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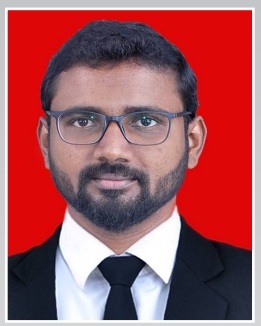
Energy Consumption Benchmarking In Pulp & Paper Sector



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Abstract: ***: This article intends to understand the current scenario of production & energy use as well as projected energy and production demand globally & nationally in future. Faster population growth rate influences the overall industrial production but the energy consumption and carbon emissions had reduced significantly. Since fossil fuels were about to extinct, We interested to do a benchmark study about the usage of energy global & nationwide. Energy benchmarking study will create healthy competition with the competitors for their growth and to protect our environment.***

The main intention of this benchmark study is to share the knowledge and allow all to compare their performance with the competing industries to identify their performance aspects.

Seshasayee Paper and Boards Limited always focus in a socially responsible manner to protect the environment by adopting new technologies with reduced primary energy consumption that produced by fossil fuels and contributing towards net zero emissions by 2050 trajectory. Circular Economy, Recycling, Process & resource efficiency, Environmental performance and sustainability will helps us to achieve net zero emissions considerably.

Interesting case studies such as installation of spiral heat exchanger & MP steam indirect heater, modifications in existing digester & evaporator and biogas firing in lime kiln were discussed to share our activities towards Energy benchmarking & Net zero emissions

Key words: ***Benchmarking, Specific energy consumption, Economy, Net zero carbon emissions***

1. Introduction

1.1 About us

Seshasayee Paper & Boards Limited established in 1960 is a wood & agro based integrated pulp & paper industry with installed capacity of 20000 TPA and upgraded continuously to present capacity of 165000 TPA. SPB's branded products have been carefully formulated to match the specific needs of various consumer segments. SPB is always committed to produce quality papers by using environmentally benign raw materials and technology.

Not only with the capacity expansion of Pulp Mill, Chemical Recovery Plant, Paper & Board Machines, we have increased marginally the mill capacity by debottlenecking resulted in generation of additional Black Liquor and putting additional load on existing Chemical Recovery plant thereby increasing mill's renewable energy share upto 70 %

2 Energy & production scenario

2.1 Global Energy Scenario

Energy is an important cost competitive and controlled variable in paper manufacturing process. According to the latest reports by British petroleum, world reserves of fossil fuels were about to extinct. It is mandate to understand the current scenario of production & energy use as well as projected energy and production demand globally & nationally in future. Global reserves, by fossil fuels, coal and oil was 1139 Billion Tons and 1707 Billion Barrels respectively. At today's level of extraction and production rates, BP's estimated proved reserves, the fossil fuels such as coal and oil would be exhausted by the year 2169 & 2066 respectively. It was reported that

- ❑ Primary energy use in 2021 was 1.3 % above 2019 levels
- ❑ Fossil fuels accounted for 82 % of primary energy use last year, down from 83 % in 2019 and 85 % five years ago
- ❑ Renewable energy increased by over 8 EJ between 2019 and 2021
- ❑ Carbon dioxide emissions from energy use rose to 39.0 GtCO2e in 2021 from 33.9 GtCO2e in 2019 levels

(Source: bp.com bp Statistical Review of World Energy 2022)

