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ENERGY EFFICIENCY & OPTIMIZATION

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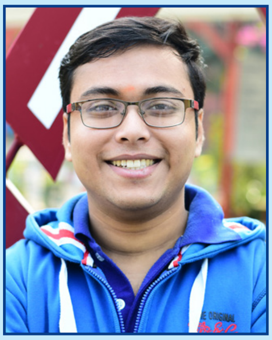

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Abstract:

In response to a discernible escalation in the demand for steam and power within our industry, a strategic initiative was launched to optimize the existing infrastructure in our company. This project was meticulously designed to address the heightened operational requirements of our plant while concurrently identifying opportunities for substantial cost savings. By undertaking this endeavor, we aimed to fortify our commitment to operational excellence, ensuring the alignment of energy resources with the dynamic needs of the industry, thereby fostering sustainable growth while maintaining a competitive edge.

A) Thermal Energy- This section encapsulates the systematic approach to calculating initial heat losses, strategically implementing insulation, micro-steam leaks & Process Improvements, and converting the resultant efficiency gains into equivalent steam savings, thereby highlighting the practical and economic benefits of embracing insulation in steam systems.

B) Electrical Energy- The paper industry, a significant contributor to global manufacturing, faces the challenge of balancing production demands with environmental sustainability. This section explores how optimizing energy efficiency can lead to substantial energy savings in the paper manufacturing process & add-on units as well as offering both economic benefits and environmental stewardship.

Keywords: *Ultrasound testing, Micro-invisible leaks, VFD, Steam Saving & Heat losses CAPA.*

Salient Points & Introduction:

Thermal Energy Savings : This research paper presents the outcomes of a comprehensive project initiated at Pakka Ltd to enhance process efficiency through collaborative brainstorming and leveraging team expertise. The focus of the initiative was the optimization of steam consumption within the existing system. Through meticulous planning and execution, the project successfully identified and implemented improvements, resulting in a substantial reduction of 2.69 TPH (Tons Per Hour) in steam usage. This paper outlines the methodologies employed, the challenges encountered, and the overall impact of the initiative on operational sustainability. The findings underscore the significance of collaborative efforts and strategic thinking in achieving substantial resource savings within industrial processes.

The outcome of the project undertaken by us led us to some key focused areas to work on, which included.

1. Steam Leakages
2. Heat loss due to no insulation

Through brainstorming and kaizen ideas, the total potential that was achievable is listed below.

Table 1 : Potential for Steam Optimization

	Area of Scope - PM-1	Area of Scope - PM-2	Area of Scope - PM-3	Area of Scope - PP-1	Area of Scope - PP-2	Area of Scope - REC.	Area of Scope -PULP MILL/ Mould pulp/washing	Area of Scope - Egg Tray	TOTAL
Steam Leakage	0.0641	0.2662	0.2573	0.0743	0.4869	0.666	0.0298	0.0324	1.877
Heat loss due to insulation	0.11	0.003	0.0448	0.11	0.1198	0.254	0.173	-	0.814
Sum	0.1741	0.2692	0.3021	0.1843	0.6067	0.92	0.2028	0.0324	2.691

Methodology -

Minor/ Invisible steam leakages: - Invisible steam leakages in industrial settings can result in noteworthy energy losses, especially in noisy environments. Even minor leaks compromise the efficiency of steam systems, leading to increased energy consumption and operational inefficiencies. These leaks not only contribute to rising energy costs but also undermine the overall sustainability of industrial processes. By implementing proactive measures to minimize these energy losses, industries can improve their operational efficiency, reduce environmental impact, and optimize energy consumption in steam-dependent applications.

Tasks Undertaken to enhance efficiency: -

- **Precision Leak Detection:**
- In noisy industrial environments, the capabilities of ultrasound (acoustic emissions) analyzers to detect even micro-invisible leaks have unparalleled precision. By utilizing the high-frequency sound waves that are beyond the range of human hearing these advanced devices can pinpoint even the smallest leaks by capturing the Ultrasound signals generated due to Friction, Impacting, and Turbulence. Heterodyning* these Ultrasound signals and extracting the audible sound component allows the inspector to easily hear the leaks while filtering the unwanted background noise. The raw data captured is digitized and converted into Time Waveforms from which the static values in decibels are extracted. This value in decibels is used to understand and quantify the severity of the leaks. Thus, Ultrasound testing provides precise localization and early identification of leaks in various industrial systems, including steam and compressed air networks.

