Sludge Reburning in Lime Kiln - Practical Aspects

Thard V.K. & Azad Veer

ABSTRACT

Sludge reburning lime kiln was commissioned at Star Paper Mills Ltd. Saharanpur in March, 1996. During its commissioning, we came across many operational problems but with our day-to-day experience, we could troubleshoot most of these problems. We now feel comfortable to operate the kiln with satisfactory performance. In this paper we wish to share our experiences of lime kiln operations.

INTRODUCTION

The paper industry is considered to be one of the most polluting industries. It generates a huge quantitiy of solid, liquid and gaseous wastes which pollute our environment. The lime sludge generated in the Soda Recovery plant constitutes the major part of the solid waste. The disposal of this sludge had become a major handicap to meet out the production target, specially in rainy season. The location of the mill and commitment of mill's management towards social obligation contributed in taking the decision to go for sludge reburning kplant inspite of huge investment with a longer pay back period.

BRIEF DESCRIPTION OF SLUDGE REBURNING SYSTEM

The green liquor generated in recovery boiler by burning organics and inorganics present in the black liquor is treated with lime in causticizing plant to produce white liquor and calcium carbonate. While liquor produced is used for pulping process and calcium carbonate in the form of lime sludge is processed in sludge reburning plant. Following reaction takes place

$$Na_2CO_3 + CaO + H_2O \rightarrow 2\ NaOH + CaCO_3$$

(white liquor) (sludge)

Sludge reburning plant consists of lime mud filter, sludge feeding system, lime stone crushing and feeding system, ESP, Rotary lime kiln, oil and oil burner management system and product lime handling system.

The lime mud filter is a precoat snap blow type equipped with latest technology and operated by a PLC. It is designed to give the sludge output at 25% moisture. The filter drum is fitted with synthetic wire cloth. Sludge output from the mud filter is taken to the kiln through a reversible belt conveyor and a screw conveyor. The crushed lime stone and E.S.P. dust are also fed to the kiln through two separate pipes.

The lime kiln is a 51 m. long and 2.7 m diameter shell. It is provided with garland chain system for sludge drying. Calcination and burning zone is insulated with double layered insulating bricks. Seven planatory coolers are mounted on the kiln shell to cool down the product lime upto 80°C and heat up the secondary air by direct contact with hot lime in counter current manner. One D.C. Motor of 22

Star Paper Mills Ltd.,
Saharanpur - 247 001 (U.P.)

KW is used for rotating the kiln at variable speed ranging from 0.1 to 1.3 RPM.

Furnace oil is used in oil burners for raising the temperature in the burning zone of the kiln upto 120°C which is required for calcination of the sludge. The oil management system is provided with a steam heater to heat up the furnace oil upto 130°C before pumping to the burner through oil flow meter and flow controller. The whole system is governed by PLC. Compressed air is used for automising the furnace oil in oil burner.

The product lime handling system consists of a hammer crusher to crush the oversize pieces of product lime and a drag chain conveyor and a bucket elevator to feed the lime into lime bin.

Safety interlocks: For the safety of crew and the equipment, the following interlocks have been provided in sludge reburning system.

(i) **Sludge feeding-**

Mud feeding to mud filter, filter drum and vacuum pump are interlocked with reversible belt conveyor through PLC.

(ii) E.S.P. current supply is interlocked with ESP inlet gas high temp. carbon Mono-oxide concentration in inlet gases, high dust level is the ESP chamber and ESP dust return system failure.

(iii) Furnace oil pump is interlocked with I.D. Fan Primary air fan, automising air pressure, D.C. Motor and low F.O. temp.

(iv) In the product lime handling system, hammer crusher and drag chain conveyor are interlocked with bucket elevator.

PRACTICAL OPERATIONAL ASPECTS OF THE KILN

(1) At the time of commissioning of the lime kiln, the dryness of sludge at the outlet of mud filter was achieved as 55% against 75% expected value. The problem was analysed and the following steps were taken in consultation with the supplier :

(i) Presence of dregs in the sludge was excessive leading to cake blindness. To overcome the problem, dregs washer was commissioned. The dryness was improved by 2-3%.

(ii) The consistency of mud to the filter vat was not uniform. To eliminate this problem, one density controller designed by our engineers was installed and commissioned. This led to further increase in dryness by 2%. Density controller also contributed towards uniform rate of sludge feeding to lime kiln and thus in better product quality and less oil consumption.

(iii) Mud feed temperature was 45-55°C only. This was raised to 70°C by direct steaming with 40 PSI. It gave improved mat formation with further increase in dryness by 3%.

(iv) During operation of mud filter it was felt that the lower vat level gives better dryness. The filter was designed to operate at 33% submergence level. It was reduced to 25% which gave a further increase in dryness by 1-1.5%.

(v) Cake cutting doctor blades were ensured to have a fine edge.

The above steps resulted in dryness level upto 63% but we have not been able to achieve the designed value of 75%.

After 4-5 months of smooth operation, it was observed that moisture in sludge had gone up and the purity of product lime reduced. The matter was further analysed and it was found that higher MgO content in the sludge could be one of the main reason. Further investigations revealed the source of MgO to be the lime stone. A search operation was started to locate the source of supply of low MgO and higher $CaCO_3$ content lime stone. But lime stone of 92-93% $CaCO_3$ and 2-3% MgO was available in vicinity of our Mills. The economics of using sea shell and getting the lime stone of good quality from other areas were also looked into but were not found as viable alternative. It was decided to monitor the quality of lime stone on a continuous basis with each consignment to prevent poor quality of lime stone. This has yielded improved results.

