more than 50 years at present, The new capacities added are based on second hand imported machines.**
- **Future Energy demand will depend on the adoption of technological advancement by the Industry**



Energy Efficiency in Chemical Recovery Cycle through reduction in:

1. Non Process Elements (NPE) in Chemical Recovery Cycle
2. Thermal Treatment of Black Liquor

Impact on Chemical Recovery Systems

Non-process elements, including chloride and potassium from the wood and chemical makeup, accumulate in the recovery cycle, adversely impacting the operation of the boiler.

Problems caused by this accumulation include:

- **Accelerate recovery boiler plugging.**
- **Plugging in the super-heater area**
- **Corrosion in the recovery boiler**
- **Increased steam demand**

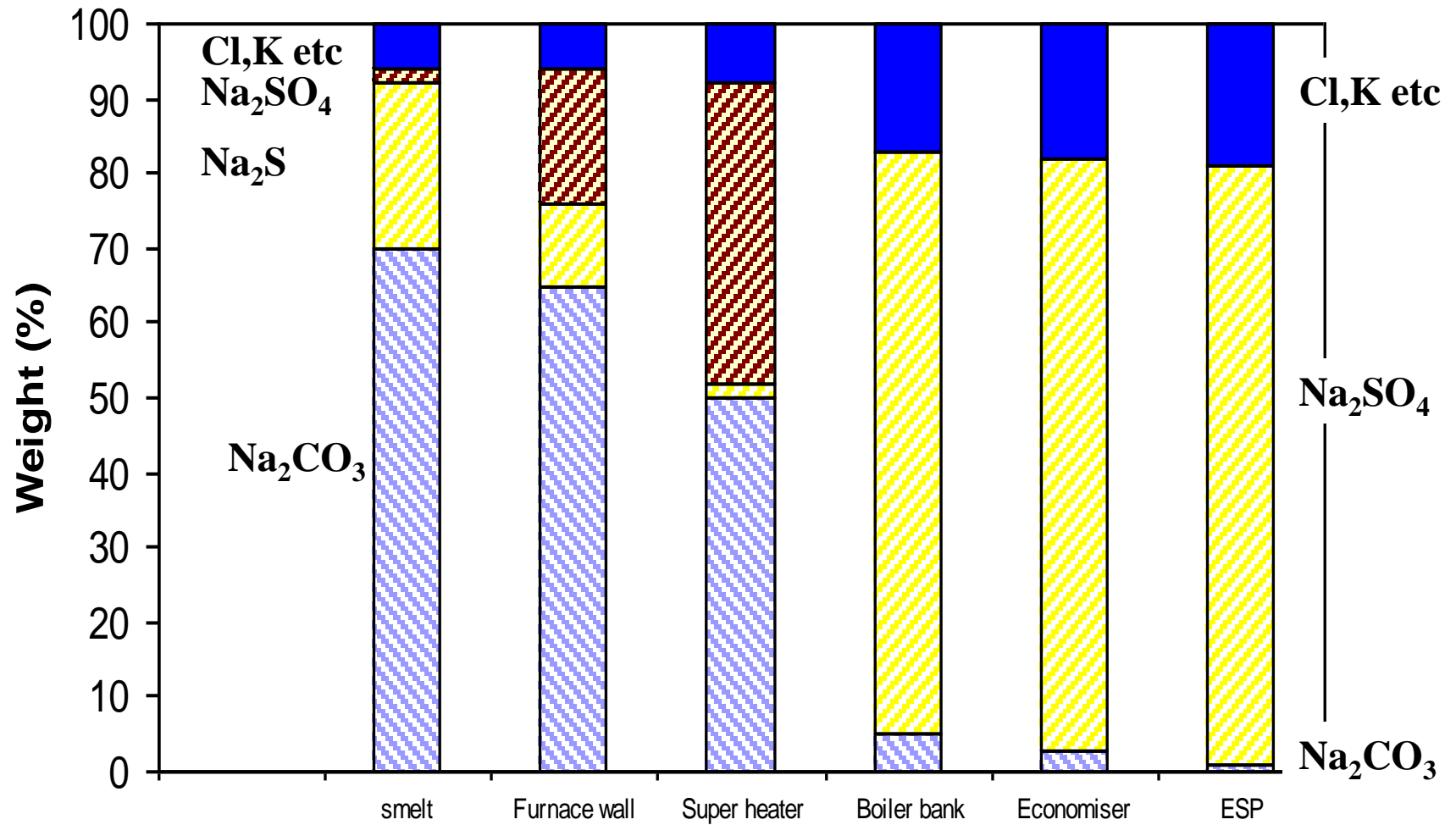


DEPOSIT THERMAL PROPERTIES

- 1. Sticky temperature** – The temperature above which the deposit has sufficient liquid phase to become sticky.