*Heterodyning - At the heart of an Ultrasound system is the process that converts an inaudible Ultrasound signal into an audible one. This is the heterodyning circuit. A center or mixer frequency is defined, for example, 38.4kHz, on either side of which is a band-pass filter that is typically 2.5 or 3kHz wide. The heterodyning process subtracts the mixer frequency from the output of the band-pass filter. For example, a signal at 40.4kHz heterodyned with a miser frequency of 38.4kHz would produce an output of 2kHz. The inaudible thereby becomes audible.

Methodology Used:

- Conducted a thorough survey of the entire steam system, including pipelines, flanges, valves, and glands, using the ultrasound analyzer.
- The Ultrasound sensors directed us toward the potential leakage points and steam line connections.
- The device captured and amplified the high-frequency ultrasound signals generated due to turbulence in the air caused by steam leakages, making them audible for detection in the ultrasound range.
- Created a detailed map of identified leakages, providing information on their severity and exact locations.
- One Thousand-Meter Steam Line Coverage showcases the scalability of the Ultrasound testing approach across extensive HP, MP, and LP steam lines.
- Below are some examples demonstrating the same:

Leak details N°	16	Severity :	
Location		Sensor	
MG NDE		FlexID2	
Distance		RMS value (dBμV)	
20.00		66.0	

LEAK ESTIMATION	
Loss (m³/h)	Loss ($/year)
3.8	4865
Comments	

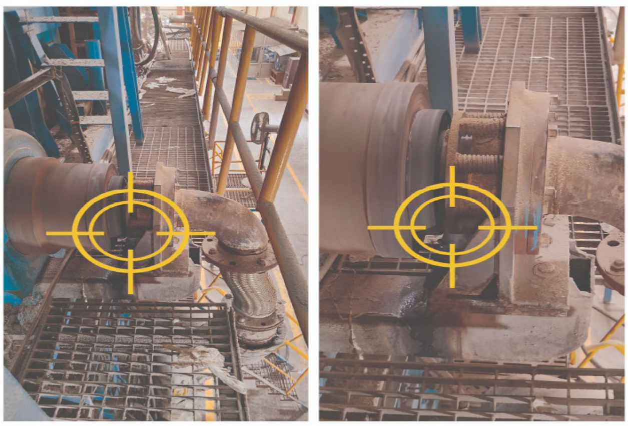

Figure No - 1.0
Steam Leakage identification near Yankee Cylinder with Ultrasound Instrument

Leak details N°	3	Severity :	
Location		Sensor	
Steam Main Header		FlexID2	
Distance		RMS value (dBμV)	
20.00		57.0	

LEAK ESTIMATION	
Loss (m³/h)	Loss ($/year)
2.2	9459
Comments	

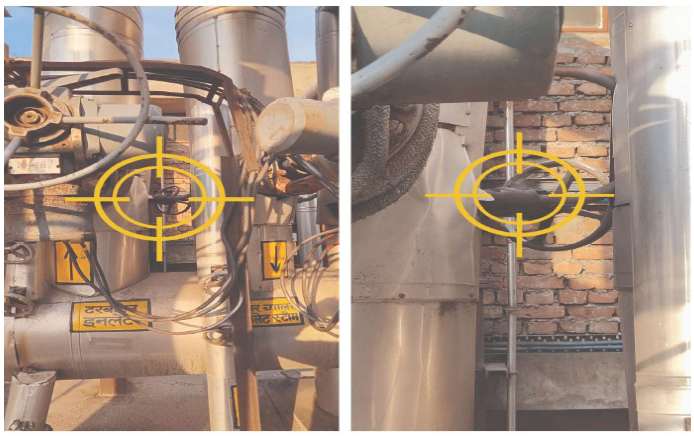

Figure No - 2.0
Steam Leakage identification near PP 2 HP Header with Ultrasound Instrument

- Highlight the significance of early detection in preventing energy wastage and reducing operational costs.
- **Calculation of steam leaks and its Impact:**

A) Quantify the impact of the Ultrasound testing initiative by presenting the cumulative savings achieved through leak detection and conversion to equivalent steam.