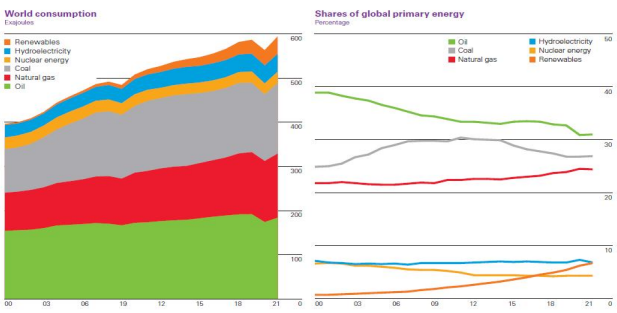


Figure 2.1 World energy consumption & share of primary energy

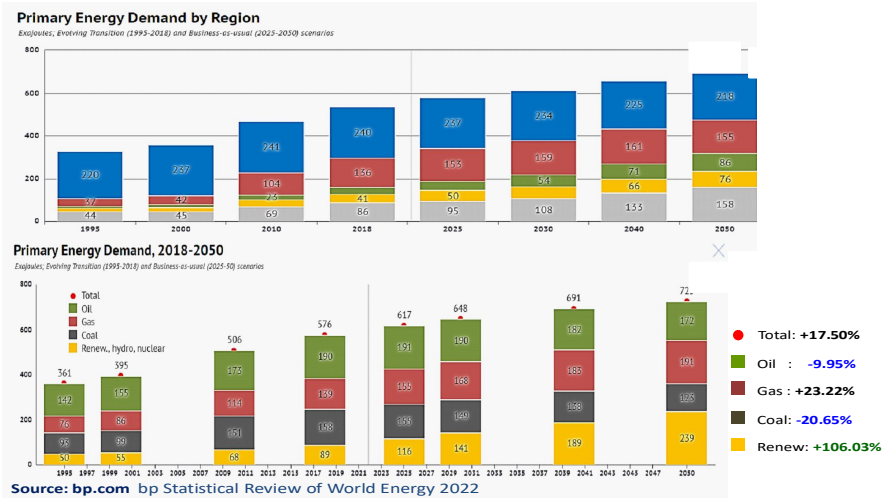


Figure 2.2 Primary energy demand

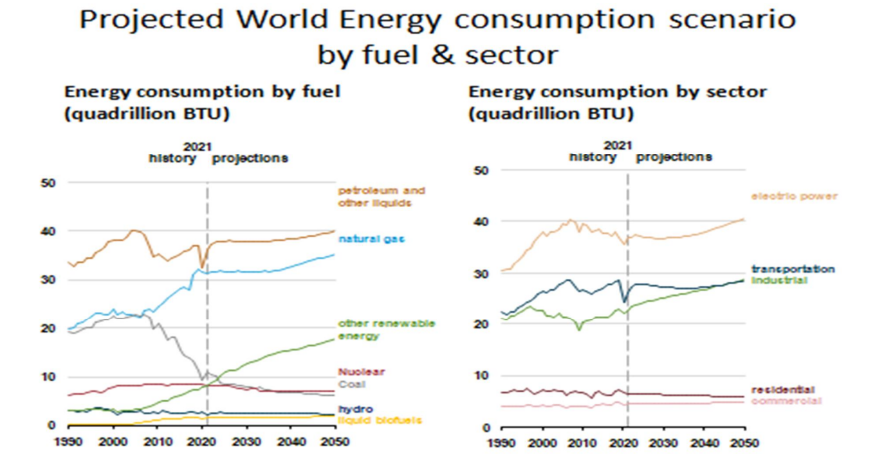


Figure 2.3 Projected energy use by fuel & sector wise

2.2 Global production scenario

Post pandemic of COVID-19, industries resume to a faster growth rate. Global manufacturing production a year-over-year output growth of 4.2 per cent in the first quarter of 2022. Industrial economies reported a similar annual output growth of 4.1 per cent, following an increase of 3.6 percent and 6.1 per cent in the last two quarters respectively. This is demonstrating a decoupling of growth in energy consumption from growth in production.

(Source: UNIDO Statistics data portal)

2.3 National Energy Scenario

There is a strong growth in primary energy by the renewables. The share of renewables in primary energy will increase from 31 % to 66 % by 2050 from the present level. Power generation with solar and wind power accounting for 55 % to 95 % by 2050 of that growth. The Government of India has set a target of installing of installing 175 GW of renewable energy capacity by the year 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power.

(Source: bp.com/energyoutlook)

2.4 National Production Scenario

Indian industries show an accelerated growth post pandemic. Manufacturing /Production in India averaged 5.89 percent from 2006 until 2022, reaching an all time high of 196 percent in April of 2021 and a record low of -66.60 percent in April of 2020. Investments in the sector have been on the rise and initiatives like 'Make in India' are aiming to turn the south Asian country into a global manufacturing hub. Considering the April-March period of 2021-22-year, production expanded 11.3 percent year-on-year. Industrial production in India grew 1.7 percent year-on-year in February of 2022, but missed market expectations of a 2.6 percent rise

(Source: tradingeconomics.com)

2.5 Energy scenario in Pulp & paper sector

The pulp & paper industry is continuously adopting the latest technologies for energy conservation. Energy efficiency in the Indian pulp & paper industry is already high but still there is a scope for improvement in this area, providing the continued use of energy efficient technologies in new plants and old plants.

Primary energy use in pulp and paper grew an average 0.1 % annually during 2010-2019. Today, Environment and Energy are the two principal challenges for sustainable development. Managing the Natural Resources without any depletion and negative impact and also making it available for future generation.

Financial Year	Total Production	Total Energy Consumption	Gross Domestic Product (GDP)	Energy Intensity
	million tonnes	million TOE	Billion USD	toe/ million USD
Average Baseline	7.38[12]	4.88	1,389	1.51
2015	17.03	10.65	2,102	2.03
2020	21.88	12.76	3,018	1.69
2025	29.28	16.02	4,233	1.51
2030	39.18	20.19	5,937	1.36

Source: BEE portal

Table 2.1 Energy scenario in Pulp & paper sector

Biomass materials are the main feedstock to the pulp and paper industry. Over the last almost two-decades the sector has experienced a decoupling of energy use from production due to energy efficiency improvements and process integration measures. Demand growth for paper and paperboard has recently accelerated and is expected to continue rising driven by population and economic growth. Efforts to curb demand and increase recycling can

therefore help reduce energy and emissions. Improving the energy efficiency is one of the key strategies to reduce CO2 emissions in the sector. Energy efficiency can be improved through higher on-site waste heat recovery and cogeneration.