- 2. Radical deformation temperature-** The temperature above which the amount of liquid phase in the deposits is sufficient to make the deposit fluid.
- 3. Ash melting temperature** – The temperature when deposit is completely on the molten stage.



Fireside Deposit Compositions



EFFECT OF Cl AND K ON DEPOSIT THERMAL PROPERTIES

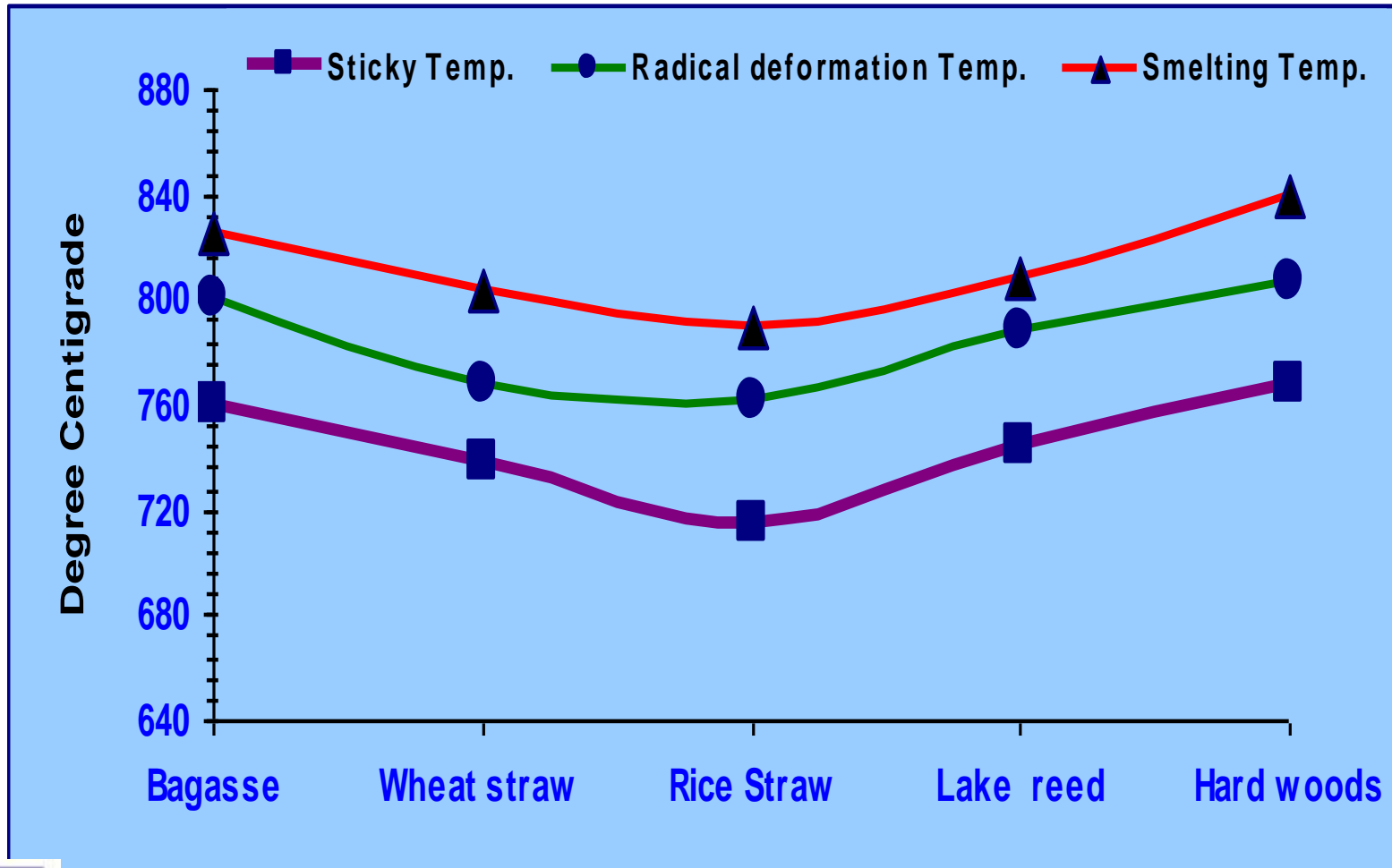
Both chloride and potassium lower deposit temperature, but their impact on deposit thermal properties is quite different.

