AN EXPERIENCE IN CHEMICAL RECOVERY (Practice & experience in MPM of black liquor evaporation, Recovery boiler operation & Causticizing)

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The Mysore paper Mills located on the banks of river Bhadra and situated 250 Km away from Bangalore, has a history dating back to 1936 The production of paper has increased from 4000 TPA then to 1,00,000 TPA now and this increase has been sustained. The Newsprint production is licensed at 75,000 TPA. It has developed from a wood-bamboo based mill to what it is today—using more non wood fibre—bagasse. The paper—sugar synergy has been unique and well established. At present 2500 TCD capacity sugarmill is giving the required quantity of bagasse. This is not the end for efforts to move away from the use of conventional and forest based raw materials. The sugarmill capacity has been slated for expansion and this will result in processing 2,50,000 tons of bagasse from 8,00,000 tons cane crushing. A consultancy agreement with M/S Honshu Paper Co. Ltd., of Japan has been finalised with an intention of obtaining a proven technology for making mechanical pulp (CTMP) from bagasse. Surplus bagasse that could be made available by neighbouring sugar mills can be procured also to the needs of the mill.

This growth rate has resulted in the personnel, gaining immense experience in all the related areas of paper making. The learning curve has never been horizontal and is so in the chemical recovery sub-system also. MPM has well recognized cost, this sub-system has to be operated efficiently always. It has also geared up fully now to meet stringent stipulations from pollution control board-water pollution and air pollution aspects as well. There is no let up in effecting improvements to the sub-system to reach the goal of highest percentage of chemical recovery.

It all started with the operation of roaster smelter initially and then old Babcock & Wilcox recovery boiler burning 120 tons of black liquor solids/day together with scott's short tube evaporators and a causticizing plant. This steam has been kept shut since 1981 after the new recovery sub-system has been commissioned for the newsprint manufacturing facility. The old system did not have the electrostatic precipitator to trap the chemical dust. The new stream has a recovery boiler to burn 270 tonnes of black liquor solids/day and a supporting evaporator plant for 100 tons water evaporation. This is followed by a causticizing section designed to produce 70 tonnes of Caustic Soda per day.

This paper shares the experience gained in the operation of the sub-system and projects the improvements contemplated.

1 PRESENT STATUS AND PIT FALLS IN OPERATION

1.1 Evaporators

The multiple effect evaporation street is for 100T/hr water evaporation, with 5 effects (2 F.C. bodies in parallel as Ist effect)

Problems encountered are as enumerated below :

1 Loss of capacity

2 Poor steam economy

Reasons for the above set backs are :

a) Clogging of the tube inside surfaces with silica, calcium and fibers

Silica and calcium deposits occur in the high temperature, high solids effects and fiber deposits occur in

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3,4 and 5th effects. Vibro-screens have been installed to remove fibers. WBL feed pump suction is from a point 1 metre above WBL tank bottom. The sludge from the bottom of WBL tank is periodically taken to SCBL tank. It is proposed to instal a desuperheater to reduce the steam temperature ann to reduce Calcium scaling.

b) Fouling of outside surface of tubes with scale and rust :

Over a period of 8-9 years the MS tubes in 3rd,4th and 5th effects have corroded badly on vapour side and needed replacement, which have been carried out now.

c) Improper circulation by the forced circulation pump of Ist effect :

The elevation of the liquor line from Ist effect was improperly located (at the same elevation as overflow suction to FC pump), whereby the FC pumps were not getting enough liquor flow., The elevation of liquorline outlet tapping was raised by 1 metre.

d) Loss in preheaters ;

Pump head was found to be inadequate to pump liquor through 2 preheaters in series from a body under vacuum to a body above atmospheric pressure.

e) Improper flash steam recovery and condensate removal :

The condensate from each effect enters flash tanks whereby the flashed vapour enters the next effect. As there are no steam traps or level controller, condensate levels are not maintained and possibility of blow through steam entering subsequent effect is there. It is proposed to have orifices installed on condensate lines.

1.2 Boilers :

The various problems encountered in the continuous operation of SR Boiler are listed below :

a) Fireside deposition and plugging.

b) Corrosion of pressure parts.

c) Plugging of cascade tubes and spray nozzles.

d) Design drawback.

a) Fireside deposition and plugging :

Black liquor contains about 45% inorganic material, making it one of the highest ash containing fuels used for steam generation. As long as cooking chemicals are recovered by burning black liquor in a furnace, the formation of ash derived deposits on heat transfer surfaces is inevitable.