2.6 Production scenario in Pulp & paper sector

Paper and paper board output increased by 0.3 % per year, demonstrating a decoupling of growth in energy consumption from growth in production. Many industries adopting renewable energy sources and recycling technology thereby cutting down the manufacturing cost for procuring virgin raw materials.

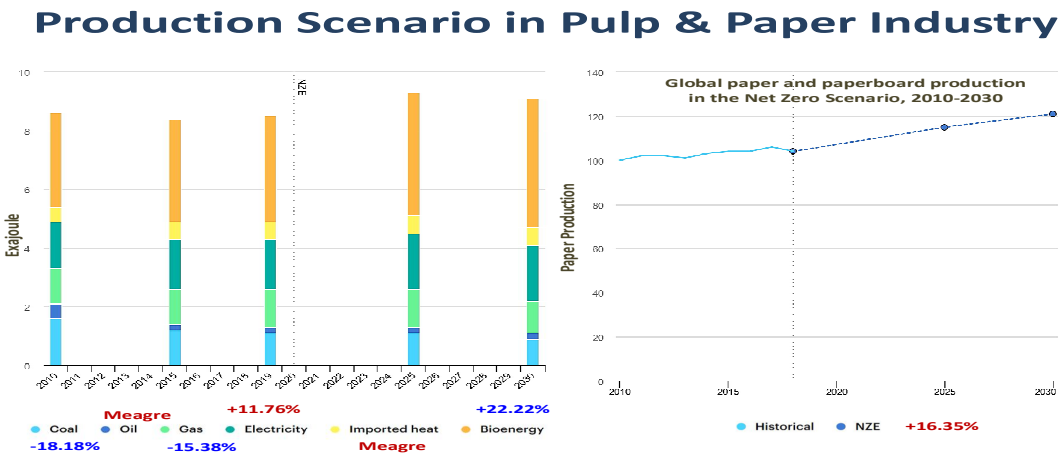


Figure 2.4 Production scenario in pulp & paper industry

3 Net Zero Emissions

3.1 About Net Zero Emissions

Net Zero Emissions is to achieve an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere. It is also described as 'carbon neutrality' and sometimes 'climate neutrality'. The feasible pathways to achieve net zero emissions

- ❑ Generate electricity without emissions
- ❑ Use vehicles and equipment that are powered by electricity instead of fossil fuels
- ❑ Use energy more efficiently
- ❑ Remove carbon dioxide from the atmosphere

