Chemical Recovery For Bagasse Pulp Based Paper Plant

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NATH PULP AND PAPER MILLS LTD., is an Agro-Waste based Paper Mill producing high grade packaging paper for box-making and also coated paper at its works in Paithan, Aurangabad. The NATH group has another mill at Vapi in the state of Gujarat, which is also an agro-waste based paper mill producing packaging paper and some varieties of low GSM bleached and unbleached papers. The combined production capacity of both the mills is, at present, about 200 TPD.

The Paithan Plant was commissioned in 1979 with one machine which was subsequently revamped and modernised to 45 TPD by 1990. In the same year company also commissioned a 55 TPD second paper machine with top wire arrangement.

The company, in the year 1990, took a bold decision to go for **Chemical Recovery Project** primarily to fully meet the Pollution Control norms prevailing in the country. In order to make the investment economically viable, the company added a 5 MW Co-generation power project simultaneously with the chemical recovery project. Both the chemical recovery and Co-generation power projects are commissioned and stabilized to a great extent.

PROJECT

NATH was probably the first company of its size manufacturing kraft paper to conceive the idea of going in for backward integration by taking up chemical recovery and Co-generation projects. It was realised that chemical recovery plant had to be linked with a power generating plant so as to make the project viable.

The chemical recovery plant was designed to cater for 90 TPD bagasse pulp i.e. max. 125 TPD black liquor solids. LTV evaporators with Forced Circulation finisher was the choice to keep the cost down. 6 Nos. LTV bodies and 2 finishers (used as Ist body) were installed so that one LTV could be kept as spare. The evaporator capacity was fixed at 53.5 TPH water evaporation with a steam economy of 5.0. The Evaporator plant was supplied, erected and commissioned by M/s. Swetha Engineering Ltd., Madras.

125 TPD Recovery Boiler having 4 nos. soda burners based on Babcock Enterprise (France) design with a cyclone evaporator and ESP were installed. Sloping hearth, with membrane wall panels, economizer and super heaters formed main components of the boiler.

A three level air system and steam atomised liquor firing is provided to minimise excess air in the system.

30 TPD causticizing plant was supplied by M/s. Hindustan Dorr Oliver Ltd. and commissioned with conventional clarifiers having sloping bottom.

A 5 MW turbo generator set of SKODA/TOYO DENKI design was supplied by DLF Industries Ltd., New Delhi and was commissioned with inlet steam capacity of 46 TPH at 42 kg/cm^2 pressure. The turbine is of extraction cum back pressure type and is capable of supplying steam for both the pulp and paper machine plants. The Turbine control system has been designed so that, in case of necessity, NPPM generation can be synchronized with MSEB grid.

The viability of both chemical recovery and power generation plants depend greatly on the prevailing rates of Caustic Soda and power vis-a-vis the production cost of own generation of these items. The price of caustic soda did not rise much in the last couple of years - on the other hand,

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at times, the price in fact went down. However, the power rates have gone up considerably since the commissioning of our projects. The combined viability of the two projects can still be maintained with a pay back period of less than 6 years.

Following is a statement giving details of representative cost, contributions possible and pay-back calculations for chemical recovery and co-generation power plant. However, the recovery project can not be viewed only from the point of view of pay back. It is primarily a pollution control project and in the prevailing circumstances, the project allows the mill to continue with chemical pulping which is economical compared to using other varieties of furnish.

