

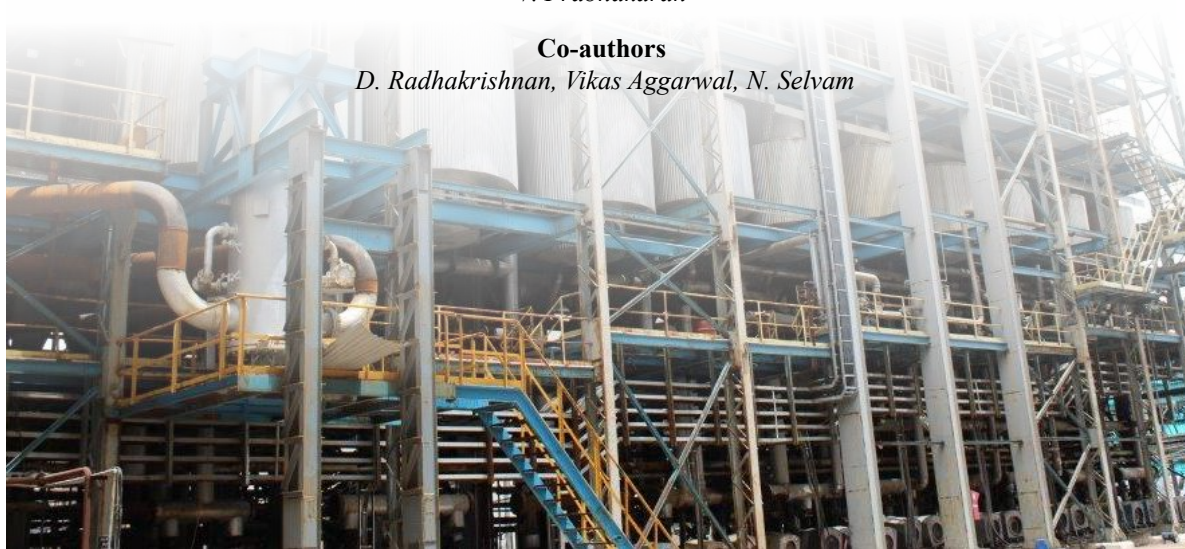
“ENHANCING BLACK LIQUOR EVAPORATION CAPACITY THROUGH PROCESS REENGINEERING”



V. Prabhakaran

Co-authors

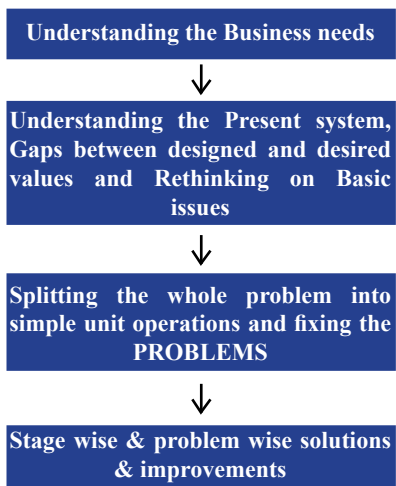
D. Radhakrishnan, Vikas Aggarwal, N. Selvam



“A scientific approach to debottleneck capacity constraints in Evaporation Plant” - Chemical Recovery Team, SPB Erode

Process Reengineering

Process reengineering is a practice of rethinking and redressing the way work is done to better support an organizational requirement and to achieve dramatic improvements in productivity, cycle time and quality



Need for Reengineering

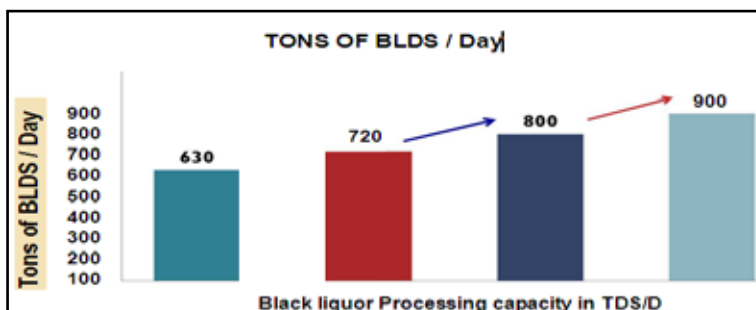
At present Pulp production capacity is 380 TPD UB wood Pulp & 45 TPD UB Bagasse pulp, which is yielding 800 Tons Black liquor dry solid/Day.