3.2 Net Zero Emissions - Global scenario

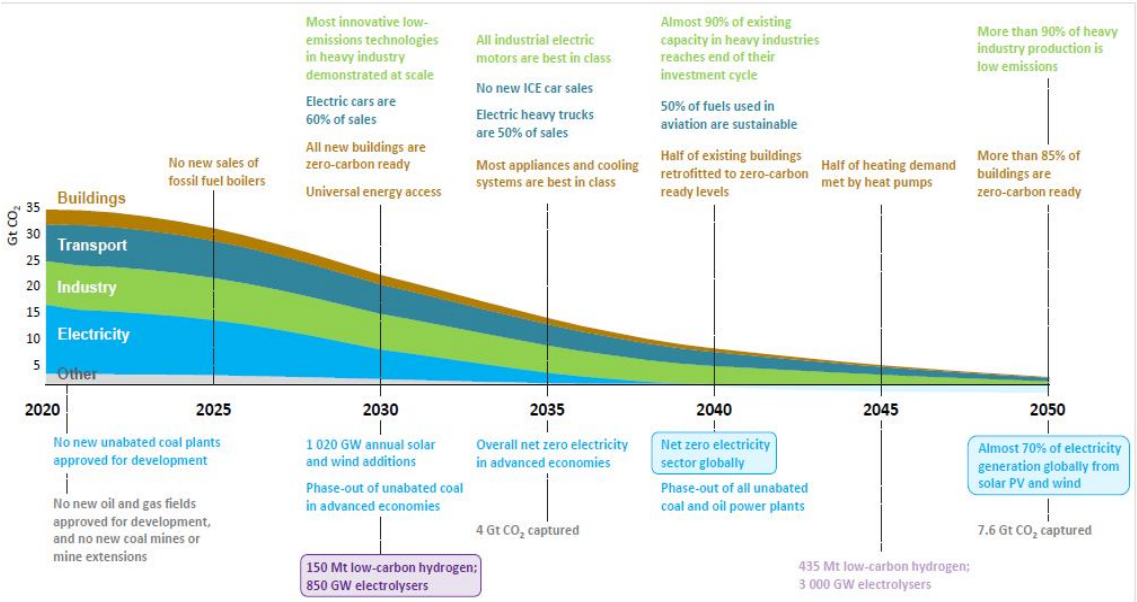


Figure 3.1 Global Net Zero emissions projections by 2050 trajectory

3.3 Net Zero Emissions – National scenario

The International Energy Agency (IEA) forecasts that India's energy demands will grow more than any other country over the next 20 years. By 2030, it is expected to overtake the European Union as the third biggest energy consumer. Although renewable energy's share in India's energy mix is increasing, coal accounts for almost 70 per cent of the country's electricity generation, according to the IEA. It plays a major role in global warming and contributes to deadly air pollution. India is the world's third-biggest emitter of GHG. India impresses the world with its leading renewable energy output and target of 450GW by 2030, linked to its leadership in the International Solar Alliance and the latest national hydrogen strategy.

3.4 Net Zero Emissions in pulp & paper sector

Net Zero Emissions by 2050 Scenario, energy use increases 0.5 % per year to 2030 while annual paper production expands 1.5 %. Greater the recycling, Lower is the energy consumption. Producing paper from recycled sources would help reduce the energy intensity. Using a higher share of bio energy and adopting waste heat recovery technologies. By 2030,

- ❑ Projected paper production increase is + 37 % can be achieved with change in product mix.
- ❑ Reduced energy demand (- 12 %) and a significant reduction of fossil fuel CO2 emissions (- 31 %) together with increased use of renewable energy (+ 25 %).
- ❑ The total employment remains the same considering higher paper production even if the productivity of the employees increases (+ 30 %).

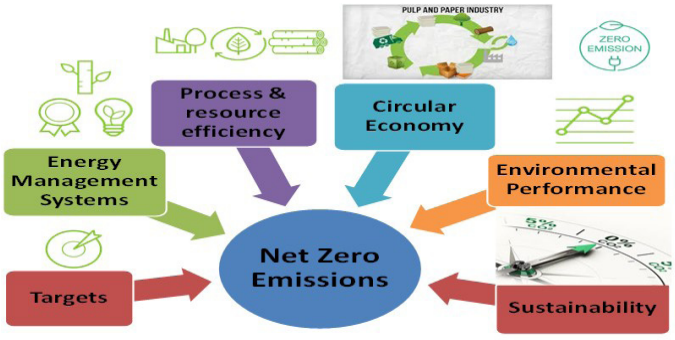


Figure 3.2 Focus towards Net Zero Emissions

4 Benchmarking

Benchmarking is a continuous improvement tool for comparing the effectiveness against competitors in terms of business (Quality, Production, Safety, Environment, Utilities and so on) as well as economics (Investment, Marketing, profiting & sustainability) near and far.

4.1 Need for Benchmarking

The main intention of the benchmarking study is to continue the knowledge sharing and allow all to compare their performance with the competing industries to identify their performance aspects. The results can be a valuable motivating force for change, both in operating practice and capital investment. A mill can assess its operating costs (energy) and environmental impact (greenhouse gas emissions) relative to its competitors and relative to the lowest values that can be obtained practically. To identify where process improvements and energy savings can be achieved, benchmarking comparisons should be made for individual process areas in the mill. Understanding and agreeing on the benefits of benchmarking

4.2 Data collection & analysis

The data collected can be classified as different sections and each individual section is compared with respect to section wise specific energy consumption and other parameters. The benchmarking study reveals the best values at which the industry is operating each section and the best practices and technologies to be adopted to become a leader in setting benchmarking standards.