B) Below attached is the table demonstrating steam leaks that were identified and arrested -

Table 2 : Summary for Steam Leakages - detected and arrested

Area.	No. of leakages found.	No of leakages arrested.	Type of Steam.	No of leakages pending.	Saving Potential m3/hr.	Saving Potential in MT/Hr.	Saving as of now MT/Hr.
Pulp mill	3	3	MP	0	1.7	0.0077	0.00767
	5	1	LP	4	6.9	0.0221	0.004
Paper Machine 1	9	9	LP	0	20.5	0.0641	0.064
Paper Machine 2	22	15	MP	7	59	0.2662	0.1815
Paper Machine 3	3	1	HMP	2	18.1	0.1178	0.039
	6	5	MP	1	23.2	0.1047	0.087
	1	0	LP	1	4	0.0128	0.000
	9	7	Cond.	2	31.2	0.0220	0.017
Powerplant 1	6	5	HP	1	7.4	0.0652	0.054
	3	2	LP	1	1.6	0.0051	0.003
	2	2	Cond.	0	4	0.0040	0.004
Powerplant 2	4	4	HP	0	9.2	0.1817	0.182
	7	7	LP	0	63.5	0.2037	0.204
	3	3	MP	0	22.5	0.1015	0.102
Total	116	95		21	336.6	1.8770	1.642

- **Operational Integrity and continuous monitoring techniques:**

A) Highlighted the role of Condition Based Maintenance in extending equipment lifespan and ensuring continuous reliability through CAPA (Corrective Action & Preventive Action).

Table 3 : Rechecking Schedule for Steam Leakages (CAPA)

STEAM LEAKAGES RECHECKING SCHEDULE

SR. NO	AREA		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	PM-1	STEAM LEAKAGES RECHECKING.	STATUS			REMARK IF ANY																											
2	PM-2	STEAM LEAKAGES RECHECKING.				STATUS			REMARK IF ANY																								
3	PM-3	STEAM LEAKAGES RECHECKING.							STATUS			REMARK IF ANY																					
4	PP-1	STEAM LEAKAGES RECHECKING.										STATUS			REMARK IF ANY																		
5	PP-2	STEAM LEAKAGES RECHECKING.													STATUS			REMARK IF ANY															
6	PULP MILL	STEAM LEAKAGES RECHECKING.																STATUS			REMARK IF ANY												
7	REC	STEAM LEAKAGES RECHECKING.																			STATUS			REMARK IF ANY									
8	EGG TRAY	STEAM LEAKAGES RECHECKING.																						STATUS			REMARK IF ANY						
9	MOULD M/C	STEAM LEAKAGES RECHECKING.																									STATUS			REMARK IF ANY			

2. **Heat losses due to ineffective insulation** - Insulating steam lines play a pivotal role in conserving heat energy. By preventing heat loss through the insulation of steam pipes, thermal efficiency is significantly improved. This not only reduces energy consumption but also enhances overall system performance, promoting cost savings and environmental sustainability in industrial operations. Insulation of steam lines is crucial for several reasons in industrial settings. First and foremost, it significantly reduces heat losses, ensuring that the thermal energy generated during the steam production process is efficiently transferred to its intended destination. This not only promotes energy conservation but also enhances the overall efficiency of the system. Additionally, insulation prevents condensation along the steam lines, maintaining the desired temperature and pressure levels for effective steam transport. By minimizing heat losses and preventing condensation, insulation plays a key role in optimizing energy usage, reducing operational costs, and promoting environmental sustainability. Furthermore, it contributes to workplace safety by preventing exposure to hot surfaces and minimizing the risk of burns for personnel working in the vicinity of steam lines. In essence, proper insulation of steam lines is a fundamental practice that combines energy efficiency, cost-effectiveness, and safety in industrial operations.

- **Calculation of Initial Heat Losses:**

A) Embark on an in-depth analysis of heat losses in a steam system devoid of insulation, meticulously quantifying the thermal inefficiencies.

- We Conducted a thorough inspection to identify areas where insulation may be incomplete, damaged, or improperly installed.