On the other hand Black liquor evaporation Plant is designed for 630 ton of Black liquor dry solid/Day & is a bottleneck to meet this requirement.

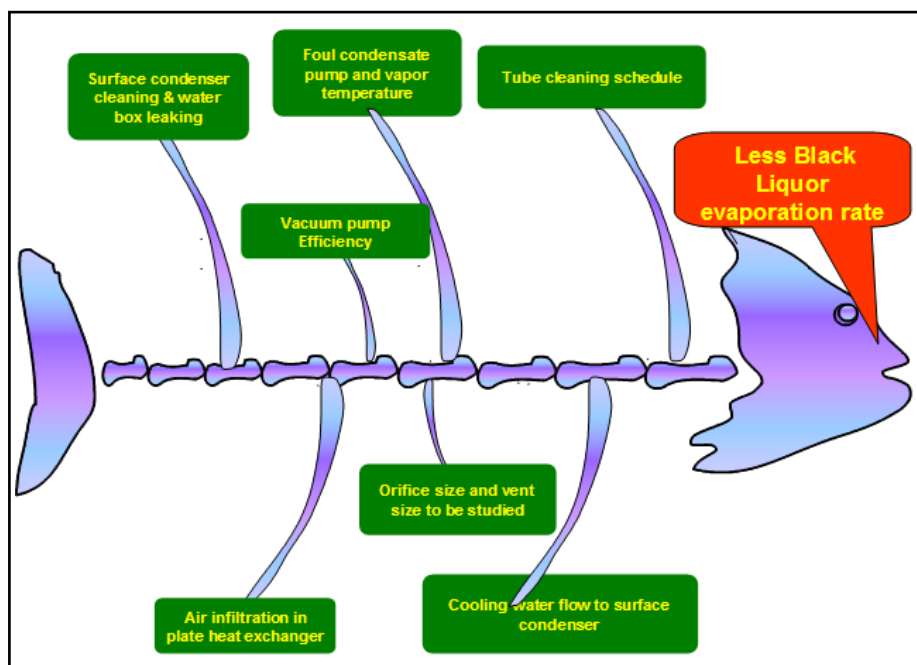
Design, Existing, Required Parameters

Parameters	Design	Current Status	Required for 425 Pulp production
WBL inlet flow	222 m ³ / hr	185 m ³ / hr	210 m ³ / hr
WBL inlet Solids	11.5 %	16 %	16 %
HBL outlet in TDS/Hr	648	710	808
Water evaporation rate	200 TPH	168 TPH	175 TPH

Gap



Root Cause analysis for Black Liquor evaporation constraints



Critical areas to be addressed

Vacuum system and NCG Handling in Evaporation plant

Cooling tower water quality, Operation & maintenance.

Issues in Increasing the Black liquor feed rate in evaporator

S. No	Causes	Primary reasons
A	Low vacuum in surface condensers	Surface condenser water box leakage. PHE air infiltration and frequent plugging of water side surface. Very high temperature Foul condensate vapor entering to vacuum pump. Orifice size for all NCG were not in line with vacuum requirement Lower volume and temperature of cooling water.
B	Cooling water flow restriction	Lower volume and temperature of cooling water.

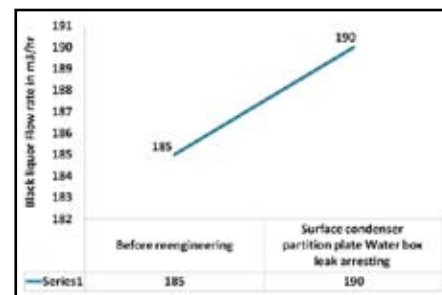
A. (1) Surface condenser water box leaking and corrective action

Poor heat transfer in Surface condenser (Condenser outlet gas temperature is high even with increased cooling water flow and Hydro blasting of the tubes).