Project cost of chemical recovery	-1600.00 lacs
Project cost of co-generation	- 1000.00 lacs
(Including pre-operative expenses)	
TOTAL	2600.00 Lacs

Payback Calculation for Chemical Recovery

Basis:

Rec. Efficiency	: 85%	Rates:
Bagasse	: 170 TPD	Caustic Soda- Rs.14100/MT
Bagasse pulp	: 90 TPD	Furnace Oil- Rs.6900/KL.
BLS	: 107 TPD	Lime-2300/MT
Paper Prodn.	: 125 TPD	Coal- Rs.1600/MT
		Power- Rs.3.54/KwH

(A) Variable Cost :

(i) Make up chemicals		
(170X0.15X0.15X14100X330)	- 177.97	lacs/yr.
(ii) Furnace Oil 2.5 KL/day		
(2.5X330X6900)	- 56.92	"
(iii) Manpower	- 30.00	"
(iv) Maintenance @ Rs.70.00/T	- 23.10	
(v) Lime 27 TPD @ 2300 per ton	- 204.93	"
(vi) Power at 180 kwH/T @ 3.54 per unit	- 262.85	"
(vii)Net steam demand 2.5 TPH	- 83.16	"
	838.93	"
(B) Interest on investment @18%	- 288.00	"
Total Expenditure	- 1126.93	"

(C) Contribution

(i) Power generated 1.13 MW from 13 TPH) (1.13X1000X24X330X3.54)	- 316.82
(ii) Caustic produced (22.7X14100X330)	- 1056.23
(iii)Total contribution	- 1373.05
Gross profit excluding depreciation	- 246.12

Pay back of chemical recovery
=1600/246.12=6.5 YRS.

Payback Calculation for Co-generation

(a) Variable cost of co-generation	
(1) Addl. fuel (0.61X1650X330X24)	-79.84 lac/yr.
(2) Maintenance cost @ Rs. 50.00/T	- 20.62 "
(3) Addl. man power cost	- 10.00 "
(4) Captive power regd. @ 80 Kw/T @ 3.54/Unit	- 116.82 "
	227.28 "
(b) Interest at 18%	180.00 "
Total Expenditure	407.28 "

(c) Contribution

2.42X24X3.54X330X1000	678.49 "
Gross profit excluding depriciation	271.21 "

Pay Back -1000.00/271.21 = 3.68 yrs.

Overall pay back

	Co-gen. Recovery	
Total variable cost	227.28+838.93	1066.21 "
Total interest@18%	180.00+288.00	468.00 "
Total contribution	678.49+1373.05	2051.54 "
Gross profit	271.21+246.12	517.33 "

Overall payback 2600/517.33 = 5.02 yrs.

Steam Demand on 125 TPD Paper Production

	LP	MP	HP	Total(TPD)
Paper Machine	375	-	-	375
Pulp mill	-	162	-	162
Evaporators	230	-	-	230
Causticizing	36	-	-	36
Rec.Boiler	28	67	10	105
FBC (Deaerator)	76	-	-	76
Misc.	15	5	-	20
				1004
				41.8 TPH

FBC Self consumption = 76 TPD

Equivalent HP steam = 76X672/774

= 66.00 or 2.75 TPH

Equivalent additional fuel = 2.75/4.5 = 0.61 TPH

THE EXPERIENCE

Recovery plant was commissioned in the middle of June 1996. In the initial 6 months i.e. up to November 1996 we faced numerous teething problems, in particular, high consumption of furnace oil and freezing of furnace hearth coupled with blockage of air-ports. Not until December 1996, the plant could be stabilised.

Simultaneously, with the commissioning of Recovery Plant, Sulphite cooking was stopped and pure caustic cooking was started at 13% (as NaOH). However, the black liquor quality with 13% cooking was far from satisfactory and we found it difficult to process the black liquor in the recovery plant smoothly. The residual alkali in black liquor was as low as 0.4 gpl. The liquor was found to be very difficult to push through because of its high viscosity. The liquor was also highly contaminated (the bagasse was still being undepithed) and Caustic dosing in the recovery plant did not help.

Meanwhile, while steps were being taken to improve the black liquor quality, several modifications were also carried out in Recovery Boiler. It was also decided to start depithing of bagasse and increase the White Liquor/Caustic soda dosing for cooking to 15% (as NaOH). List of some important modifications already carried out in recovery boiler are:

1. Cleats were welded on to the membranes and refractory lining was done upto secondary air level.
2. Soda burners were inclined downwards to about 40 Deg. from horizontal position; the tilting point was also raised.
3. An economizer by-pass duct was provided to maintain cyclone inlet gas temp. which was going down at low load conditions.
4. An attemperator is provided to maintain Super Heated steam temperature which shoots up at times.