Below is the list of areas depicting the scope for savings in our industry -

Table 4 : Potential for Savings through Insulation on Steam Lines

Area.	Area of Patches found. (m2)	Area of Patches arrested.(m2)	Type of Steam.	Area of Patches pending (m2)	Saving Potential in MT/Hr.	Saving as of now MT/Hr.
Paper Machine 1	2.951	2.951	LP	0.000	0.113	0.113
Paper Machine 2	0.319	0.319	LP	0.000	0.003	0.003
Paper Machine 3	1.431	1.431	HP	0.000	0.018	0.018
	0.502	0.000	MP	0.502	0.005	0.000
	1.868	1.868	LP	0.000	0.020	0.020
Powerplant 1	1.914	1.914	HP	0.000	0.065	0.065
	1.355	1.355	LP	0.000	0.018	0.018
	8.914	8.914	Cond	0.000	0.028	0.028
Powerplant 2	0.558	0.558	HP	0.000	0.006	0.006
	0.717	0.717	HMP	0.000	0.009	0.009
	0.558	0.558	MP	0.000	0.022	0.022
	2.312	0.000	LP	2.312	0.079	0.000
	0.279	0.000	Cond	0.279	0.003	0.000
Pulp mill	49.47	49.47	LP	0.000	0.468	0.468
Recovery	2.033	2.033	HP	0.000	0.053	0.053
	0.279	0.000	MP	0.279	0.003	0.000
	4.732	4.732	LP	0.000	0.043	0.043
	1.993	0.000	Cond	1.993	0.028	0.000
Total	**82.185**	**76.82**		**5.365**	**0.984**	**0.866**

- Utilize comprehensive calculations to determine the extent of energy wastage and associated economic implications caused by the absence of insulation due to ignorance of small patches or height constraint areas. Comprehensive calculations can precisely quantify the energy wastage resulting from improper/ uninsulated small patches or areas with height constraints in industrial processes.
- Employed standard conversion factors to translate the cumulative heat loss into an equivalent amount of steam.
- Expressed the recovered energy potential in terms of steam production.

Below is the calculation sample for reference:

- **Conversion to Equivalent Steam Savings:**

  Translate the reduction in heat losses post-insulation into equivalent steam savings, providing a tangible and relatable metric for the economic and energy impact.

- **Strategic Insulation Implementation:** Showcase the selection of insulation materials and methodologies, emphasizing their role in thermal losses improving overall system efficiency, and implementing horizontal deployment.

