

## Over All Improvement in Chemical Recovery and Lime Kiln by Innovation and Out of Box Thinking

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**Abstract:** *In Indian Pulp and Paper Industries, many Mills have adopted latest technologies with their capacity expansion of Pulp Mill, Chemical Recovery and Paper & Board Machines. The Mills still having old conventional technologies also marginally have increased their Pulp Mill capacity by debottlenecking of the plant, resulting in generation of additional Black Liquor and putting additional load on exiting Chemical Recovery.*

**Key words:** Chemical Recovery, Box Thinking, Lime Kiln

### Introduction

J K Paper Ltd, Unit: CPM located at Fort Songadh, (Gujarat), commenced production in 1968, acquired by JK Group in 1992, turned around in 1994-95, Paper Plant Capacity: 55,000 TPA, manufacturing Copier Paper, Writing Printing Paper, Security Paper, Industrial grade and Packaging Board Plant commenced production in 2007 Capacity: 90,000 TPA, manufacturing virgin grade Packaging Board.

### Brief of Chemical Recovery Plant

J K Paper Ltd, Unit: CPM is having six effect evaporator with capacity of 57 T/hr water evaporation, which has increased to 65 T/hr water evaporation by adding two additional bodies. There are total 11 Nos of bodies. In first effect, there are 3 Nos of bodies (lamella type) and remaining 8 are tubular type. In 2<sup>nd</sup>, 3<sup>rd</sup> & 4<sup>th</sup> effects there are 2 Nos of bodies in each effect and in 5<sup>th</sup> & 6<sup>th</sup> effect there is only single body in each effect.

### Increase of black liquor solids of Cascade Evaporator

By increasing Pulp Mills production capacity (Fig.-1), generation of weak black liquor from Pulp Mill had increased, characteristics of weak black liquor are given in Table-1. The existing evaporator capacity was 57 T/ hr water evaporation, handling of excess black liquor was the major bottleneck at evaporator section. To handle the excess black liquor at evaporator it was decided to add two more bodies in existing evaporator. Unit: JKPM was having spare bodies of old evaporators and it was decided to shift two bodies and installed at CPM evaporator section to debottleneck. These two extra bodies were successfully installed and commissioned in 2014-15, after that evaporator capacity increased upto 65 T/hr water evaporation and solid concentrations of cascade inlet, outlet and firing liquor got increased, results are shown in the Table-2 & Fig.-2.

### Chemical Recovery Boiler

Recovery Boiler was designed for firing of 335 T dry solids per day. By increasing firing liquor solids the additional advantages observed at Recovery Boilers are:

- Reduction in cascade jamming problem.
- Uniform char bed on hearth by controlling primary and secondary air duct pressure.
- Less liquor carry over
- Firing liquor pressure reduced from 1.2 kg/cm<sup>2</sup> to 0.7 kg/cm<sup>2</sup> by increasing firing header size from 3 inch to 6 inch, it helped to minimize black liquor carry over
- Reduction from sodium sulfate to sodium sulfide increased
- Sulfidity of white liquor increased (Fig.-3)
- Sustainability of Boiler
- Advantage of inlet temperature at ESP

By increasing black liquor solid, runnability of Recovery Boiler has been increased resulting no furnace oil is being used, except for startup & shut down.