Suspension was to check the leakage of water boxes in the bottom dish. It was found that inlet and outlet partition plate was eroded and the cold water partially short circuiting in the hot well.



A (1). Black liquor Flow improvement after Surface condenser water boxes leak arresting



A. (2) Post condenser Change over from PHE to S&T condenser

Due to poor performance of surface condenser heat load transferred to PHE was too high and leads to failure of gaskets, resulting in air leak leading to poor vacuum.

Due to poor cooling tower water quality PHE choked.

So, the condenser from old evaporator is shifted as replacement for PHE.

Vacuum leak avoided and water circulation increased due to increased heat transfer area.

The fabrication and detailed engineering of water and vapor line inclination was done by in-house resources.

Resulted in increased vacuum from 585 mm Hg to 605 mmHg.

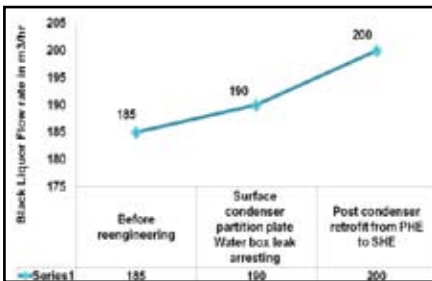
Negative impact is more foul condensate generation from 6 to 8 m3/hr.

A.(2) Post condenser - Shell and tube type





A.(2) Black liquor Flow improvement after Post Condenser retrofit from PHE To Shell and tube heat exchanger



A.(3) Foul condensate Vapor recirculation

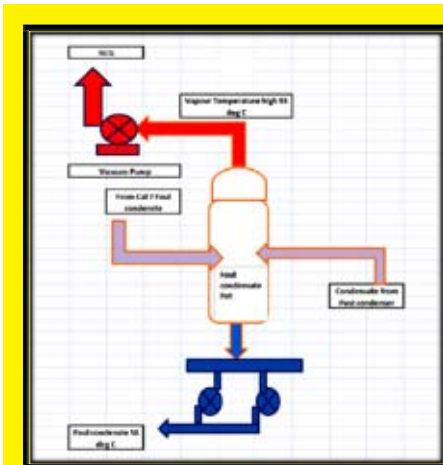
Foul condensate vapor temperature is high as 55 deg C and reducing vacuum in evaporation plant 615 mmHg instead of 640 mmHg.

Checking the vapor temperature going to vacuum pump resulted in finding of Hot vapors directly going to vacuum pump.

The hot vapor is recirculated to post condenser by introducing foul condensate recirculation pot with LT and Level control valve and resulted in reduction of vapor temperature to 48 deg C .

And also the foul condensate generation increased from 8 m3/hr to 14 m3/hr.

A.(3) Foul condensate Vapor recirculation



S. No	Description	Old Orifice dia	New Orifice dia	Remarks
1	Cal -1A top vent	10	6	Change in Orifice dia, helped in reducing vapour load to condenser and thereby vacuum increased
2	Cal - 1A bottom vent	12	8	
3	Cal -1B top vent	10	6	
4	Cal -1B Bottom vent	12	8	
5	Cal-1C top vent	10	6	
6	Cal -1C bottom vent	12	8	
7	SCFT 1	50	40	
8	Foul condensate from Cal -7	45	40	

B.Mist cooling - Fan less cooling tower

Due to high TDS & TSS cooling tower water quality cooling tower spray nozzles choked frequently resulting in 20% reduction in capacity of cooling tower Leads to poor vacuum and hindering pulp production .

So the alternate technology for replacing current cooling tower system to handle high TDS water with less blow down the mist cooling technology was chosen.