Table 5 : The calculation for Savings through Insulation on Steam Lines

RECOVERY												
S.No.	Patch - 1	Patch - 2	Patch - 3	Patch - 4	Patch - 5	Patch - 6	Patch - 7	Patch - 8	Patch - 9	Patch - 10	Patch - 11	Patch - 12
Area.												
	LP Line.								MP Line.	HP LINE	feed water	HP
Length (m)	2	10	10	1	1	4	8	3.5	3.5	1	50	50
Size, ID (m)	0.0762	0.0508	0.025	0.1524	0.0508	0.0508	0.0127	0.0254	0.0254	0.0127	0.0127	0.0127
Radius (m)	0.0381	0.0254	0.0125	0.0762	0.0254	0.0254	0.00635	0.0127	0.0127	0.00635	0.00635	0.00635
Thickness (m)												
Temperature in °C	150	150	150	150	150	150	150	150	180	480	130	280
Pressure kg/cm²	5	5	5	5	5	5	5	5	8	65	68	65
Surface Area (S = 2 x π x r x L) in m²	0.478536	1.59512	0.785	0.478536	0.159512	0.638048	0.319024	0.279146	0.279146	0.039878	1.9939	1.9939
Temperature Difference (Δ T) in °C	120	120	120	120	120	120	120	120	150	450	100	250
Thermal Conductivity of carbon steel in W/(m-K)	45	45	45	45	45	45	45	45	45	45	45	45
Heat transfer coefficient in W/(m²-K)	100	100	100	100	100	100	100	100	100	100	100	100
Heat Loss before insulation = (Heat transfer coeff. X S X ΔT) in W	5742.432	19141.44	9420	5742.432	1914.144	7656.576	3828.288	3349.752	4187.19	1794.51	19939	49847.5
watts to kJ/s conversion factor	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Heat Loss before insulation in kJ/s	5.742432	19.14144	9.42	5.742432	1.914144	7.656576	3.828288	3.349752	4.18719	1.79451	19.939	49.8475
Enthalpy in kJ/kg	2734	2734	2734	2734	2734	2734	2734	2734	2786.21	3369.18	1255.41	2775.99
Heat loss =(W X 0.001)/Enthalpy in kg/s	0.002100377	0.007001258	0.003445501	0.002100377	0.000700126	0.002800503	0.001400252	0.00122522	0.001502826	0.000532625	0.015882461	0.017956657
Heat loss in TPH = Heat loss saved/sec x 60 x 60	7.561358888	25.20452963	12.40380395	7.561358888	2.520452963	10.08181185	5.040905925	4.410792685	5.410175112	1.917450537	57.17685856	64.64396486
Steam loss in TPH	0.007561359	0.02520453	0.012403804	0.007561359	0.002520453	0.010081812	0.005040906	0.004410793	0.005410175	0.001917451	0.057176859	0.064643965
TOTAL	***0.203933464***											
Temperature Difference (Δ T) in °C	50	50	50	50	50	50	50	50	50	50	50	50
Heat After insulation = (Heat transfer Coeff. X S X ΔT)	2392.68	7975.6	3925	2392.68	797.56	3190.24	1595.12	1395.73	1395.73	199.39	9969.5	9969.5
Watt to kJ/s conversion factor	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Heat Loss after insulation in kJ/s	2.39268	7.9756	3.925	2.39268	0.79756	3.19024	1.59512	1.39573	1.39573	0.19939	9.9695	9.9695
Enthalpy in kJ/kg	2734	2734	2734	2734	2734	2734	2734	2734	2786.21	3369.18	1255.41	2775.99
Heat loss =(W X 0.001)/Enthalpy in kg/s	0.000875157	0.002917191	0.001435625	0.000875157	0.000291719	0.001166876	0.000583438	0.000510508	0.000500942	5.91806E-05	0.00794123	0.003591331
Heat loss in TPH = Heat loss saved/sec x 60 x 60	3.150566203	10.50188734	5.168251646	3.150566203	1.050188734	4.200754938	2.100377469	1.837830285	1.803391704	0.21305006	28.58842928	12.92879297
Steam loss in TPH	0.003150566	0.010501887	0.005168252	0.003150566	0.001050189	0.004200755	0.002100377	0.00183783	0.001803392	0.00021305	0.028588429	0.012928793
TOTAL	***0.074694087***											
NET SAVED	***0.129239377***											

Results

Implementing measures to address steam leakages, insulating equipment, and improving process efficiency across the plants have collectively led to substantial energy savings. The identification and prompt repair of steam leakages have minimized energy losses, optimizing the performance of steam systems. Insulating equipment, particularly steam lines, has significantly reduced heat losses, ensuring that thermal energy is efficiently utilized. Process inefficiencies were systematically addressed, resulting in streamlined operations and reduced energy consumption across various plant processes.

Conclusion

The concerted efforts to tackle steam leakages, implement insulation, and enhance process efficiency have yielded tangible benefits in energy conservation. The reduction in energy wastage not only contributes to cost savings but also aligns with sustainable practices in industrial operations. These proactive measures not only improve the overall energy efficiency of the plants but also reflect a commitment to environmental responsibility. Continuous monitoring and optimization of these practices are essential for sustaining these positive outcomes, fostering a more resource-efficient and environmentally conscious industrial landscape.

Electrical Energy Savings :

The focus of the initiative was the optimization of Electrical Power consumption within the existing system. Through meticulous planning and execution, the project successfully identified and implemented improvements, resulting in a substantial reduction of 272 kW in power usage. This paper outlines the methodologies employed, the challenges encountered, and the overall impact of the initiative on operational sustainability. The findings underscore the significance of collaborative efforts and strategic thinking in achieving substantial resource savings within industrial processes.

Table 6 : Potential for Power Optimization

	PM-1	PM-2	PM-3	PP-1	PP-2	REC.	Pulp mill / mould pulp	Egg Tray	ETP	T/W	TOTAL
Air Leakage	3.03	3.33	4.23	0.73	3.27	6.24	8.24	1.82		23.9	54.79
Excess Air loss				6	10						16
Process Improvement	3	28.7	8	10	12	28	38.88		10	62.7	201.28
Sum	6.03	32.03	12.23	16.73	25.27	34.24	47.12	1.82	10	86.6	272.07

The outcome of the project undertaken by us led us to some key focused areas to work on, which included.