Potassium lowers the first melting point as its concentration increases, but has little impact on the amount of liquid phase.

Sticky temperature and radical deformation temperature, which are a function of the concentration of liquid phase, are strongly affected by chloride concentration and not by potassium.



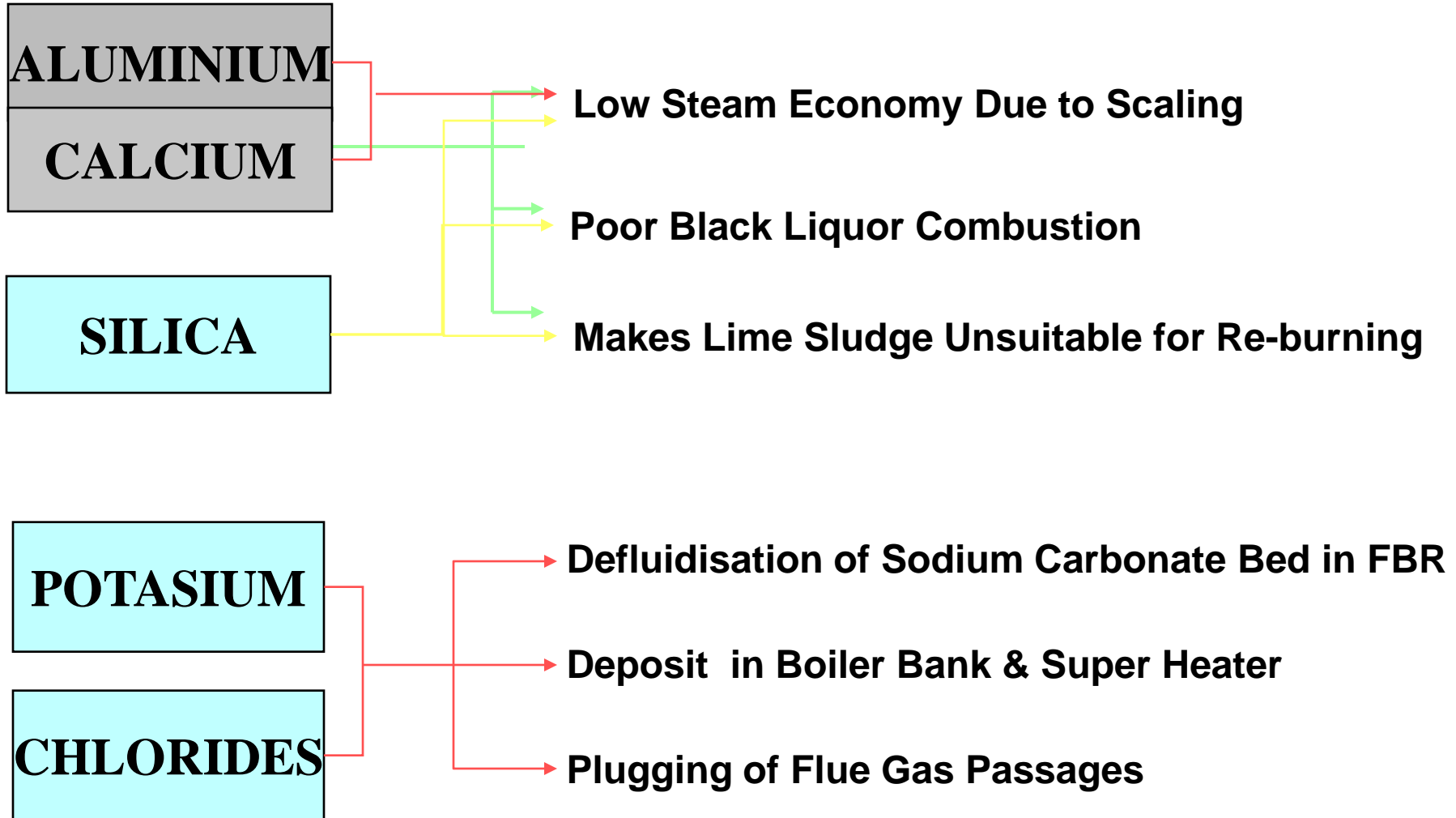
THERMAL PROPERTIES OF BLACK LIQUOR ASH SAMPLES



Effect of Potassium & Chlorides on Thermal Behaviour of Black Liquor

Raw material	Potassium, % w/w	Chloride, % w/w	Ash Melting temp, °C	Smelting temp, °C
Case- I As found in the original black Liquor				
Bagasse	0.40	0.02	805	826
Wheat Straw	2.64	1.0	738	788
Case- II After External addition of chloride & potassium				
Bagasse	2.53	1.96	722	793
Wheat Straw	3.70	1.93	720	776

