Experience with black liquor evaporation and cross recovery of CMP spent liquor at Hindustan Newsprint Limited

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ABSTRACT

This paper deals with the experiences in the operation of LTV Evaporator with Black Liquor from Kraft Mill as well as from Chemi-mechanical Pulp Mill. It gives details of various problems encountered, operational strategies adopted, the reasons, proposed remedies and planned course of action.

The operation of Black Liquor Evaporator in a pulp and paper mill has a vital bearing on the running of a mill especially when it depends on a single street of evaporator. The ability to quickly and accurately trouble shoot any evaporator problem is often critical to a mill's production as multiple shut-downs to correct evaporator problems are very costly and lower the recovery efficiency of the mill.

Hindustan Newsprint Limited, a subsidiary company of Hindustan Paper Corporation Limited, has an installed capacity of 80,000 MT/Annum of newsprint. The raw materials used are reed and bamboo for chemi cal pulp and eucalyptus hybrid and grandis for chemi-mechanical pulp production.

Pulping Process :

The newsprint in Hindustan Newsprint Limited is made using chemi-mechanical pulp (CMP) produced from eucalyptus wood and chemical pulp (CP) produced from reed and bamboo.

Chemi-Mechanical Pulping

The eucalyptus wood is chipped, screened and the chips are washed. The washed chips are treated with steam and caustic soda solution. The impregnated chips are pressed in screw press to remove the spent liquor. A DKP Press is provided in between the two refining stages to extract the liquor. The unbleached pulp is washed and bleached by two stage hypo chlorite treatment. The DKP Press liquor and Screw Press liquor are mixed and sent to Recovery plant after filtering through 100 mesh screen in Lut Filter. The spent liquor is having average 4–5% total solids and TTA of 10 gpl as Na_2O. An average of 30–40% chemicals used for impregnation is recovered. Most of unbleached filtrate is drained as it is uneconomical to recover the chemicals. The design production capacity of the plant is 228.5 T/day and the bleached pulp yield is 80%. Capacity utilization is around 92%. In November, 1989, hydrogen peroxide bleaching in place of calcium hypochlorite bleaching was introduced which resulted in improvement in newsprint production.

Chemical Pulp Mill

The chemical pulp is produced from reeds and bamboo by using the conventional kraft process. The chips are cooked in stationery digesters. The pulp is washed on brown stock washers by countercurrent washing. The washed pulp, after screening, is bleached by conventional method. The bleached pulp is stored in high density chest. The design production capacity of the plant is 100 T/day, averge production is 60 T/day and bleached pulp yield is 40%.

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Soda Recovery Plant

The Soda Recovery Plant in Hindustan Newsprint Limited comprises of an LTV sextuple effect evaporator with water evaporation capacity of 60 T/Hr, combustion engineering design, a BHEL make recovery boiler with handling capacity of 200 Ton B L. solids/day and a conventional causticizing plant of production capacity of 425m³ of white liquor per day.

Evaporator :

The present sextuple effect evaporator with water evaporation capacity of 60 T/Hr supplied in 1978 was designed to concentrate only reeds black liquor from 12% T.S. to 50% T.S. Later, as the discharge of CMP spent liquor was contributing enormous colour and BOD load to the effluent, this liquor having 4-5% T.S. was taken along with liquor from kraft pulping for recovery cycle. This resulted in an average inlet concentration of 8-9% T.S. In the beginning, since the production of newsprint was low, the problems in evaporation did not affect the running of other plants. The evaporator plant has always been operated as five effect because one of the body is isolated for cleaning of the scales from the tubes. The capacity available for evaporation was reduced to 52.0 T/hr. As the newsprint production has increased to 90,000 MT/ annum in the last two years (1990-91 and 1991-92), the operation of the evaporator has become critical and needs more attention. The problems experienced and the action taken are given below. The composition of individual CP & CMP Black Liquor and the mixed feed liquor to the evaporator is given in Table I.

TABLE I
TYPICAL ANALYSIS OF BLACK LIQUORS

	Black liquor from CP	Black liquor fromCMP	Mixed Black liquor feed to Evaporator
ph	11.6	11.3	12.3
°Tw/°C	15/48°C	3/40°C	15/60°C
TTA as Na_2O gpl	30.4	8.68	30.4
RAA as Na_2O ,,	7.4	1.49	5.3
Total solids %	13.8	4.6	9.8
Organic matter %	61.0	63.0	63.3
Inorganic as NaOH %	39.0	37.0	36.7
Silica gpl	2.9	0.08	2.4
Total Sodium as Na_2O gpl	44.6	18.3	40.9
Calorific value Cal/g	2707	—	2740

The Equipment :

The black liquor evaporator system comprises of 6 Nos. LTV rising film evaporators with integral vapour head, one. LTV rising film concentrator, with integral vapour head, one external preheater, one surface condenser and one condensate level control tank. The vacuum system comprises of a 2-stage ejector system with indirect contact precooler and intercondenser and a hogging ejector. Centrifugal type catchalls are mounted on the upper portion of the evaporator heating element.