Plugging of flue gas passages as a result of massive deposit build-up has been resulting in considerable down time thereby affecting mill production to a large extent. Further, when these deposits fall down to the hearth they consume lot of oil to melt and to clear air supply ports and smelt spouts. This is followed by an instability in combustion.

A study was taken up to find out the causes of such clogging. It invariably indicated the necessity of maintaining a low pressure firing of black liquor with minimum black liquor temperature to have 'pop corn' size spray. It is observed that an increase in the dead load recirculated in the system, due to less causticizing efficiency and low reduction hinders the operating parameters. Then the firing pressure, temperature, type of spray and hence the furnace condition gets disturbed. Increased firing pressure and temp, results in the low bed fine spray condition which results in excessive carry-over and fouling of heat transfer surfaces. Also, the ratio of primary to secondary air, if not maintained to create the required turbulence in the secondary zone leads to more carry-over.

b) Corrosion of pressure parts :

Corrosion in general terms refers to deterioration of metal when it reacts with its environment. Corrosion manifests itself in increased down-time and enchanced maintenance costs.

Corrosion of pressure parts in Recovery boiler is mainly observed in the following areas :

(i) Economiser

(ii) Superheater

(i) Economiser :

A study was taken up to find out the frequent failure of Economiser tubes particularly at the inlet header. It indicated that the temperature of water at the inlet was low and hence it was leading to a low temperature acid corrosion. Another reason was violent load and pressure fluctuations on the boiler.

ii Superheater :

Radiant super-heaters are also subjected to severe corrosion. Since the commissioning of the boiler, secondary superheaters have been changed twice already. Third change has become due. Super-heater corrosion is mainly external. Metal thinning takes place from outside and finally leads to the opening of the tubes. It is observed that wastage of metal is severe at the outlet bends. A study conducted to find out the reasons of these failures indicated the primary reason as-over heating of platens due to load variations and gas entry at higher temperature to superheater. Recovery boiler is a constant heat input boiler and power boilers should take care of the load variations. Due to the poor quality of coal, many times the main header pressure drops caused by overdrawal of steam. When the power boiler resume the normal supply, load on Recovery boiler is reduced abruptly. During this time the flow through platens is very low due to which the overheating of metal takes place. Also we have observed unequal heat distribution across the platens.

c) Cascade Evaporator Plugging :

Direct contact evaporator tubes get blocked and concentration increase in the evaporator falls below the acceptable level. The above mentioned problem was observed frequently after we strated consuming bagasse liquor which is having higher viscosity. The main reasons for this jamming are excessive dust loading in cascade and low residual alkali of semi-concentrated black liquor.

The salt cake mix tank had a screen of 12.5 mm opening which was changed by a screen of 10 mm holes At the same time maintaining of more or less the same open area was ensured. This has resulted in the reduction of the choking of spray gun nozzles and consequent interruptions.

d) Design drawback :

The BHEL make recovery boiler of MPM is of the older version of "combustion engineering" design, incorporating only two levels of air, one below the spray guns and the other above the spray guns. It uses conical spray nozzles which are very sensitive to changes in temperature and pressure. Available literature indicates that such two level air systems and conical spray nozzles lead to inherently less stable beds. Either the bed can grow too high or cause a low bed reduction efficiencies. As a result of conservative approach in design, the operating crew is forced to adopt fine spray conditions. The net result is an increased carry-over, higher rate of clogging and low reduction efficiency.

1.3 Electrostatic Precipitator :

The particulate trapping in the recovery boiler is an effort towards pollution abatement and also to improve the economics of paper making by getting back the chemical pulping process. The pollution control board has stipulated 150 mg/NM^3 emission from this stack.

The gas from the furnace splits and takes two paths to pass through four chambers of the electrostatic precipitator. At a gas flow rate of 1,29,240 m^3/hr, the efficiency is 98% when a treatment time of 9.63 seconds is allowed. In this situation the stack emission is likely to get restricted to 150 mg/NM^3—the limit fixed by the statutory authorities. The details of the design are furnished in Annexure II.