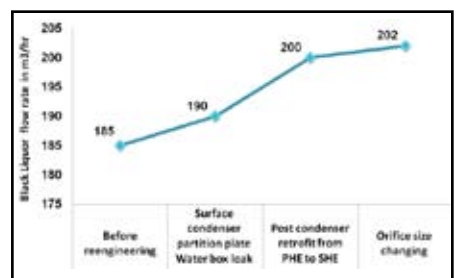
The advantages of mist cooling includes, Fanless cooling resulting in power saving and Approach (Water outlet temp – Wet bulb temperature)of 3 deg C achieved by the project.

Operation friendly, Choking of water nozzle can be cleared while operating itself, Can take high COC and TDS cooling water.

Mist cooling system



B. Black liquor Flow improvement after Orifice size changing

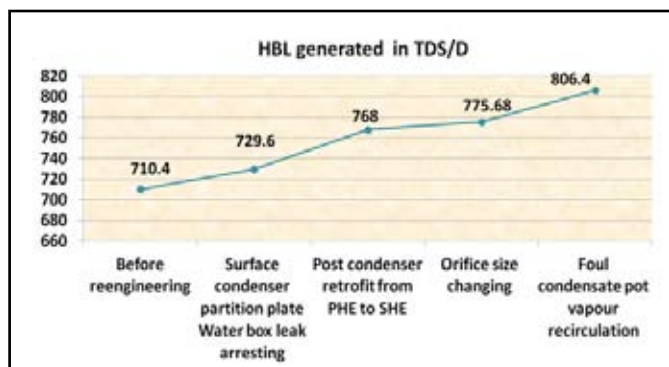
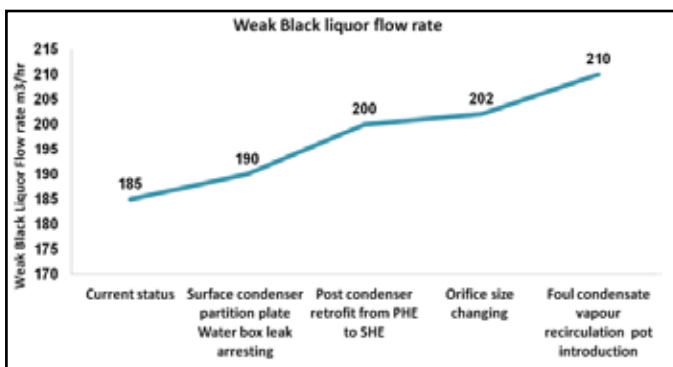


Issues In Increasing the Black liquor feed rate in evaporator

S. No	Causes	Primary reasons	Results
A	Low vacuum in surface condenser	Surface condenser water box leakage attended.	Evaporation Rate increased from 185 m3/hr to 190 m3/hr
		Post condenser changed over from PHE to S&T condenser	Evaporation rate increase from 190 m3/hr to 200 m3/hr
		Foul condensate vapor recirculation improved by introducing POT.	Evaporation rate increase to 210 m3/hr
		Orifice size for all NCG were modified	Evaporation rate increase to 203 m3/hr
C	Cooling water flow problem	Fan less mist cooling introduced.	For sustainability and spare O & M provided

Overall Improvement in evaporator by redressing vacuum system limitation

Overall Improvement in evaporator performance



Summary

Parameters	Previous	Target		% Improvement against	
				Previous	Target
WBL inlet flow m3 / hr	185	208	210	13.5 %	1.0 %
WBL inlet Solids %	16	16	16	-	-
HBL outlet in TPD	710	800	806	13.5 %	1.0%
Water evaporation rate TPH	168	175	176	4.1 %	

Benefits achieved after reengineering

Able to process more BL generated thereby enhancing Pulp production capacity from 350 TPD to 410 TPD of unbleached pulp.

Immediate necessity of up gradation of evaporator by huge investment was taken care by Process reengineering.

Monetary gains:

Pulp production increased by 60 TPD.

Additional Green steam 340TPD and green Power generation (1.7MWh).