4.3 Energy consumption benchmarking in SPB

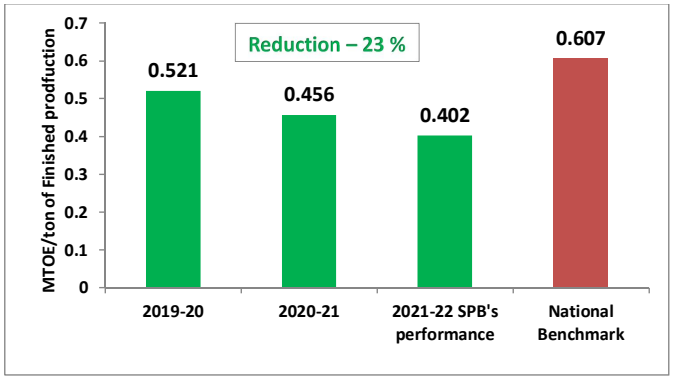


Figure 4.1 Benchmarking in Specific energy consumption

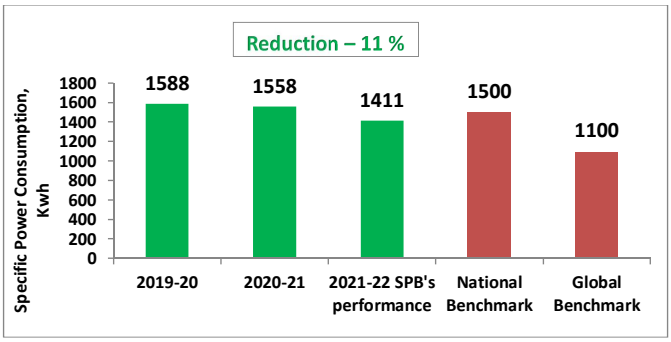


Figure 4.2 Benchmarking in Specific power consumption

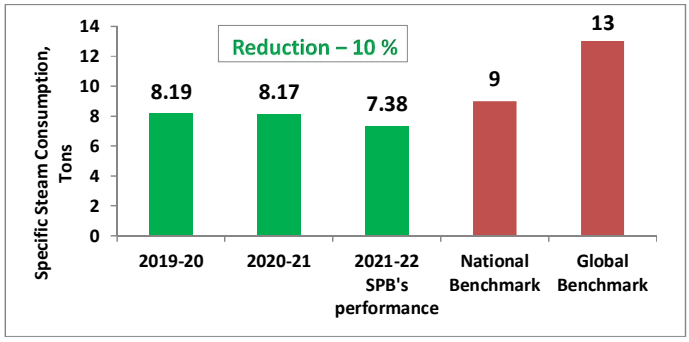


Figure 4.3 Benchmarking in Specific steam consumption

5 SPB's approach towards Energy Benchmarking & Net Zero Emissions

There are four approaches to set an action plan towards achieving Net Zero Emissions.

Energy Efficiency

There are still opportunities for energy efficiency improvements. Energy efficient industrial equipments and process integration options are exploited to their maximum economic potentials in the period to 2030 in the NZE.

Behavioural Change

There are three main types of behavioural change included in the NZE. They are reducing excessive or wasteful energy use, transport mode switching and materials efficiency gains

Electrification

The acceleration of electricity demand growth from 2% per year over the decade to 3% per year by 2050, together with an increased share of renewable electricity generation. The rise in electricity demand is being managed by ensuring the stability and flexibility of electricity supply through DSM, operation of low emissions sources of generation including hydropower and bioenergy and battery storage.

Renewables

In industry, bio energy is the direct renewable energy source for low and medium temperature needs in the NZE. Solar thermal and geothermal also produce low temperature heat for use in non energy intensive industries.

Bio energy, solar thermal and geothermal together provide about 15% of industry heat demand in 2030, roughly double their share in 2010, and this increases to 40% in 2050. The indirect use of renewable energy via electricity adds 15% to the contribution that renewables make to total industry energy use in 2050.

6 Case studies

Some interesting case studies were discussed here so as to share our approaches towards energy benchmarking & Net Zero Emissions.

6.1 Installation of Spiral heat Exchanger for WBL – WL heat exchange process

White liquor temperature could not be maintained in RDH station with the conventional shell and tube heat exchanger. This had necessitated looking into alternate advanced heat exchanger with state of +the art technology.

Figure 6.1 Spiral heat Exchanger

Spiral heat exchanger is a single flow channel and 100% pure counter current flow heat exchange concept, produces flow path with high shear rate and turbulence resulting in high heat transfer co-efficient and low fouling tendency.

Advantages of spiral heat exchanger

The continuous curving flow channel produced, results in intense scrubbing effect that prevents fouling of deposits formation. The resultant overall heat exchange can be anywhere from 30 to 50% higher than in conventional shell and tube heat exchanger. It eliminates leakages, Intra, external & bypassing unlike S&T heat exchanger.

Performance highlights

Parameter	Present	Earlier
Heat Exchanger	Spiral Heat Exchanger	Shell & Tube
White liquor outlet temperature	100 - 120^{0}C	85 – 100^{0}C
WBL supply temperature to Chemical recovery Complex	82^{0}C	90^{0}C

Benefits Achieved	
Steam savings	25 TPD
Annual steam savings	9125 Tonnes
Cost savings	45.62 Lakhs

6.2 Installation of MP steam indirect heater for Heavy Black Liquor

Heavy Black liquor is heated with direct and indirect heat exchangers. In existing LP steam indirect heater, the heater gain is only 5 °C. The firing temperature is further increased with the MP steam through a direct heater upto 130 °C. MP steam entry into the boiler can be avoided. Existing indirect heater uses LP steam as a heating medium which meets the demand for 580 TPD of HBL firing. New MP steam indirect heater designed and installed to meet up our future requirement upto 950 TPD

Figure 6.2 MP steam indirect heater

Outcomes of the project:

❑ The delta T of 15°C, which was raised through direct steam, is now increased through the new indirect heater. ❑ MP steam entry to boiler of about 20 TPD is avoided. ❑ The condensate is collected and taken back to the DM water. ❑ Steam per ton of solids raised from 3 to 3.15 immediately on commissioning & presently upto 3.25 tons.