The Carona Voltage designed to be developed in the existing arrangement is 43 KV corresponding to 70 KV peak. The system comprises mainly of two units-the transformer rectifier unit (TR unit for short) and the control cubicle. The TR unit has an oil cooled H.T. transformer. oil cooled rectifier diode stack with voltage sharing resistors, hjole storage capacitors and diodes, a high frequency choke, the current sensing resistor, the sugar diverter, the spark gap and other related accessories. The control cubicle was supplied along with the T.R. unit in 1978-80 and consists of thyristor A.C. regulator, the current limiting reactor, input switchgear, protective and control circuitry. This is an improved version of the earlier designs wherein controls were obtained by transductors in the transformer primary side. In this improved version, the control is obtained by means of thyristors in transformer primary. The thyristors with their fast switching characteristics result in a fast response system and higher precipitator efficiency is the natural outcome.

After 3 or 4 years of operation MPM was again on the horns of dilemma. The performance of the precipitator deteriorated to the point where it was no longer satisfactory. The collecting electrodes started deteriorating fast. The temporary repairs were seeing through the operation. But the situation subsequently was one of, limping along with a reduced output and hence it was decided to replace all the 612 M.S. collector plates and the damaged emitter electrodes numbering around 2304. It was done so, but the engineers worked with a relaxed frame of mind only for less than 2 years. The operation was unreliable and ultimately the overall chemical recovery of the mill plummetted to a low percentage. The manufacturer M/s BHEL were called upon for help. It was then decided to revamp the entire precipitator in two stages without stopping the recovery boiler. M/s BHEL agreed to supply collector plates made of corten steel to delay the effects of corrosion. This work was completed at an expenditure of Rs. 30 lakhs, using a bypass for flue gas for operating the recovery boiler during revamping. The inlet chambers have a microprocessor control now replacing the thyristor control. The performance is being observed closely. Primarily the microprocessor control is used for current regulation and spark rate control. Highest precipitation efficiency is possible to get, even with the precipitator parameters varying considerably. The arrangement has a 8 bit microprocessor 8085 A and provides charging current in an optimum way. This has been incorporated in an existing T-R unit. The different gas temperatures, dust compositions, gas flows etc., the spark rate is maintained at optimum level. For different conditions of sparking current the ESP will be corrected by regulating the rectifier. If the values are out of set limits, it gives an indication.

2. Upgradation Plans

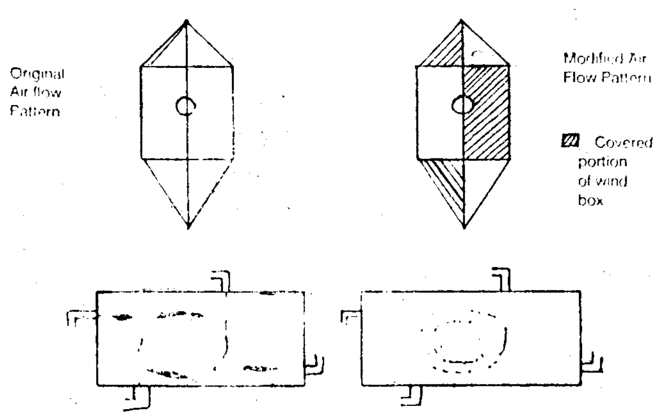
The remedial measures implemented to reduce the drawbacks mentioned above are narrated here :

2 1 Installation of microprocessor based controller for accurate control of liquor temperature.

Since the atomising steam for liquor is drawn from the common header, any variation in the draw was affecting the steam pressure thereby reducing spray liquor temperature. As the conventional pneumatic controller had a time lag, it was not possible to sense these variations quickly. After replacing it with electronic controller, temperature variations are minimised and hence we are able to maintain the POP-CORN size spray.

2 2 Modifications of secondary air wind box :

The air supply system is a two tier one, primary and secondary air are distributed in 60 : 40 ratio. Secondary air is introduced into the furnace tangentially at four points where load carrying burners are located. Secondary air is required to supply oxygen to complete the combustion and also it should provide the necessary turbulence to generate intimate mixing of air with the gases liberated from the lower portion of the furnace. It must also generate an even gas temperature profile across the width of the furnace at the gas outlet plane. The original tangential air system was modified to concentric one by altering the secondary air wind box as shown below :



In the concentric secondary air system air enters in two concentric firing circles. The upper compartment of the wind box injects air on small target circle while the lower compartment injects on larger target circle. This model reduced the flue gas temperature peaks thereby minimizing the sticky nature of the gas.