IMPACT OF NON-PROCESS ELEMENTS ON VARIOUS RECOVERY UNIT OPERATIONS



K Compounds in Recovery Furnace

Solids or liquids



Gases



Cl Compounds in Recovery Furnace

Solids or liquids

NaCl

KCl

Gases

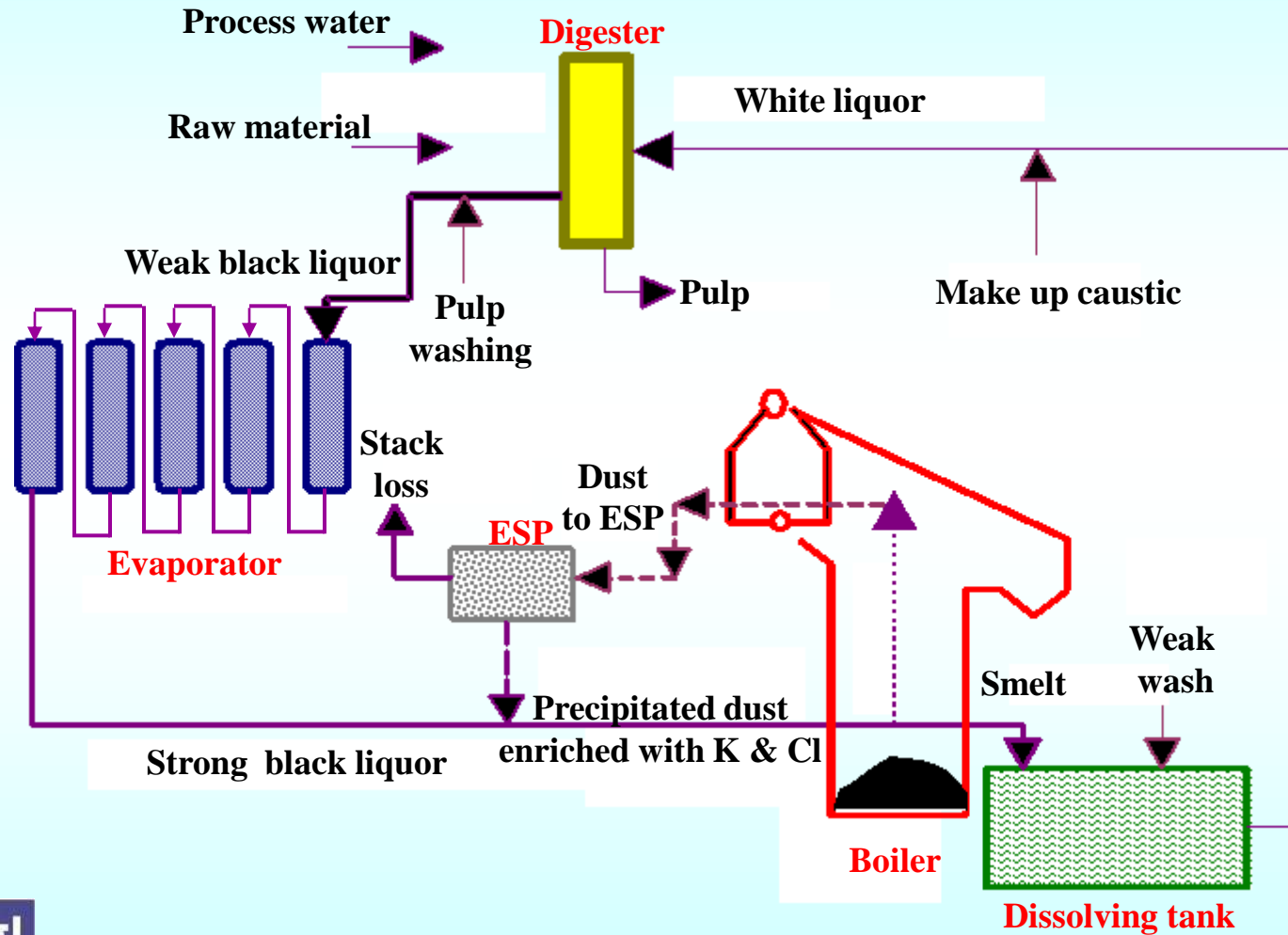
NaCl

KCl

HCl



BUILD-UP OF NON-PROCESS ELEMENTS IN CHEMICAL RECOVERY CYCLE



Enrichment of Potassium & Chlorides at Various Stages in a Recovery Boiler

Enrichment Ratio	Super Heater Deposits	Boiler Bank Deposits	Economiser Deposits	ESP Dust
Chloride Enrichment Ratio	2.8	1.9	3.4	8.8
Potassium Enrichment Ratio	8.8	12.8	9.4	10.9

Control/Reduction of Non Process Elements

- **Control measures in non-wood based mills**
 - **Leaching Of Non – Process Elements from Agro Residue Raw Materials**
- **Control measures in wood based mills**
 - **Efficient Debarking**
 - **High Sulphidity**
 - **Purging of Grits and Dregs**