Benefits Achieved	
HBL fired	950 TPD
Extra Steam generation @ 0.1 t/t	95 TPD
Annual cost savings	260 lakhs

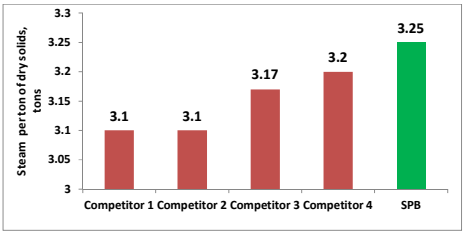


Figure 6.3 Benchmarking in steam per ton of solids

6.3 Process reengineering in Evaporation plant

To increase greener energy production from recovery boiler, phase wise developments were carried out without any capital investment in evaporation plant and digester in wood pulp mill. By debottlenecking of evaporation plant and modification of digester, HBL production was increased.

Phase 1 – Shifting of ash crystallization to first effects from second effects and Diversion of PCFT 1 vapour to Cal 3 vapour header

Phase 2 – Running Calandria 2A & 2B, liquor in series whereas vapour in parallel

Phase 3 – Modification of existing digester in wood pulp mill. It was detailed in next section i.e 6.5

Changes Made	Before (m3 / hr)	After (m3 / hr)	Advantages
Shifting of Ash crystallization	210	210	BLS fired 806 tpd, tube jamming in 1st effect reduced from 800 tubes to 180 tubes and cleaning frequency increased to 55 days from 35 days
Diversion of vapour from PCFT# 1 to CAL#3 vapour header	210	215	BLS fired at 810 tpd.
Running CAL 2A and 2B, liquor in series and vapour in parallel mode.	215	260	BLS fired at 860 tpd. We anticipate that with the given figures we may able to fire 900 tpd of solids firing. Once WBL processing rate was increased, then we looked into modification of digester.

Benefits Achieved	UOM	Value
Investment	Rs. Lacs	24
Savings	Rs. Crores	8.15
Increase in Pulp Production (Unbleached)	TPD	350 to 460

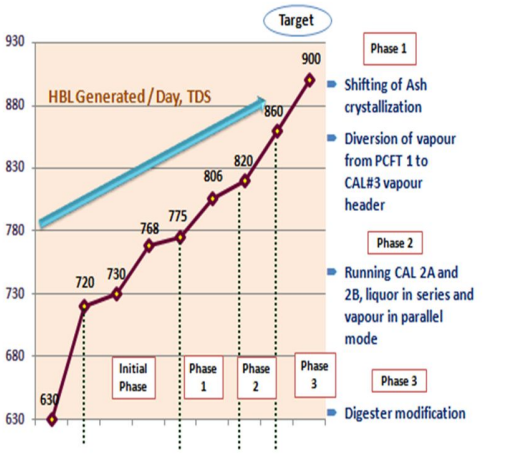


Figure 6.4 Increase in HBL production

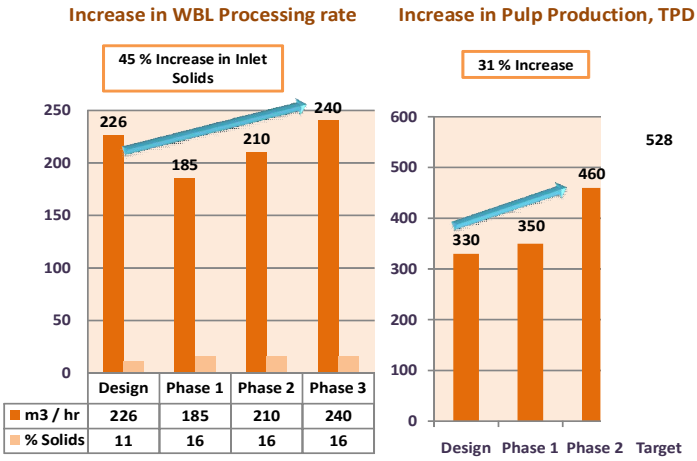
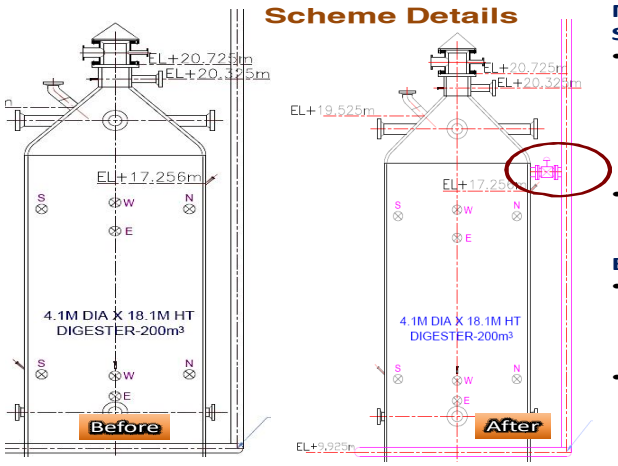