System Description :

The WBL is fed to fifth and sixth effect. The liquor from fifth effect is routed to sixth effect The liquor from sixth effect is then pumped through integral heaters of sixth and fifth effect into the fourth effect. The liquor from the fourth effect is pumped to the third effect through an integral heater of fourth effect. From the third effect liquor is pumped to the first effect through an integral heater of third effect followed by external heater. The first effect and second effect has two passes. Liquor from the first pass is fed by gravity to second pass. The liquor from first effect is routed to the second effect and then to LTV concentrator. The concentrated black liquor from the concentrator is then pumped to liquor storage tank.

Live steam is fed to the first effect, as well as to the concentrator. Vapour follows a forward path with concentrator vapour going to fourth effect shell.

Live steam condensate from first effect as well as concentrator is sent back to boiler without recovering the heat whereas contaminated condensate is flashed into the subsequent effects and is pumped out of the system from sixth effect. Contaminated condensate from surface condensor is separately pumped out.

A schematic representation of the evaporation system is given in Fig. 1.

Problems encountered during the operation :

Till the year 88--89, the problems in evaporator did not affect the running of the other plants because the time available for cleaning of the effects and for trouble shooting was sufficient.

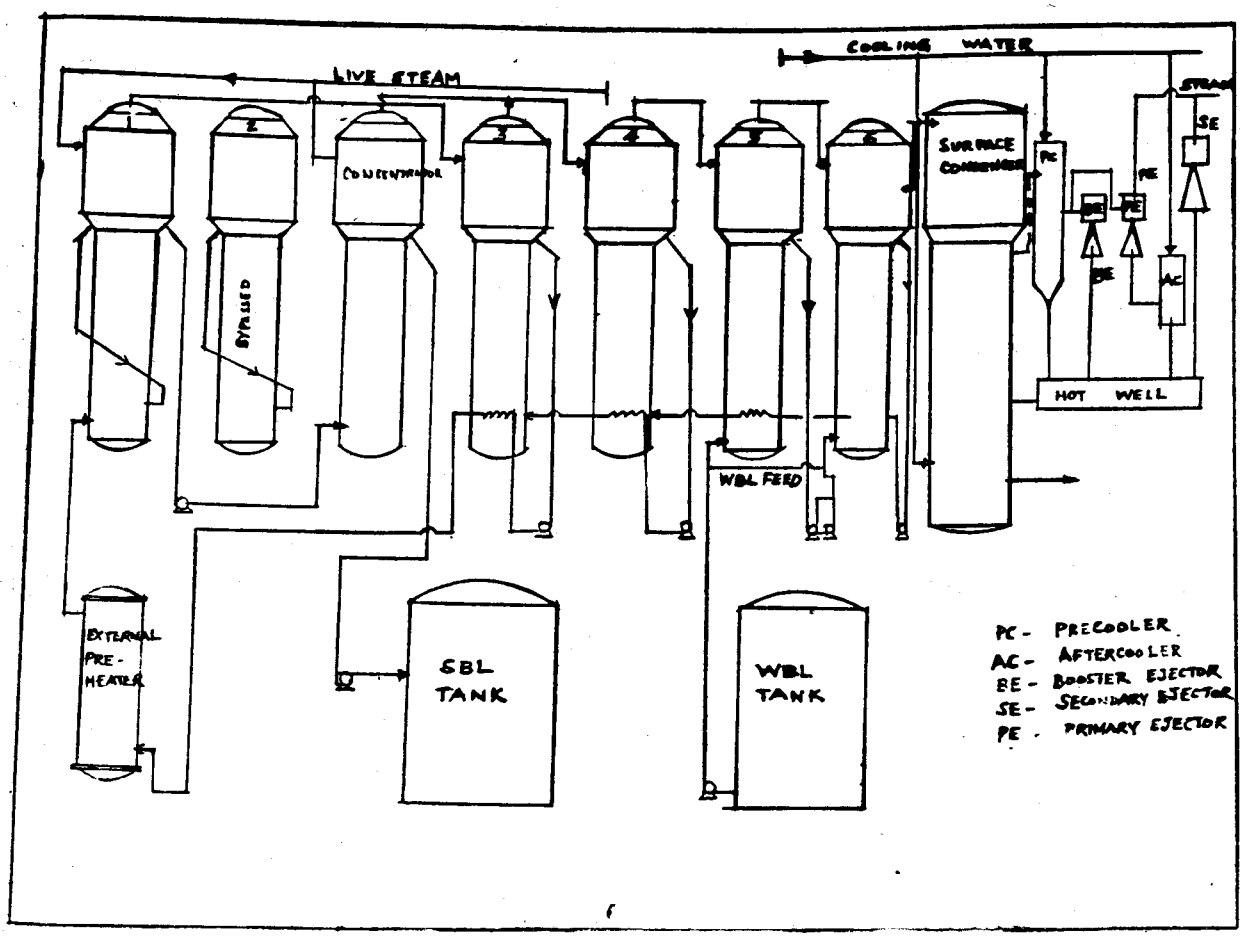

FIG. I FLOW DIAGRAM OF EVAPORATOR PLANT

As the newsprint production and pulp mill production increased, the evaporator could not handle all the black liquor produced. The required rate of evaporation for the present rate of newsprint production and design rate of evaporation is given in Annexure I. The problems faced are related to the followings :

a) Low capacity

b) Contaminated condensate

c) Instability in evaporator

a) Low capacity :

The available water evaporation capacity is not sufficient to meet the incoming black liquor resulting in accumulation of weak black liquor. The reasons are :

(i) The available design water evaporation rate has reduced to maximum 52 T/hr because of five effect operation as one effect has to be bypassed for cleaning.

(ii) The required rate of water evaporation has increased due to low solids (4-5%) in CMP black liquor received.

(iii) The scaling in the effects reduced the water evaporation capacity.

b) Contaminated condensate :