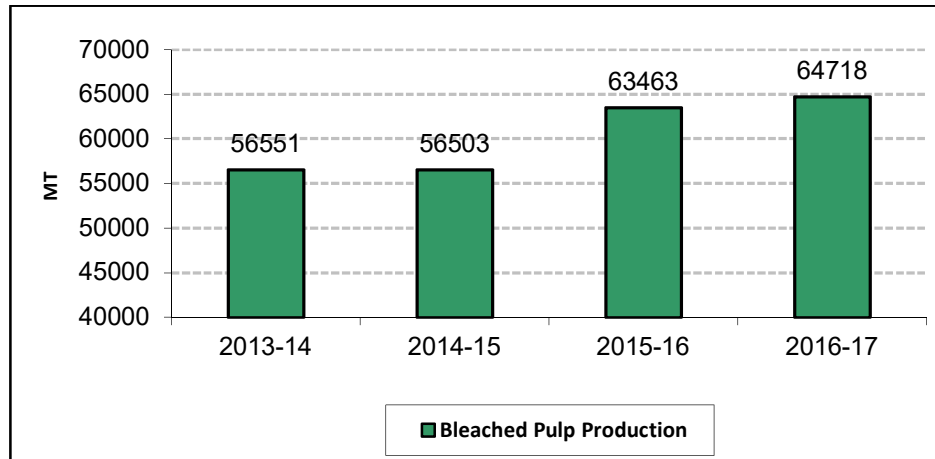


Fig.1. Bleached Pulp Production, MT

Table 1. Characteristics of Weak Black Liquor

Sr. No	Parameter	Value
1	Total Solids, % w/w	17.3
2	Free Alkali as Na <sub>2</sub> O	6.6
3	Inorganics, % w/w	52
4	Organics, % w/w	48
5	GCV, k cal/kg	3045
6	SVR, ml/g	30
7	Sodium as Na, % w/w	18.9
8	Carbon as C, % w/w	33.2
9	Hydrogen as H, % w/w	3.8
10	Nitrogen as N, % w/w	0.70
11	Sulphur as S, % w/w	1.5
12	Chloride as Cl, % w/w	1.6
13	Silica as SiO <sub>2</sub> , % w/w	1.2

**Increase of black liquor solids of Cascade Evaporator:**

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- Cascade Inlet solids were increased from 50% to 54%.
- Cascade outlet solids were increased from 63 - 64% to 69 - 70%.
- Firing liquor solids were increased from 64 - 65% to 70 - 71.0%.

Table 2. Black Liquor Solids at different stage

Sr No	Particulars	Unit	2013-14	2014-15	2015-16	2016-17	2017-18
1	Cascade Inlet	%	49.6	50.9	52.6	53.4	54.2
2	Cascade outlet	%	62.9	64.0	68.0	69.3	70.0
3	FLT screen outlet (Firing liquor)	%	63.8	65.2	69.0	70.1	71.0