Figure 6.5 WBL processing rate & Pulp production

6.4 Modification of existing digester in wood pulp mill

We are sort of pulp to match paper production. Major modifications in paper machines recently have increased the pulp demand further. Moreover, necessity of generating more green power is the need of the hour. To address these issues, following modifications were thought of.

- **Modification 1 -** To have top air evacuation in one digester with dual logic with the existing system (With middle and top valve openings).
- **Modification 2 -** Enlarging the middle header from 12" diameter to 16" diameter control valve in one digester with self-draining.
- **Modification 3 -** Enlargement of discharge line nozzle size from 300 mm diameter to 500 mm diameter by replacing discharge valve.

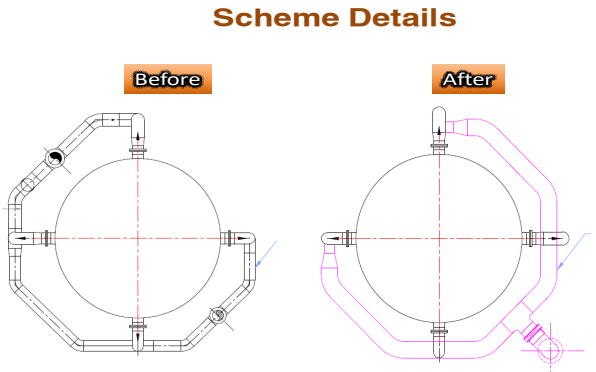


Modification – 1 (Chip fill Sequence)

- **To have top air evacuation in one digester with dual logic with the existing system (With middle and top valve openings)**
- **Investment – Rs. 24.51 Lacs**

Benefits Achieved

- **Chip fill quantity in digester increased by 1.5 Tons / digester**
- **Chip fill time reduction achieved is by 7 minutes minimum (from 32 minutes to 25 minutes)**

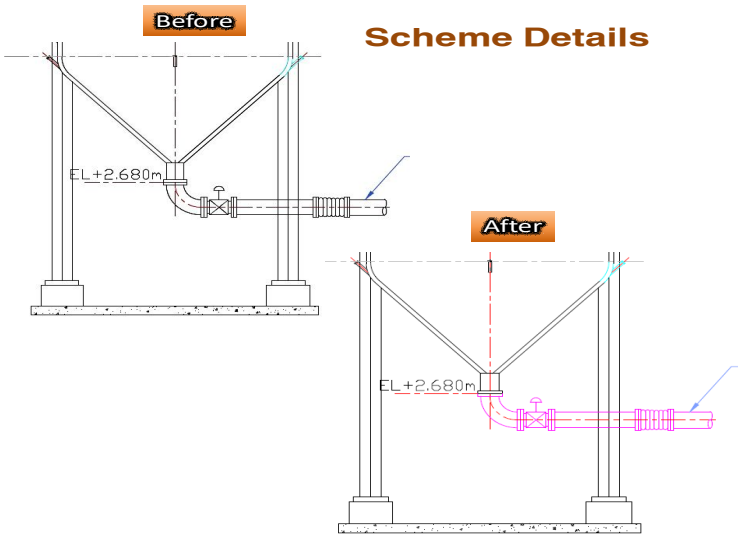


Modification – 2 (TTT Sequence)

- Enlarging the middle header from 12" diameter to 16" diameter control valve in one digester with self draining.
- Investment – Rs. 34.07 Lacs

Benefits Achieved

- Circulation volume increased from **130 LPS to 180 LPS**
- TTT time cycle reduced by **15 mins / cycle.**
- **Uniform Temperature profile achieved.**



Modification – 3 (Pump out Sequence)

- Enlargement of discharge line nozzle size from 300mm diameter to 500mm diameter by replacing discharge valve.
- Investment – Rs. 101.52 Lacs

Benefits Achieved

- Clean pump out in **one stroke**
- Cycle time reduction from **310 minutes to 290 minutes**/pump out
- **Displacement liquor entry under low velocity.**

Outcomes of the project	UOM	Value
IIncrease in Pulp Production	TPD	380 to 430
Increase in Green Energy	%	6
Investment	Rs. Lacs	148
Savings	Rs. Crores	8.15

With continuous improvements in evaporator & pulp mill, there is a strong growth in the renewable energy share within our mill. Over the last five years, 43 % growth in the use of renewable energy.