The combined condensate removed from the evaporator should be free from colour. Due to the unstable flow of liquor in tubes, the liquor is being carried along with vapour resulting in entrainment of condensate.

c) Instability in evaporator operation

Frequent fluctuation of steam, outlet black liquor concentration leads to the unstable operation.

Though there are various reasons for the above problems, the major reason is scaling.

Scaling

Scaling is the deposition of solid material on to evaporator tubes or heat transfer surface. It is generally due to the deposition of materials which become insoluble as the concentration and viscosity of the liquor increases. It has been observed that with CP black liquor, the rate of scaling has been less and with the addition of chemi-mechanical pulp mill liquor, the rate of scaling has increased. The first and/or second effect where temperature is higher, frequently gets scaled. The typical scale analysis is given in Table II. The major components of the scale are the silica, calcium, fibre and organic compounds. The frequency of the effects by passing for the years 88–89, 89–90, 90–91 are given in Table III.

TABLE II
ANALYSIS OF SCALES FROM EVAPORATOR

	—	Effect I	Effect III
Loss on ignition	%	18.3	20.7
Acid insoluble	%	47.6	34.7
Silica	%	47.0	33.8
R_2O_3	%	1.45	39.8
Ca as CaO %	%	15.0	15 0
Mg as MgO	%	1.47	3.98

TABLE III

	88-89	89-90	90-91	91-92
Number of times effect change over for cleaning due to scaling	15	18	23	35

Since the residual active alkali (RAA) in CMP black, liquor is low, the mixed CP and CMP black liquor is also having low RAA in feed which results in colloidal instability of black liquor and faster scaling on the tubes.

Measures undertaken for prevention of Scales

Certain measures for scale prevention have been followed based on operational experience and lab analysis.

— Caustic addition to mixed weak black liquor feed to raise RAA level from an average 5–5. 5 gpl as Na_2O to 7—8 gpl as Na_2O.

First effect steam desuperheating is done and steam temperature is maintained according to the pressure in the calendria.

— In order to reduce the fibre content in black liquor within the limits, the CMP spent liquor already filtered in Lut Filter is again filtered in Malone Filter in CP Plant and then taken to Recovery Section.

— Cleaning of all the effects is done annually.

— Cleaning of all the tanks is done annually.

— Reduction in Recovery boiler is maintained around 88—89%.

— Causticity in W.L. is maintained high.

— Cleaning of vapoursides of 3,4,5,6 effects is done annually.

In addition to the above, routine water boiling and weak white liquor boiling are also done to remove scales.