1. Air leakages across the Plant
2. Excess Air losses in Power Plant
3. Process Improvements

Through brainstorming and kaizen ideas, the total potential that was achievable is listed below.

1. Compressed Air Leakages: Compressed air leakages in industrial settings result in significant energy losses. These leaks compromise the efficiency of pneumatic systems, leading to increased energy consumption and higher operational costs. Addressing and minimizing compressed air leaks through regular maintenance and monitoring is essential for improving overall energy efficiency in industrial facilities. By implementing proactive measures to detect and repair leaks promptly, businesses can mitigate energy wastage, reduce environmental impact, and enhance the sustainability of their operations.

Detection and task taken -

a) Ultrasound (Acoustic Emissions) Analyzers are utilized for easily detecting compressed air leaks. By capturing high-frequency waves in the Ultrasound range, these machines help identify the distinctive hissing noise produced due to Friction, Impact, and Turbulence by air escaping from lines and valves from other sounds in the sonic range. The detected leaks can be quantified in terms of volume or pressure loss. Converting this information into power (kilowatts) involves assessing the energy lost through the leaks and estimating the potential power generation that could be harnessed if the compressed air were conserved.

b) One Thousand-Meter Air Line Coverage for detection of air leaks.

c) Showcase the scalability of the Ultrasound testing approach across extensive Air Lines.

d) Discuss the challenges addressed and efficiencies gained through the comprehensive coverage of the entire system.

e) Below are some examples of how the captured ultrasound data was used for leak detection across lines in our industry.

Leak details N°	22	Severity :	
Location		Sensor	
Second Floor		Flexible Sensor	
Distance		RMS value (dBµV)	
20.00		61.0	

LEAK ESTIMATION	
Loss (m³/h)	Loss ($/year)
3.9	215
Comments	
HV - 117	

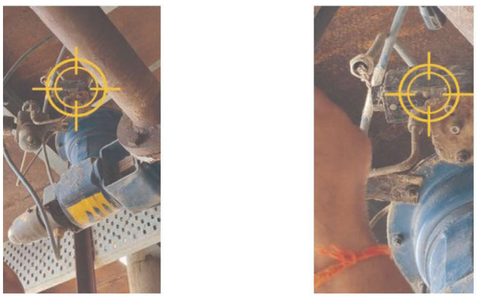

Figure No - 3.0
Quantification of Air Leakages in Recovery Boiler (HV – 117)

Leak details N°	16	Severity :	
Location		Sensor	
Second Floor		Flexible Sensor	
Distance		RMS value (dBµV)	
20.00		57.0	

LEAK ESTIMATION	
Loss (m³/h)	Loss ($/year)
3.1	171
Comments	
HV - 113	

Figure No - 4.0
Quantification of Air Leakages in Recovery Boiler (HV – 113)

Calculation of air leaks and its Impact:

f) Above we have attached the table demonstrating air leaks identified, arrested & calculated/converted to kW.

g) Quantify the impact of the Ultrasound testing initiative by presenting the cumulative savings achieved through leak detection and conversion to equivalent power.

h) Emphasize the direct correlation between reduced air losses and significant cost savings.

Table 7: Quantification of some Air Leakages

Area.	No. of leakages found.	No of leakages arrested.	No of leakages pending.	Saving Potential m3/hr.	Saving Potential in Kw.	Saving as of now Kw.
Recovery Evaporator.	34	31	3	64.7	5.62	5.12
Recovery Recausticizer.	6	6	0	11.6	0.94	0.94
Recovery Boiler.	8	8	0	16	1.30	1.30
Recovery ESP.	19	14	5	16.9	0.03	0.03
Mould Machine.	3	0	3	6.4	0.64	0.00
Egg Tray.	3	0	3	9.4	0.93	0.00
Softwood.	12	0	12	21.3	1.72	0.00
Pulp mill	53	0	53	96.7	7.84	0.00
Wet washing.	10	0	10	32.6	2.64	0.00
Paper Machine 1	13	3	10	37.5	3.03	0.70
Paper Machine 2	22	2	20	33.5	3.33	0.30
Powerplant 1	7	5	2	9	0.73	0.52
Powerplant 2	23	3	20	40.3	3.27	0.43
TFH						
Total.	213	72	141	395.9	32.03	9.34