(2) The second problem came up with the vacuum pump. After 2-3 months of commissioning of mud filter, the vacuum pump started giving problem of rotor jamming. The analysis revealed that the raw water used for sealing in vacuum pump was the contributing factor for scaling on the rotor. The number of alternatives of raw water were considered. Finally, the machine back water of pH = 6.0 was found to be the best alternative for sealing water. Scaling on the rotor was eliminated by using paper machine

back water and also resluted in a saving of 12 M^3/ hour fresh water.

(3) **Variance in sludge feed:** Initially the variance in sludge feed rate to lime kiln was 60 to 65%. Installation of density controller brought it down to 30-35%. On further analysis of the problem, it was observed that one hour cycle of cake cutting of precoat is leading to cake blinding and thus variance in sludge output from the filter. Different cake cutting in sludge feed was minimum i.e. around 20-30% with about 20 minute cycle of cake cutting.

(4) **Blockage in Chain zone of kiln shell:** During commissioning it was observed that feed material was blocking the flue gas passage in chain zone causing puffing at burner end and causing uncomplete combustion of furnace oil. The discussions were held with the supplier and a decision was taken to reduce number of chains by 10% This resulted in elemination of this problem.

(5) **Product quality:** There was a wide variation in the quality of product lime at the time of commissioning. It was found that by feeding the sludge at uniform feed rate to the kiln, variations were reduced significantly. We are presently achieving a purity of 78-80% available CaO in the product lime.

(6) **Furnace oil consumption per ton of produced lime:** Initially the F.O. consumption per tonne of lime was 255 litres/ton. The main reason for higher oil consumptions were :-

Higher moisture content in the sludge feed, variation in the sludge feed rate, Poor quality of furnace oil having less calorific value and contamination and Excess air to the lime kiln. Excess air to the lime kiln was controlled by strict vigilence on the CO and O_2 analysis and keeping O_2 content in flue gases by 2-3%. By applying corrective measures over other factors, we could achieve furnace oil consumption of 204 litre ton of produced lime against designed value of 185 Litre/tonne. The designed figure could not be achieved due to lower utilisation of capacity of lime kiln i.e. 65-70% and due to higher moisture in sludge feed. We are still working to reduce the furnace oil consumptions and hope to achieve the desired value in near future.

BENEFITS ACHIEVED FROM LIME KILN

By putting the sludge reburning plant we have achieved the following benefits:

(i) Higher available CaO in product lime i.e. 74-78% at the consumption point against 60-62% in case of purchased lime. This has led to better and smooth working of causticizing plant with significant improvement in the quality of white liquor. Comparative data are given in table No. 1.

(ii) Elemination of sludge disposal problem to a great extent and thus combating solid waste pollution.

(iii) Uninterrupted supply of consistent quality of lime for causticizing plant.

(iv) Conservation of natural resources of lime stone.

(v) Economics of one month operation of the kiln given in table No. 2 which also shows the profitability of lime kiln.

CONCLUSION

Since the installation of rotary lime kiln is capital intensive, the paper industry is normally reluctant to put up this plant. Our experience of 3

Table No. 1 - Showing improvement in W.L. Quality.

Sl. No.	Particulars	With purchased lime	With generated lime
1.	Causticizing efficiency	78-80%	82-84%
2.	T. Na_2O in W.L.	95-98 gpl	102-105 gpl
3.	Total suspended solids in wt.	250-300 ppm	50-80 ppm
4.	G.L. Processing Rate	450-500 M^3 per day	600 to 850 M^3 per day

Table No. 2

LIME-KILN PRODUCTION COST OF LIME (JANUARY 99)

Sl. No.	Particulars	ACHIEVED				Remarks
		Quantity/ MT product	Quantity	Rate (Rs)	Amount (Rs. lacs)	
1.	Lime produced at Lime-Kiln	--	1641.3 MT	--	--	
2.	Lime purity at generation point	--	77.88%	--	--	
3.	Expenditure on generated lime					
3.1	Lime stone	.25 MT	405.3 MT	788.00	3.19	
3.2	Furnace oil	204.2 Lt	335110 Lt	5.78	19.37	
3.3	Dynamix	--	240 Lt	230.00	.55	
3.4	Purchased power	38.3 KWh	62900 KWh	4.39	2.76	
3.5	Steam	.17 MT	274 MT	594.00	1.63	
3.6	Maintenance and consumables	50 Rs	--	--	.82	
3.7	Manpower	30 Rs	--	--	.49	
3.8	Total for generated lime			1755.32	28.81	
4.	In case equivalent amount of lime at 65% purity at table feeder had to be purchased	--	1966.5 MT	2518.00	49.52	
5.	Savings					
	- Due to generated lime	--	--	--	20.71	
	- Due to sludge handling	Rs 0.71 lacs per month	--	--	.71	
	- Nett savings				21.42	

C:\VPP\MIS\KILN.WKS

years with lime kiln shows that proper selection of equipments for putting up the lime kiln and strict control over process parameters are key factors in operating a lime kiln.

ACKNOWLEDGEMENT

The authors are thankful to the management of Star Paper Mills Ltd. to give us inspiration and guidance to overcome the problems faced in commissioning the lime kiln and permitting us to present this paper.