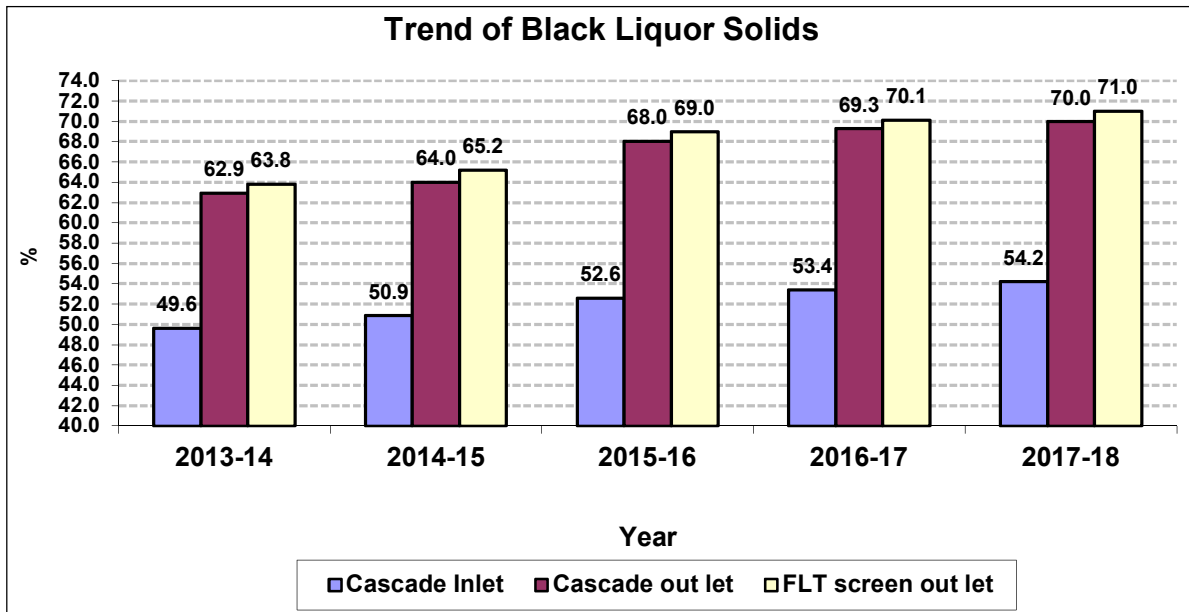


Fig.2. Trends of Black Liquor Solids at different stage

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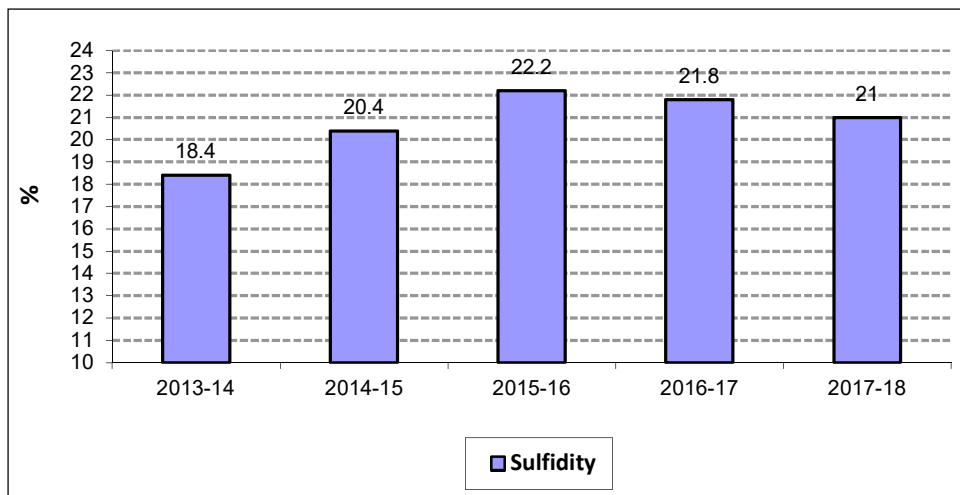


Fig.3. Sulfidity of White Liquor

**Causticizing Plant:**

JKPL, Unit: CPM is using Bamboo in raw material furnish (25-35%), trend of raw material is shown in Table-3, silica content in bamboo is higher as compared to hard wood. Processing of Bamboo mixed liquor at recovery is more difficult than the hard wood black liquor, silica content in black liquor is given in Table-4.

White liquor production capacity of causticizing plant was 78 T/day. To increase the white liquor production capacity, causticizing plant diverted into two streets (Fig.-4).

In street no -1 there are 1 No of white liquor clarifier and 3 Nos of mud washers. In this street purchase lime (as lime make up in lieu of lime stone) and lime kiln product lime is being used, sludge of this street used in rotary lime kiln feed.

In street No. 2, there are 1 No of white liquor clarifier and 2 Nos of mud washers. In this street only Lime Kiln product lime is being used and sludge is being purged out due to more silica content. Dregs from GLC also washed in 2<sup>nd</sup> street and directly purged out from old filter.