Table 8 : Air leakage calculations

Example- Recovery Evaporator. (Refer to the above table for values)	
m^3/hr.	64.7
Saving as of now: of leakages found	(No. of leakages arrested * Potential saving) / No.
Calculation:	(31 * 5.62) / 34
Saving as of now in kW/Hour	5.12

2. Excess Air optimization -

a) Implementing an interlock system between the Secondary Air (SA) fan and an online oxygen analyzer optimizes excess air in power plants. This interlocking mechanism adjusts the SA fan based on real-time oxygen levels, ensuring precise combustion, and minimizing excess air. By saving on unnecessary air supply, this approach enhances power plant efficiency, ultimately leading to power savings.

b) Excess Air in the boiler was reduced from 60% to 31% maintaining a 5% oxygen level in flue gas. An online oxygen analyzer was installed which was interlocked with SA fans which controlled excess air and boosted combustion efficiency which resulted in better thermal efficiency as well as power saving at the air end side.

Table 9 : Load comparison for CT Fan 02 of Evaporator

SR NO	EQUIPMENT NAME	Location	Rated (KW)	Previous Running Load (KW)	New Running Load (KW)	Saved Power (KW)	Remarks
1	CT Fan No.2	PP2	18.5	18.067	12.045	6.02	Metallic blades of fan replaced by FRP blades

Table 10 : Load comparison for CT Fan 02 Powerplant

SR NO	EQUIPMENT NAME	Location	Rated (KW)	Previous Running Load (KW)	New Running Load (KW)	Saved Power (KW)	Remarks
1	CT Fan No.2	PP2	18.5	12.045	10.037	2.01	VFD used to reduce rpm

3. Process Improvement –

a) **Motor and Pump Efficiency: -** In any industry, the efficiency of motors and pumps plays a critical role in optimizing production processes and minimizing energy consumption. Motors are used to drive various machinery involved in paper manufacturing, such as pulping, refining, and drying equipment. The efficiency of these motors is essential to ensure cost-effective and sustainable operations. Likewise, pumps are integral in transporting pulp slurry and various fluids throughout the industry. Efficient pumps contribute to the overall energy efficiency of the system by reducing friction losses and ensuring smooth fluid flow.

The Major tasks taken are as follows:-

- **Motors replaced to enhance efficiency (due to over-capacity) -**

i. Broke tower agitator motor size reduction from 22 kW to 18.5 kW

ii. UTM pulper agitator motor size reduction 75 kW to 45 kW

iii. The back water pump motor size was reduced from 7.5 kW to 2.2 kW.

iv. ETP Backwater pump 22 kW motor replaced with 15 kW motor.

- **Pumps replaced to enhance efficiency –**

i. CWP No-1 to be replaced with an energy-efficient pump.

- **Others –**

i. The hood exhaust blower was interlocked with the MG motor which resulted in a saving power of 0.8 kW.

ii. The Evaporator CT fan metallic blade was replaced with FRP blades which saved 8 kW.

iii. The Power Plant Cooling tower fan -2 metallic blades to be replaced with FRP blades.

iv. Separate Trim Nozzle Pump install 2.2 kW against 7.5 kW.

v. Implementing an interlock system linking cooling tower fans with temperature sensors enables automatic fan shutdown during normal temperature conditions. This intelligent control mechanism prevents unnecessary fan operation, resulting in energy savings and improved overall efficiency in the cooling process.

b) VFD Implementation for Precision Control & Optimization of speed in rotating equipment:

i. A VFD panel was installed on caustic supply pumps A and B which saved 13.88 kW.

ii. A VFD panel was installed on Powerplant cooling tower fans to control RPM.

iii. A VFD panel offers fine-tuning of the RPM of cooling tower fans throughout the power plant and the evaporator as per the process demands thereby offering a targeted approach to energy optimization. By adjusting the respective fan's speed based on operational requirements and external conditions, such as ambient temperature and cooling demand, the system can maintain optimal performance while minimizing unnecessary energy expenditure. The optimized RPM strategy not only reduces energy consumption but also extends the lifespan of equipment and contributes to the plant's overall sustainability efforts.