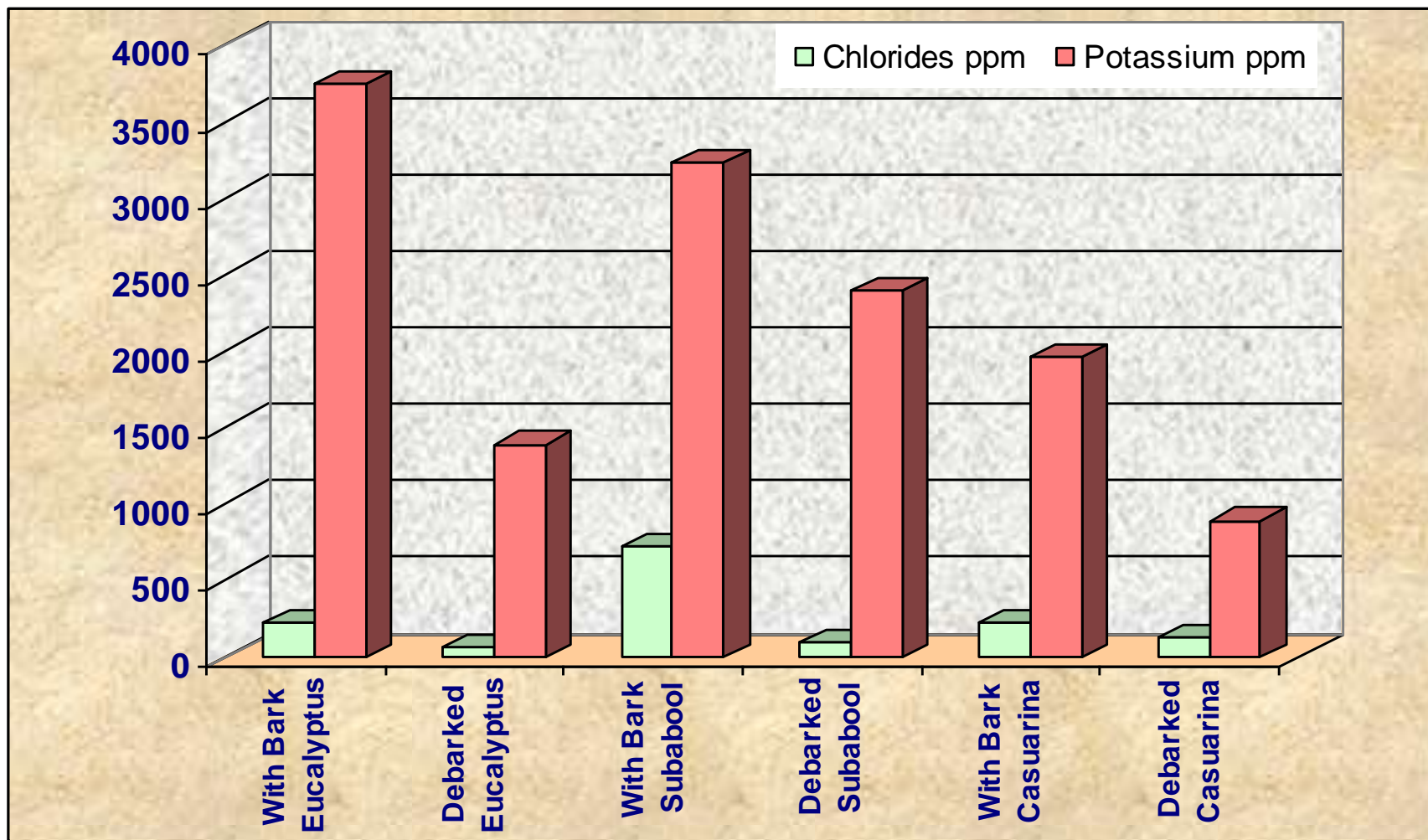


EFFECT OF HOT WATER LEACHING OF AGRO BASED RAW MATERIALS ON NON-PROCESS ELEMENTS

Particulars	Wheat straw black liquor		Rice straw black liquor	
	Before treatment	After treatment	Before treatment	After treatment
Silica,% w/w as SiO ₂	3.0	2.7	2.5	2.2
Potassium,%w/w as	3.1	1.72	3.7	1.85
Chlorides, %w/w as	1.5	0.59	1.95	0.60
Thermal Properties:				
Stickytemp,°C	738	760	715	750
Radical deformation temp,°C	768	785	762	798
Smelting temp., °C	804	830	790	828



Chloride and Potassium Content in Different woods (with & without bark)



Partial Purging of ESP Ash

Purging the ESP dust is one way of chloride & potassium removal from chemical recovery cycle. This approach is being practiced for many years in some mills. However, this approach significantly increases the make up chemical requirement and economy of the mill is adversely affected.