All these actions in pulp mill & recovery plant yielded results. The bagasse pulp dropped in kappa No. from 36 to 32 (Avg.), RAA increased from

0.8 to 1.5 gpl and also the liquor fluidity improved. The liquor throughput in the boiler also improved reducing the oil support considerably. There was improvement in the hearth condition and blockage of air ports reduced considerably.

Cooking chemical was further increased to 15.5% and cooking time reduced from 2.0 hours to 1.5 hours which, in turn, showed an improvement in RAA to between 3.4 and 4.0 gpl - still maintaining the same pulp Kappa No.

Meanwhile, NATH was approached by Aurangabad Paper Mills Ltd. with a request to process their black liquor solids of about 25 TPD so that they could continue to use bagasse pulp without contravening the instructions of Pollution Control Board. A mutually satisfactory agreement was drawn up between the two started processing APM's Black Liquor. This improved the loading of the recovery boiler and the liquor through-put capacity has since increased to between 2.75 to 3.0 Tons per hour on an average. At this loading, there is still a requirement of 4 to 4.5 TPD furnace oil support. However, it has been that on certain days when the loading of the boiler was upto 90 TPD, the furnace oil support was not required.

The air distribution vis-a-vis duct pressures are still a cause of concern and are being attended to.

SUGGESTIONS FOR AGRO-WASTE BASED MILLS OPTING FOR CHEMICAL RECOVERY PLANT (Say for 125 TPD plant)

(1) Chemical Recovery Project should be coupled with a co-generation power project.

(2) Main features of the Plant

(a) Evaporators

(i)	Black Liquor Solids handling capacity	: 125 TPD
(ii)	Water evaporation capacity	: 53.5 TPH(60 TPH : design)
(iii)	Black liquor concentration	: From 8% to 45% : min.
(iv)	Steam economy	: 4.96 T/T

(b) Recovery Boiler

. Black liquor from bagasse cooking by soda process.

. Evaporators Concentration	:45% dry solids @ 90 Deg. C
. HHV	:3300 KCal/Kg. dry solids (3100-3200 KCal/Kg. is more realistic)
. Solids design rate	:5210 Kg/hr. or 125 TPD

. Black Liquor Solids

Elemental Analysis	: % weight (assumed)
Sodium (Na)	: 15.8%
Carbon (C)	: 41.5%
Hydrogen (H)	: 4.1%
Sulphur (S)	: 0.4%
Oxygen (O)	: 34.5%
Nitrogen (N)	: 0.3%
Silicium (as SiO_2)	: 3.0%
Inerts	: 0.4%

. Feed water Temp.	: 105°C
. Steam Pressure	: 42 Kg/Cm^2 g
Temperature	: Outlet 420+/-5 Deg.C
Flow	: 16.67 TPH Gorss

Flue gas leaving cyclone evaporator

- Flow	: 42.03 TPH
- Temperature	: 160 Deg.C

- Dust loading inlet to ESP : 10 g/Nm^3
- Dust loading outlet of ESP : 100 mg/Nm^3

(c) Recausticizing plant

White liquor capacity : 320 Cum/Day. Max. 100 ppm suspended solids.

Total Titratable Alkali (TTA) : 100 gpl (as NaOH)

Soda Loss in lime mud cake from filter : Maximum 1% (on B.D.Basis)

Causticity : Minimum 82%

Lime handling plant

Jaw Crusher Capacity : 5 TPH

Size Reduction : 4-5 Inch. to 0.5-1 Inch.