2.3 Use of stationary spray guns :

Spray gun oscillation is now stopped to reduce the carry over. This has resulted in an improved bed condition. Also, the straight barrel of the liquor gun is bent by 10° to avoid spray hitting corners and subsequent ledge formations. It is angled down at 30° below horizontal. The experience of other mills which have adopted methods successfully have also been emulated. The bed combustion stability is maintained inspite of lower area of firing.

2.4 Replacement of Economiser bottom header :

Last year the Economiser bottom header was replaced along with all the stubs which were completely worn out due to acid corrosion. We have also procured a feed water heater to preheat the feed water sufficiently so that low temperature corrosion is avoided. The design value of 105°C of FW inlet temperature is not enough to prevent low temperature corrosion, occuring at economiser inlet more so in the case of SR Boiler.

Details of feed water heater :

Feed water flow—Max. 35 T/hr

Inlet feed water temperature—100-110°C

Outlet—130-135°C

Feed water pressure—90 kg/cm²

Steam pressure/temperature—48 kg/cm²/180°C

2.5 Avoiding overheating of Superheaters :

To avoid overheating, we have restricted steam temperature to 420°C. Also flue gas temperature is restricted to 550°C at superheater zone and this is accomplished by soot blowing in the area at appropriate time intervals. Liquor firing is restricted to prevent gas temperature going high at S H. inlet. This is the constraint for reaching rated solids firing capacity.

Providing microprocessor control on the outlet zone is also contemplated for achieving better control.

2.6 To overcome design deficiency retrofitting optimising air and liquor delivery and for re-evaluation of convective heat transfer surfaces.

To increase the boiler availability, to reduce carry-over and to increase the reduction efficiency, MPM is seriously thinking to retrofit the existing outdated recovery boiler with a three level air system and an improved liquor delivery system. Keeping in view the possible increase in pulp production in near future, the soda recovery boiler may become a bottleneck, unless steps are taken to increase the availability of the boiler. Also some rearrangement/re-location of convective heat transfer surface is planned to limit furnace exit flue gas temperatures.

For instance, the repeated superheater failures, with the reasons attributable to high temperature metal wastage can be got over by an increase in screen tube area. This may also reduce boiler bank plugging to a considerable extent. Details have to be worked out by a consultant/designer and it is estimated that this retrofit would result in a 10-15% increase in steam generation.

2.7 Revamping of ESP :

The overall chemical recovery in the mill has been just satisfactory now and it is the desire to take it to 95% or more. Efforts in all areas are being made and enhancing the performance of ESP is one. Perhaps the maintenance of electrode alignment is to be relooked. Alignment is a vague way to imply the degree to which the location of the electrodes of a revamped precipitator is arranged within+/—10mm. Since the electrodes are 6 metres high, the precision required is greater. The required skill is not available to take a relook at alignment and to use our own resources. Unfortunately electrodes do not remain aligned. Slight bends and movements accumulate, eventually the performance begins to deteriorate, Misalignment causes maldistribution of the corona current. It is hard to quantify the effect of any given degree of misalignment in terms of the precipitator. Possibly increasing the clearance between electrodes may improve matters. A change in power input may then become possible. A consultant will be of help in these matters. It may also be a good idea to seek assistance from the precipitator manufacturers. These alternatives will be tried in MPM shortly and attempt will be made for bettering the performance further.

2 8 Limesludge Reburning :

To obtain pure quality of lime and also to avoid disposing of lime sludge by land filling, a Rotary lime kiln Installation is planned under OECF assistance, M/s Honshu Paper Co , of Japan are the consultants and they are liklely to begin the studies shortly.