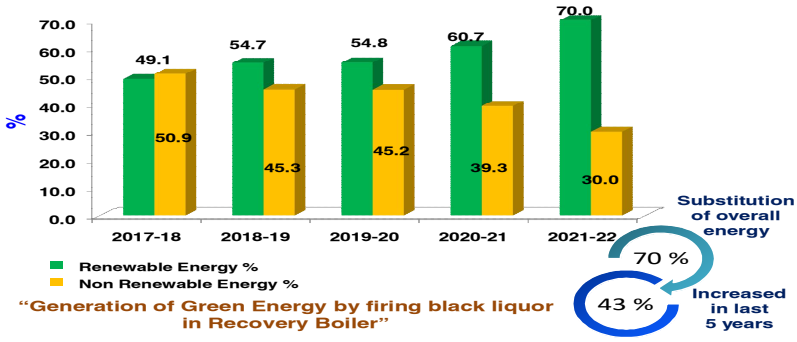


Figure 6.6 Share of renewable energy

6.5 Production of bio gas from foul condensate and firing it in lime kiln

The foul condensate coming out from the evaporator is usually treated in a stripper column. But in our mill, the foul condensate is let out to the sewer creating huge impact to the environment. To assess the organic load for effective treatment, the environmental cell analyzed the various parameters to minimize the load to ETP at source. Based on the study it is found that the pith filtrate from bagasse pulp mill and foul condensate from evaporator have high potential for generating biogas. Foul condensate along with the bagasse effluent is treated biologically in an anaerobic lagoon for generation of bio gas. Care being taken for mitigating H2S by addition of Ferric chloride. With low Investment, the generated bio gas is fired in rotary lime kiln replacing 3 to 3.5 MT / Day and this reduces 20% load to ETP. Biogas is a renewable energy and this contributes for mill's renewable energy share in increasing trend.

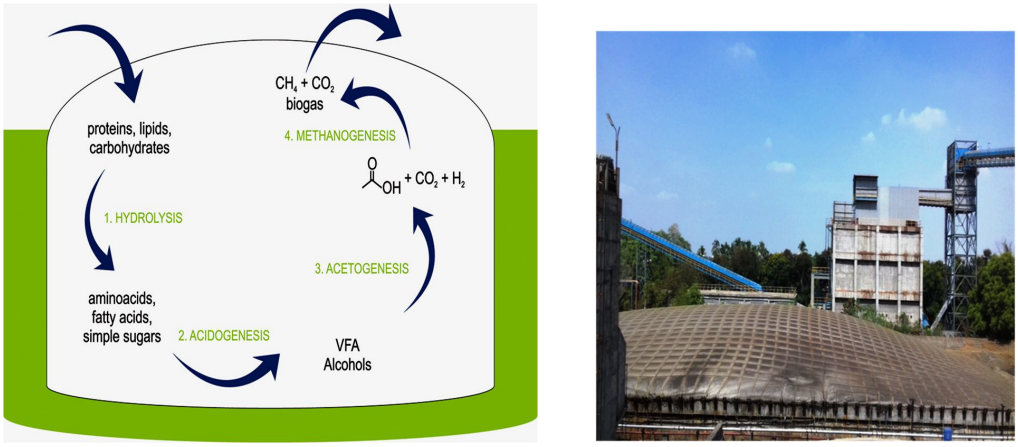


Figure 6.7 Biogas production in anaerobic lagoon

Outcomes from this project:

- ❖ Elimination of odor nuisance
- ❖ Reduced energy and nutrient consumption in the aeration system

Benefits achieved:		
Furnace oil reduction	MT / day	3 – 3.5
Savings	Rs in Crores / Annum	7.9

Key highlights from the case studies

- ❑ Steam saving from Spiral heat Exchanger – 25 TPD
- ❑ Green steam generation from recovery boiler after MP steam indirect heater – 95 TPD
- ❑ Process re-engineering in Evaporation plant – 5% increase in RE share.
- ❑ Digester modification to enhance pulp production and Green Energy – 32 TPD pulp production increased & 4% increase in RE share
- ❑ Usage of bio gas to reduce fossil fuel use in Lime kiln – 3.5 TPD Furnace oil reduction

Conclusion

It is now mandate to understand the energy & production scenario globally and nationwide. By understanding the present level and projected energy and production scenario, the knowledge will bring us to have benchmark with the competing industries and make ourselves to search for opportunities towards energy conservation, performance indicators and Net zero emissions.

Pulp & paper sector is growing at a faster rate to cater the demands for paper. Anyhow, growth in energy use is quite decoupling with the growth in production. Recycling sources and energy from renewable sources not only save fossil fuel but also bring down the energy cost considerably. Certain case studies covering wood & agro based pulp mills and recovery operations were discussed to share our approach towards energy benchmarking & Net Zero Emissions.

Acknowledgement

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