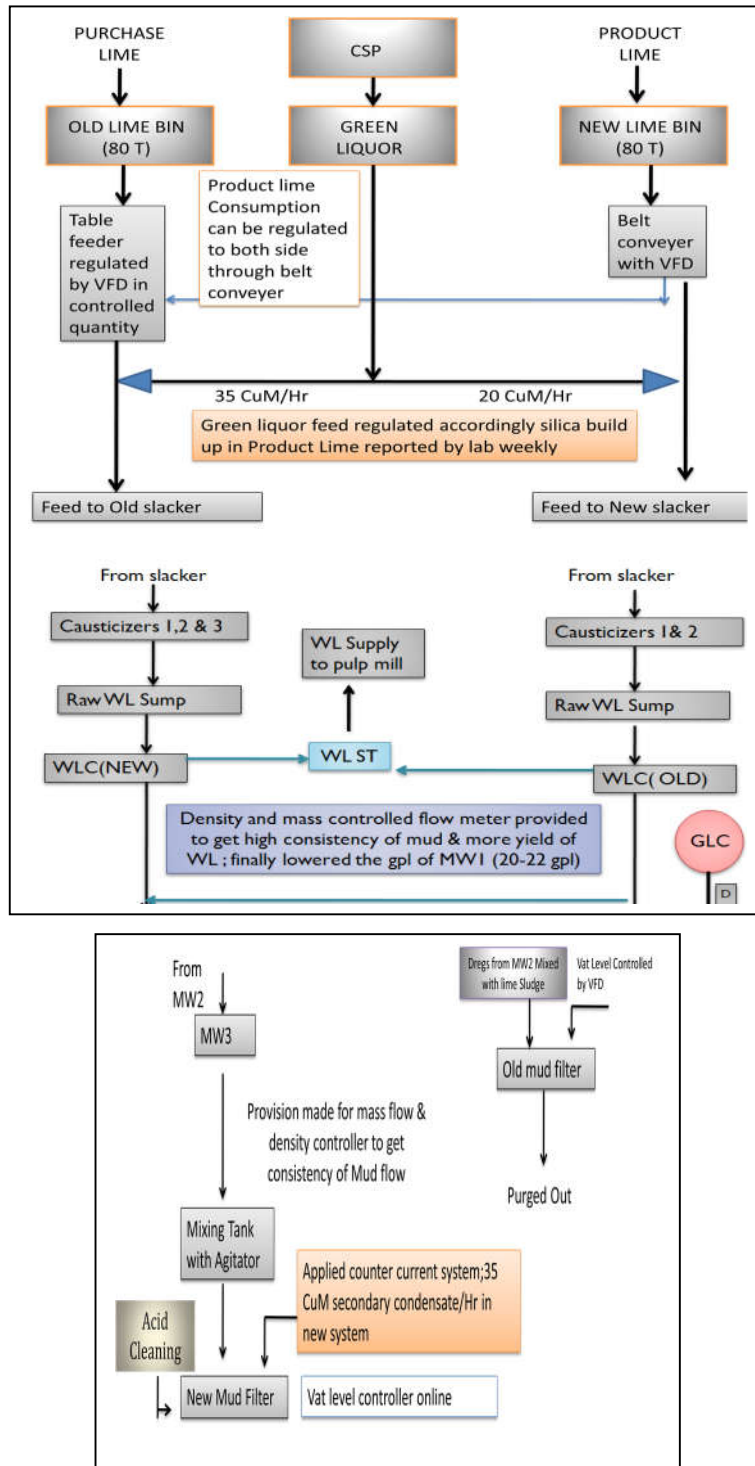


Fig. 4. Causticizing plant

Table 3. Raw Material Furnish

Sr No	Particular	Unit	2013-14	2014-15	2015-16	2016-17	2017-18
1	Bamboo	%	17	22	35	35	27
2	Wood	%	83	78	65	65	73

**Table 4.** Silica content in Black Liquor, Green Liquor & white Liquor

Sr No	Particular	Unit	2013-14	2014-15	2015-16	2016-17	2017-18
1	Black Liquor	gpl	1.8	2.0	2.5	2.4	2.2
2	Green Liquor	gpl	1.4	1.7	2.0	1.9	1.8
3	White Liquor	gpl	0.58	0.57	0.74	0.68	0.62

**Table 5.** Acid Insolubles in Lime sludge & Product Lime

Sr. No.	Particulars	Unit	2013-14	2014-15	2015-16	2016-17	2017-18
1	Lime sludge from New filter	%	5.4	6.5	6.4	5.4	3.6
2	Product Lime	%	8.1	9.4	9.7	8.3	6.7

### Rotary Lime Kiln with producer gas plant.

Rotary Lime Kiln with Producer Gas Plant was installed and commissioned in 2009-10. Installed capacity of Lime Kiln is 90 TPD, running with Producer Gas Plant. To run the Lime Kiln effectively following innovative ideas were implemented:

- Producer Gas Plant process parameters were optimized.
- Increased mud filter dryness from 55% to 60% (Fig.-6).
- Primary air changed from ambient air to 75°C by modifying suction duct near kiln shell.
- Lime sludge characteristics (feeding to lime kiln) were improved in terms of silica content and dryness, results are shown in Table No-5 & Fig.-6.
- Lime Kiln process parameters were optimized as per production and purity.
- The major advantage achieved by implementing all above innovative ideas is zero furnace oil consumption at Rotary lime kiln and running with Producer Gas Plant and its by product tar (Fig.-7), resulting production cost of lime reduced from Rs. 5200.00 to 4800.00 per ton of product lime. Trend of purity of product lime shown in Fig.-8.