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ANNEXURE I

DATA SHEET

PURPOSE	Mysore Paper Mills Limited 1 × Type V2R Boiler						
BOILER DESIGNATION	3937 — 4242	17-4 — 33-21	V2R	1317 — 1219	5500 — 18000	E2P-6000 — 40 6F	
LOCATION	INDOOR						
	Black liquor						
FUEL	Sodium (Na)	Carbon C	Hydrogen H	Oxygen O_2	IN	S	H.H V. K.cal/Kg.
I	18 98%	36.6%	3.22%	35.78%	2 08%	3.34%	3300
II	18 3%	37.8%	3 5%	36.5%	2 0%	1.9%	3300
(50% Bagasse liquor)							

FURANCE	Width : 3937 mm	Depth . 4242 mm	Volume : 225 m^3
	Type : Fusion welded Panels		
		Type	H.S Area in m^2
SUPERHEATER	Stage I	Platen	317
	Stage II	Platen	428
ATTEMPERATOR	Type	Number of Stages	Medium of Spray
	Spray	Inter Stage	Feed Water
AIR HEATER	Type	H.S in m^2	No. of Block
	Steam coil	861	One
CASCADE EVAPORATOR	4572 × 2743—A	—	One

	BURNERS :	**Black liquor gun**		
		Capacity	No. of per blr.	Location
FUEL BURNING EQUIPMENT	Black liquor	270000kg. of DS/24 Hrs.	4	2/Side water wall
	Steam atomised starting oil Burner	300 kg/hr/Br	4	Front/Rear
	Steamed atomised load carrying oil Burner Br	700 kg/Hr/Br	4	Front/Rear Sidewalls

Predicted Performance

The performance figures furnished below are predicted only and are not to be construed as being guaranteed except where the points coincide with the guarantees.

1. Design Fuel—Elemental Analysis*

		Dry Solids	Black Liquor
Total Carbon	%	38,2	19.10
Total Oxygen	%	35.6	62.24
Total Sodium	%	18.8	9.40
Total Hydrogen	%	2.5	6.81
Total Sulphur	%	2.6	1.30
Total Inerts	%	2.3	1.15
		100.00	100.00
Higher heating Value : Kcal/kg		3300	1650
Solids content	%	100	50

* **Before the addition of raw and precipitated salt cake.**

II Capacity :

Black liquor at 50% Solids	Kg/day	540,000
Black liquor dry solids	Kg/day	270,000
Steam generated	Kg/hr	33,000
Steam generated	Kg/Kg of B.L.	1.46
Steam Temp. at S.H O.	°C	450
Steam pressure at S.H.O.	Kg/Cm^2g	63
Design pressure	Kg/Cm^2g	75
Salt cage make up(Anhydrous)	Kg/day	16,000
Sulphidity/Reduction	% TAPPI	25/94+/—2

III Temperatures :

Air to F.D. Fan	°C	26.7
Air to Furnace	°C	150
Feed Water	°C	105
Water to drum	°C	140
Gas leaving S.H.	°C	570
Gas leaving Boiler bank	°C	390
Gas leaving Economiser	°C	330
Gas leaving cascade	°C	160
Black liquor to furnace	°C	115

IV Pressure Drop :

Superheater	Kg/Cm^2	3.9

V Gas Side Losses :

Furnace and S.H.	mm Wg	6.0
Boiler Bank	mm Wg	6.0
Economiser	mm Wg	13.0
Cascade evaporator	mm Wg	75.0
Precipitator, DTPA valve Dmpers and ducts	mm Wg	60.0
		160.0

Design Details of Electrostatic Precipitator

Gas flow rate	:	129240 m^3/hr
Temperature	;	160°C
Nos.	:	2
Efficiency	:	98%
Pressure drop across the precipitor	:	12 mm water column
Velocity of gas at electrode zone on total area	:	0.748 m/Sec.
Treatment time	:	9.63 second

Collecting Electrodes

No. of rows of collecting electrodes per field – 17

No. of collecting Electrode plates per field—153

Total No. of plates—612

Emitting Electrodes :

No. of electrodes in each row—36

No. of electrodes in each field—576

Total No. of electrodes 2304

Plate wire/spacing—125 mm

Control Cubicle Specification

Input	:	415 V, single phase, 50 C/s
Output	:	i) 43 KV mean corresponding to 70 KV peak ii) 400/600/800 MA mean DC
Control Features	:	i) Constant current control (IM&IS) ii) Spark rate control (S&T) iii) Arc control iv) Voltage limit
Facilities available	:	i) Measurement of AC/DC current, AC/DC voltages and spark rate. ii) Auto/Manual control of power supply iii) Overload and under voltage trip iv) Alarm annunciation
Ambient	:	i) 50°C Max. air temperature ii) Control cubicle suitable for indoor installation only. iii) Transformer rectifier unit suitable for outdoor installation.