Cross Recovery of CMP Spent Liquor

Spent liquor from Chemi-Mechanical Pulp Mill is processed to recover chemicals more from the point of pollution control rather than economics. Other observations by the addition of CMP spent liquor are.

(I) Average WBL feed concentration has reduced from 12–13% solids to 8–9% solids.

(II) Frequently, there is a change in the inlet WBL concentration resulting in entrainment of black liquor in the contaminated condensate.

(III) Since Residual Active Alkali from CMP spent liquor is low, additional alkali has to be added to increase it to the desired level.

(IV) Rate of scaling of the effects has increased after the introduction of H_2O_2 bleaching in CMP plant in place of hypochlorite bleaching as sodium silicate used as a buffering agent in H_2O_2 bleaching is carried in CMP spent liquor.

Other Problems in Recovery Boiler

Due to scaling of the effects, the outlet concentration has reduced to 42-43% B.L. solids instead of 50% in the strong black liquor produced from Evaporator. This requires increased water evaporation rate in the direct contact evaporator in Recovery Boiler. Since our capacity utilization of the boiler is around 60%, the flue gas temperature is less than the normal resulting in corrosion of ducts, ID Fan impeller, ESP internals etc.

Proposed Plan of Action

Circulation Pumps for 1st and 2nd Effect

The addition of CMP Spent liquor has increased the viscosity of mixed liquor in 1st and 2nd effect. In order to ensure good heat transfer in 1st or 2nd effect and to reduce the rate of scaling, a pump-aided circulation is being put in service for each pass of 1st and 2nd effect.

Vacuum Pump

Since the operating cost of a vacuum pump is lower than the cost of operating an ejector, a vacuum pump is being installed. Additional advantage is that entrainment due to variation in steam pressure can be avoided. Details of operating costs are given in Table IV.

TABLE IV

ENERGY REQUIREMENTS FOR STEAM JET EJECTOR AND VACUUM PUMPS

Equipment	Energy used	Annual Cost (Rs.)
Steam jet ejector	270 kg. steam/ hr	8.55 lakhs
Vacuum Pump	55 KW	4.36 lakhs

Additional Street of Evaporator

At present, an average of 30—40% of chemicals used for impregnation in chemi-mechanical pulp mill is recovered. In order to increase the recovery of chemicals from CMP and to reduce the problem due to effluent, a twin drum press will be installed in CMP. Since the quantity of CMP spent liquor will be further increased, an additional street of evaporator is being installed only to process CMP liquor separately and mixed along with concentrated CP black liquor in the strong black liquor tank.

Conclusion

The mixing of hard wood black liquor from chemi-mechanical pulping with kraft mill liquor changes the characteristics of black liquor feed to the evaporator. The problems are likely to be overcome by processing CMP liquor separately in the new street of evaporator and by modification of the existing evaporator.

ANNEXURE-1

I. Design Water Evaporation

Water evaporation rate for sextuple effect operation		60 T/Hr max.
water evaporation rate for quintuple effect operation		52 T/hr max.

II. Required water evaporation rate for present level of production

Present newsprint production	TPA	90,000
Pulp furnish 1 MT of paper	BDMT	0.915
CMP : CP pulp ratio		77.5:22 5
Considering 10% usage of imported pulp, CMP pulp produced per day	BDMT	192
B.L. Solids/ton of pulp		0.125
% of B.L. Solids in spent liquor	%	4
B.L. Solids from CMP pulp/day	Ton of BLS	24
Spent liquor from CMP pulp at 4% Solids	MT	600
CP pulp produced/day	MT	56
B.L. Solids/ton of pulp	MT	1.86
B.L. Solids from CP pulp	MT	104
Weak black liquor for CP liquor at 14% solids	MT	740
Total amount of liquor produced per day	MT	1340
% solids in mixed feed liquor	%	9.6
% solids in outlet of evaporator	%	50
Average combined water evaporation rate required per hour for CP& CMP liquor	MT/Hr	45
Considering efficiency of evaporator, taking water boiling and effect changing into account at 90%	MT/Hr	50

III Present Water Evaporation Rate in Evaporator

After taking a cleaned body into circuit we are able to operate the plant 60 m^3/hr WBL feed rate and when the scaling in the effect has reached a maximum, within a period of 10-15 days, WBL feed rate is coming down to 48 M^3/hr and solids in concentrated liquor is on an average 43% solid.

Average WBL feed feed rate at 10% solids	m^3/hr	54
At Sp. Gr. 1.08 feed rate	MT/hr	58.32
Average SBL production rate at 43% solids	MT/hr	13.56
Average evaporation	MT/hr	45