### Key points to reduce the furnace oil consumption to zero:

- Segregation of green liquor flow in two parts (35 cum/hr and 20 cum /hr), resulting white liquor generation increases from 78 tpd to 110 tpd.
- Both street generated lime mud handled and washed separately.
- Lime mud generated from product lime is purged out as silica contained in the system.
- Lime mud generated from purchased (35% of total lime consumed) and from product lime is fed to Lime Kiln.
- Purchased lime is used as make up (35% of total lime consumption) in place of limestone.

### Optimization of operation at mud filter

- Mud density : 1.14 gm/cc  
 Vat level : 30 %  
 Slurry temperature : 85°C  
 Slurry flow : 13.5 cum/hr  
 Vacuum : 550 mm hg
- Assured counter current washing system.
  - Checking of doctor blade & its gap weekly.
  - Online effective acid cleaning system provided.

### Optimization of operation at Rotary Lime Kiln-

- Adjustment of flame by regulating radial & axial primary air flow.
- Primary air pressure controlled (550 to 360 mmwc )
- Short circuiting of secondary air is arrested.
- Temperature of primary air is increased, from ambient to 75°C (Fig.-5)
- ID fan RPM is controlled as per balanced draft.

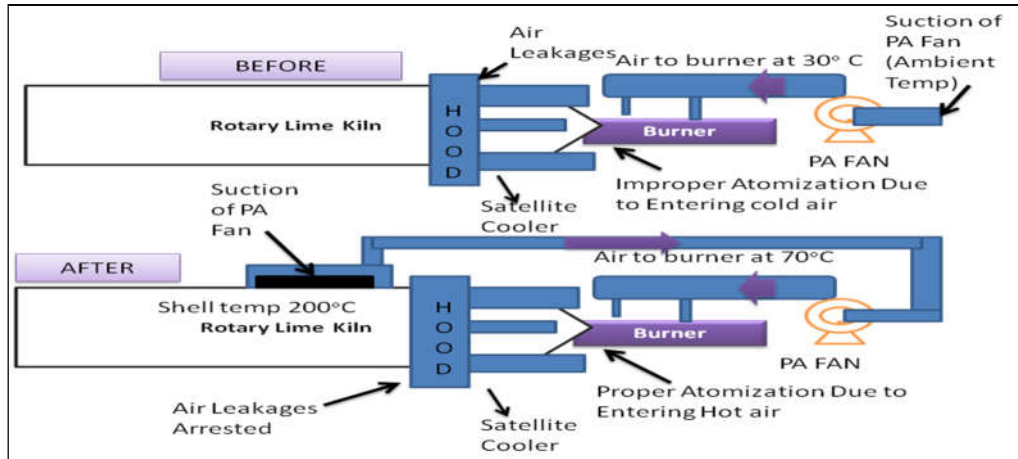


Fig. 5. Improvement jobs at Rotary Lime kiln

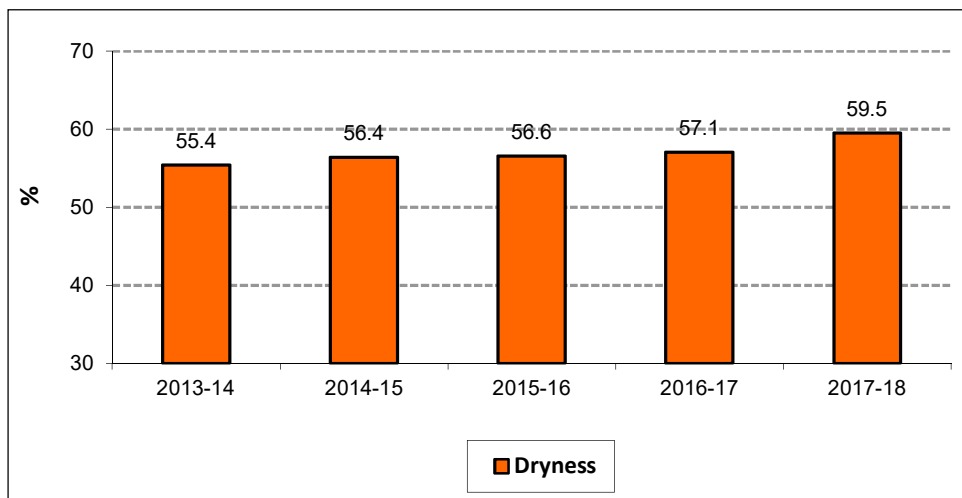


Fig. 6. Filter Cake Dryness

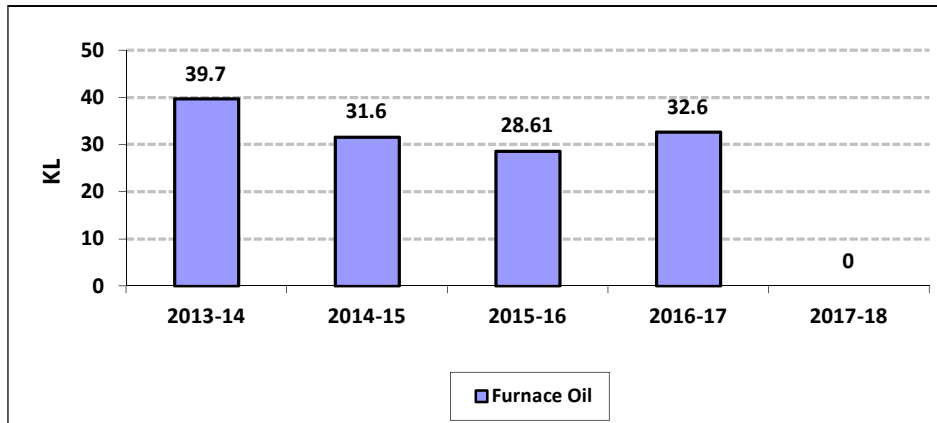


Fig-7. Furnace oil consumption at Rotary Lime Kiln

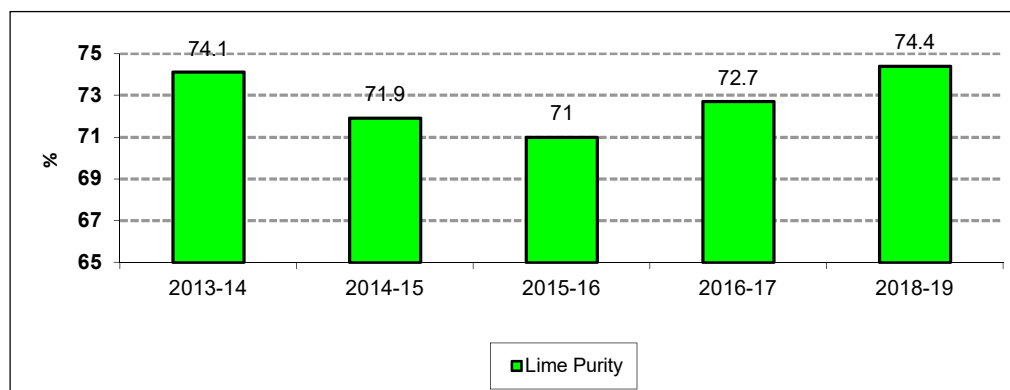


Fig. 8. Lime purity of Rotary Lime Kiln

#### Conclusions:

- Concentration of firing black liquor increased from 64 - 65% to 70 - 71.0%.
- White liquor Sulfidity increased from 18% to 21 - 22%.
- To handle higher silica content of lime, two streets causticizing process implemented. Resulting white liquor generation increased from 78 TPD to 110 TPD and increase of dryness of filter cake.
- Elimination of use of furnace oil at Lime Kiln and operating 100% with Producer Gas Plant and its by product tar, which has reduced production cost of lime.
- Purging out lime sludge make up with purchase lime. No limestone is being added at lime kiln.

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