Lime Sludge Reburning-A Major Step Towards Cleaner Production in Star Paper Mills

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ABSTRACT

Disposal of lime sludge generated by an Integrated Pulp & Paper Unit is a great problem, specially for the mills which are located near the urban areas. This problem increases manifold in rainy seasons. Strict Pollution Control acts also do not allow to dispose off the solid waste in populated area. Therefore, Star Paper Mills has installed a lime sludge reburning kiln to overcome all the problems connected with sludge disposal & to have good quality of lime.

INTRODUCTION

The paper industry is considered to be one of the most polluting industry. A significant quantity of solid and liquid wastes are generated in various sections of the mills. It is our social obligation and also statutory requirement to keep the environment pollution free and for this, efforts are to be made to identify the pollutants and arrest them at the source itself. Recycling is the key for pollution abatement and to bring the industry in the category of zero effluent industry.

Chemical recovery units are helping the paper industry to a great extent in reducing the liquid waste generated by Pulp Mill and thus reducing pollution load on stream. But Chemical Recovery units also generate inorganic non degradable solid wastes such as lime sludge which now-a-days has posed great problem for their disposal. About 0.5 tonnes solid waste (lime sludge) on D.D. basis is generated for 1 ton O.D. Pulp production by a Kraft Mill. This sludge is dumped into low land area or stock piled in a big plot and thus causing land pollution. Sludge reburning lime kiln which converts the waste into wealth i.e. sludge into lime is the answer of land pollution problem.

In our country sludge reburning kiln has received last priority by the Paper Industry, being a highly capital intensive unit and also it is considered to be a dead investment. But because of the strict pollution control regulations and non-availability of land for dumping the lime sludge and rising cost of good quality lime, it has become a necessity to instal a lime sludge reburning kiln.

Also by recycling lime sludge into process, requirement of lime stone for lime production is also reduced, thus conserving natural resources.

Star Paper Mills has installed a sludge reburning lime kiln to produce 80 Tons/day lime in March 1996. This has made a considerably close system in Causticizing Plant resulting in minimising the solid waste generation and better availability of lime with higher purity (available CaO). This has helped the Mills in generating more clear white liquor with higher causticizing efficiency.

A comparative statement of lime requirement and solid waste generation in case of purchased lime vis-a-vis product lime is given in **Table-I.**

Data showing comparison between results with purchased lime and generated lime.

GENERAL INTRODUCTION OF THE PROCESS

The lime mud generated in Causticizing process after reaction of lime with Green liquor, is washed thoroughly in two stage counter current lime mud washers, so as to make the sludge free from residual Na_2O to a maximum extent. Residual Na_2O should be less than 0.3% for a good quality sludge feed. The thick sludge from underflow of LMW II is stored in a sludge tank from where it is sent to vacuum filter at a constant density containing about 15 to 20% solids. The filtered cake obtained from Vacuum filter

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Table-I

S.No.	Particulars	With purchased lime	With Product lime
1.	Available Calcium Oxide in	61 to 65%	74 to 78%
2.	Lime required per ton of NaOH generated	1.4 Ton	1.2 Ton
3.	Causticity in W.L.	80%	81.5%
4.	Suspended solids in W.L.	150 to 250 ppm	50 to 65 ppm
5.	Solid waste disposed off	90 Tons/day on O.D. Basis	4-5 Tons/day on O.D. Basis

containing about 32 to 33% moisture is fed to Lime Kiln through a screw conveyor.

A certain amount of lime mud is always lost during causticizing in the form of gritts and in milk of lime preparation. This loss of lime mud is compensated by lime stone. The lime stone is crushed to about 1/2 inch size and added to the kiln together with the filter cake and is burnt to lime. This lime stone also serves to maintain a high level of calcium carbonate in the sludge.

The exhaust gases coming out of the kiln are ladden with micro particles of feed sludge and burnt lime. To keep the environment pollution free, these gases are passed to Electro-static precipitator. The precipitated dust is also fed to the kiln through a separate tube and mixed with the fresh feed.

Feed comprising of lime sludge, lime stone and precipitated dust travels through the kiln from feed end to burner end. On the other end, called as burner end, furnace oil is fired through air automised oil burners. The hot gases generated by burning of furnace oil travels towards feed end. During its travel through the kiln, the feed undergoes various operations like drying of sludge, agglomeration and calcination. The calcinated hot lime passes through planatory coolers where it comes in contact with fresh air being drawn into the kiln in counter current fashion. The heat of lime is thus transfered to the air which is used to preheat the air required into the kiln for combustion of Furnace oil. The cooled lime is finally fed to a chain conveyor and from there through a bucket elevator, it is stored into the bins.

MAIN EQUIPMENTS USED

The main equipments used in lime kiln are

i) Snap blow filter

ii) Make-up lime stone feeding system

iii) ESP and dust return system

iv) Lime Kiln

v) Burner Management system

vi) Burnt lime handling system

SNAP BLOW FILTER

This is a precoat vacuum filter designed to give filtered cake containing 75% dryness. The operation of this filter has been supported by Programmable Logic Control (PLC). The special feature of this filter is removal of its precoat in parts at a fixed and predetermined interval of time. This allows a new & fresh precoat formation without disturbing the whole system. The filter cake is fed to the kiln through a belt conveyor and a screw conveyor.