Bucket Elevator : 5 TPH

Table Feeder : 2 TPH

(d) Fluidized Bed Combustion Boiler

1. Steam flow Kg/Hr : 30000
2. Steam Pressure Kg/Cm^2 : 42.0
3. Steam temp. Deg.C. : 420 +/- 5
4. Feed Water Temp. : 105 Deg.C
5. Thermal efficiency on GCV basis : 84% Minimum
6. Flue gas temperature at the outlet of air heaters Deg.C : 160
7. Gross calorific value of coal KCal/Kg. : 3800
8. Fuel consumption Kg/hr: 6323
9. ESP : Dust concentration of gases leaving ESP 150 mg/NM^3.
10. MDC : Outlet dust concentration 4000 mg/NM^3.
11. Coal Handling Plant : Capacity 25 MT/Hr. 100% minus 6 mm.
12. Ash Handling Plant : System suitable for coal handling an ash content of 60%.

Note: A 35.00 TPH steam boiler would be a better choice.

(e) Turbine

(1) Inlet steam at turbine stop valve — Pressure : 40 Kg/Cm^2 G; Temp. : 415 Deg.C

(2) Extraction Steam — Pressure : 8 Kg./Cm^2 G; Flow range: 9 to 16 TPH

(3) Back Pressure Steam — Pressure : 3.5 Kg/Cm^2; Flow range: 31 TPH

(4) Out put of Turbo alternator under max. operating conditions shall be 4700 KW

(3) Pulping

It is our experience that a black liquor having 3-4 gpl RAA as NaOH at 9-10% WBL con centration does not pose fluidity problems. Slight dosing of caustic soda in evaporator to maintain its pH at +12 is recommended. Prefilteration of weak black liquor is essential through a 100 mesh vibrating screen.

Large washers with a specific loading of 2.5 T/M^2 i.e. 40 $M^2$for 90 T pulp per day would give 11-12% concentration of Weak Black Liquor as well as minimise washing loss.

(4) Recovery Plant

(i) Recovery Boiler

Precise sizing of the recovery unit is absolutely essential to keep costs under control as well as maintain continuity of operation. Therefore, it is essential to know the cooking conditions and yield so as to be able to know the Black Liquor solids to be processed in the recovery unit.

A sample calculation is given below:

Depithed bagasse/digestor 8.5 MT BD

= 8500.00 Kg.

Chemical Charges (AA) 14.5% as NaOH

White Liquor Volume = 12.84 m^3/Digestor

Bagasse = 8500.00 Kg.BD

NaOH 1232.5 Kg. as NaOH

@ 96 gpl = 1232.50 Kg.as such

Na_2CO_3 308.1 kg. as NaOH

@ 24 gpl = 408.30 kg. as such

= 10140.80 kg.solids

BD pulp produced at 53% = 4505.00 kg.solids

Black liquor dissolved

solids (BLS) = 5635.80 kg.solids

BLS per ton of pulp = 1.25

Less:Loss in pulp mill @5%= 1.187

Black liquor solids going to

chemical recovery = 106.83 TPD.

Studded tube upto secondary level are essential to retain heat in the lower portion of the recovery boiler for ease of smelt flow. Refractory lining which was in practice earlier is not considered essential today.

(ii) Evaporators

Considering 10% WBL concentration the evaporator capacity works out to 45 TPH water evaporation to produce liquor at 45% concentration.

Falling film evaporators are cost prohibitive for smaller units; however, if possible, falling films finishers should be considered. Forced circulation units consume high power off-setting the benefit of steam economy.

Causticizing

Traditional causticizing, due to reason of high silica content, is desirable. Stationary slaker should be preferred wherever good quality lime is available (+75% CaO). Raised flat bottom clarifiers cum storage tanks should be ideally chosen to keep the cost of tankages and civil work down. A 30 TPD recovered caustic plant is ideally sized for 90 TPD pulp for an unbleached Kraft Mill having soda cooking.

In order to encourage mills of medium capacity to go for chemical recovery and co-generation projects, it is suggested that the Pulp & Paper Technical Association should take up this matter strongly with the appropriate Government Authorities to make available low interest scheme bearing long term fund to paper industries going in for pollution control measures such as chemical recovery scheme.

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