c) Refiner speed optimization results in energy saving across mills. Optimizing their rotating speed is instrumental in achieving energy savings. They play a crucial role in refining fibers for paper production, and their rotating speed directly impacts the efficiency of the refining process. By fine-tuning and optimizing refiner speeds, it is possible to achieve the desired fiber properties with reduced energy consumption. This optimization ensures that the refining process operates at the most energy-efficient levels, contributing to cost savings and overall sustainability in pulp mill operations. Additionally, it aligns with the industry's commitment to resource efficiency and environmental conservation.

Specific Energy -

The parameter to characterize the refining effect is the amount of energy that is delivered to the pulp. This is called the Specific

Energy, E and it is calculated as,

$E = (P – P_{\text{no load}}) / (Q * C)$

(Where Q is the volumetric flow rate through the refiner and C is the consistency. It is usually given in kW hr./ton)

It is observed that if the P no load is reduced the amount of effective energy available increases with the same specific energy.

The Speed of the Rotor disc plays a vital role in determining the no-load power of the Refining system. The No-load Power can be calculated from the following formula:

P no load = 76.0614 x (RPM/100)3 x (Da/100)4.3 x (Hs/0.45) x (Gd/0.25)

where,

P no load = no-load (measured in kW)

RPM = rotational speed of the motor (revolutions/minute)

Da = diameter of the active surface of the refiner plate (inches)

Hs = section ratio (dimensionless)

Gd = groove depth (inches)

Note: We must multiply by '2' if it is a double disc refiner…

Note: that most published no-load data for refiners is based on brand-new cast refiner plate fillings with a typical section ratio of about 0.45 and an available groove depth of about 0.25".

It is evident from the above that if we can reduce the speed of the disc the power can be reduced drastically, however, there is a minimum limiting speed of the rotor disc to be maintained to ensure the rotor tip velocity is not reduced below 20 m/sec.

In our plant, we have a 21-inch TDR with a Power rating of 132 kW and a rated speed of 960 RPM. The P no load of the Rotating Assembly was found to be 65% of 132 kW which is 85.8 kW.

After conducting trials by reducing the speed with a VFD, the P no load power was reduced to 40% of the initial 132 kW which is 52.8 kW.

Also, the Tip velocity was reduced to 21 m/sec.

This resulted in 33 kW of Electrical Energy savings without any change in the refining capacity.

Result:

Focused efforts on enhancing motor and pump efficiency, implementing process improvements, minimizing excess air losses in power plants, addressing process inefficiencies, and mitigating air leakages across the plant have collectively yielded significant energy savings. Improved motor and pump efficiency contribute to optimized energy usage in various industrial processes. Process improvements, including advanced technologies and streamlined workflows, enhance overall operational efficiency, reducing energy consumption. In power plants, minimizing excess air losses ensures more efficient combustion, maximizing energy extraction. Addressing process inefficiencies and air leakages further contributes to comprehensive energy conservation.

Conclusion:

The comprehensive approach to improving motor and pump efficiency, optimizing processes, reducing excess air losses, and addressing inefficiencies and air leakages has resulted in noteworthy energy savings across the plants. These initiatives not only lead to economic benefits through reduced energy costs but also underscore a commitment to sustainable and responsible industrial practices. Continuous monitoring, regular maintenance, and a proactive stance toward energy conservation are imperative for sustaining these positive outcomes, ensuring ongoing efficiency gains and environmental stewardship in industrial operations.

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List of Abbreviations:

Abbreviation.	Description
TPH	Tons/hour
PM-1	Paper Machine-1
PM-2	Paper Machine-2
PM-3	Paper Machine-3
PP-1	Powerplant-1
PP-2	Powerplant-2
Rec	Recovery
HP	High Pressure
MP	Medium Pressure
LP	Low Pressure
kW	Kilowatts
ETP	Effluent Treatment Plant
TW	Tableware
UTM	Under the Machine
CWP	Cooling Water Pump
CT	Cooling Tower
VFD	Variable Frequency Drive
RPM	Rotations Per Minute
TDR	Triple Disc Refiner