NPE Removal & control Increases Mill Efficiency by:

- **Reducing chemical makeup costs**
- **Increasing stability of mill operation with less frequent stoppages for washing**
- **A reduction of corrosion in the recovery boiler**
- **An increase of recovery boiler steam production**
- **Creating steam savings from reduced soot blows**
- **Allowing increased super-heater temperature for increased power generation**
- **Presence of High amount of NaCl in black liquor also causes heat loss from recovery Boiler. It goes out with the smelt at 900°C.**



Energy Conservation options in Chemical Recovery Cycle

Thermal Treatment of Bagasse Black Liquor for increasing the Product Liquor Concentration.

1. High viscosity of bagasse black liquor at high solids concentration is known to limit the product liquor concentration from evaporators.
2. Lignin – Carbohydrate Complexity (LCC) are the main reason for high viscosity of bagasse black liquor.
3. Thermal treatment of bagasse black liquor will result in firing of black liquor at increase solid. The solids of firing black liquor can be increased from 68% to 74%.



Thermal Treatment of Black Liquor

- **LCC bonds in Bagasse Black liquor can be broken at elevated temperature.**
- **Studies conducted at CPPRI reveals that at a temperature around 185 – 190°C for 20 minutes breaks the LCC bond (Thermal treatment)**
- **Breaking of LCC bond after thermal treatment reduces viscosity by 40%.**
- **Thermal treated Black Liquor has higher swelling volume ratio (SVR) i.e. 17 as compared to original Black Liquor (13).**



Case Study:

1. Generation of additional steam by enhanced calorific value (from 68% to 74% solids)

Before thermal treatment NCV at 68% solids - 2039 kcal/kg

After thermal treatment NCV at 74% solids - 2219 kcal/kg

Difference in calorific value - 180 kcal/kg

Additional heat released by combustion of 900 T/day solids = $900 \times 180 \times 1000$
= 162×10^6 kcal/day
= $162 \times 10^6 / 663.6$
= 224 t steam

t/day

(Enthalpy of steam at 65 kg/cm² = 663.6)

Annual saving = $224 \times 330 \times 741$ = Rs 5.48 crores per annum

Net Annual saving = 5.48×0.6 = 3.28 crores per annum

2. Saving of stack heat losses by increasing Black liquor Solids from 68% to 74%

Water with one kg Black Liquor Solids at 68%	= 0.47 liter
Water with one kg of Black Liquor Solids at 74%	= 0.35 liter
Additional water	= 0.47 - 0.35 = 0.12 liters
Additional water in 900 t Black Liquor Solids	= 900 x 1000 x 0.12
	= 108 t/day
Heat loss with 108 t water	= 108 x 540 x 1000
	= 58.32 x 10 ⁶ Kcal/day
Additional steam generation	= 87.88 t/day
Additional steam generation	= 87.88 x 0.6 = 52.7 t/day
	≈ 53 t/day
	= 53 x 330 x 741
	= 1.30 crores
Total saving	= 3.28 + 1.30
	= 4.588 Crores



Economics:

Total Savings

= 5.248 Crores

Cost of Thermal Treatment Plant

= Approx. Rs 10.0 crores

Payback

= 26 Months



Conclusion:

1. Reduction in viscosity of Bagasse Black Liquor through thermal treatment can reduce energy consumption in Evaporator section.
2. Reduction in viscosity will also help in generation of more Energy by increasing firing concentration.
3. Thermal treatment will also have the positive impact on burning of Black Liquor as SVR increases after thermal treatment.
4. Presence of NPE in Chemical Recovery cycle creates numerous problems in Chemical Recovery. They can also lead to shutdown of Boiler frequently & leads to consumption of more Energy.
5. Appropriate control/removal measures should be taken for reduction of NPE in recovery system

THANK YOU