MAKE-UP LIME STONE FEEDING SYSTEM

This system comprises of a jaw crusher, bucket elevator, lime stone bin, table feeder and a conveyor belt.

ESP & DUST RETURN SYSTEM

ESP dust return system comprises of a screw conveyor to remove the dust from inside of ESP, a rotary feeder & a screw to carry the dust from rotary feeder to the pipeline going to the kiln.

LIME KILN

Lime Kiln has been supplied by L&T, Cement Machinery Division. The kiln shell is of 2.7 Mt. diameter and 54 Mt. length. It is supported over two sets of riding rollers. It is driven by a variable speed D.C. Motor. One diesel set is also there to rotate the Kiln during start-up or shut down or during power failure.

The special feature of this lime kiln is its planatory coolers mounted in a planatory arrangement around the kiln to cool the calcined lime.

BURNER MANAGEMENT SYSTEM

The furnace oil after preheating upto 130°C & proper filtering is automised with compressed air. Primary air is also supplied through a primary air fan to control the shape of the flame and also to help combustion of fuel. It is supplied at ambient temp. main air supply required for complete combustion is provided as secondary air which is drawn into kiln through planatory coolers by an I.D. Fan mounted after ESP & before the chimney. By keeping a negative draught at burner end, required secondary air is drawn nto the kiln. This air is heated by the heat transferred from the hot product lime.

BURNT LIME HANDLING SYSTEM

Product lime after passing through coolers is screened to separate bigger size lumps. The accepted size lime is fed directly to the chain conveyor and bigger size lumps are passed to a hammer crusher to break into small pieces and then fed to chain conveyor. The chain conveyor carries the lime to bucket elevator which feeds the lime to lime bins.

MAIN CONTROLLING PARAMETERS

For getting the best quality of product lime at a minimum possible fuel consumption, the following parameters are being controlled:

1. Feed to the Kiln

Sludge and stone feed to the kiln should always be at a constant rate. Correct functioning of mud filter is of crucial importance for better & economical functioning of kiln. For keeping constant feed rate at a higher dryness, the following parameters need attention:

i) The lime mud being fed to the sludge filter vat should have constant solid content. This is controlled by a sludge density controller.

ii) Temperature of lime mud at filter vat should be always more than 70°C.

iii) The lime mud must be dregs free. For this green liquor dregs removal system has been installed.

iv) The lime mud must be containing minimum impurities like MgO, Silica and metallic oxides. Presence of MgO in lime sludge affects the Cake formation and also dryness. MgO & Silica content should be less than 2% in lime mud.

2. Quality of Lime stone

Best quality of lime stone must be used as make-up lime stone. $CaCO_3$ content of lime stone must be atleast 96% with silica less than 1% and MgO less than 2%. Higher MgO & Silica content lime stone must be strictly avoided.

3. Furnace Oil

Furnace oil should be properly filtered and preheated before firing. A good automisation of fuel must be assured to get higher heat value and good combustion.

4. Secondary Air

Secondary air should be controlled in such a manner that in the outlet gases going to ESP, oxygen content remains 1-3% only & CO content should be less than 0.1%. A good flue gas analyser mounted in ESP inlet gas duct may provide a better control over secondary air supply & thus reduced fuel consumption.

5. ESP Outlet gas temperature

ESP outlet gas temperature should be kept around 150°C to avoid loss of heat alongwith flue gases and also it will ensure effective working of ESP.

6. Laboratory support

To have a better and effective control over product quality and better economy, hourly checking of product lime for loss on ignition (LOI) is one of the essential requirement. Product LOI must be maintained between 0.8 to 1.2%. LOI less than 0.8% shows overburning of product and thus less reactivity of lime and higher oil consumption. LOI more than 1.2% shows incomplete calcination. Complete analysis of feed material (sludge & lime stone) and product lime is being done at a regular interval, atleast once on alternate day. Available CaO in product lime & moisture percentage in sludge cake is being checked every two hourly.

7. To maintain higher $CaCO_3$ content & lesser impurity level in the lime mud, certain amount of purging of sludge is necessary.

8. Correct measurement of sludge feed, stone feed and oil feed helps in better control and assessment of kiln performance.

Table-II

Lime Kiln :: Profitability of Produced Lime At Various Capacity Utilisation

Sl. No.	Particulars	Capacity Utilisation:58% Quantity	Rate (Rs)	Amount (Rs. lacs)	Capacity Utilisation:90% Quantity	Rate (Rs)	Amount (Rs.lacs)
1.	Lime produced at Lime-Kiln	1385.2 MT	-	-	2149.4 MT	-	
2.	Lime purity (at generation point)	78.00 %	-	-	78.00%	-	-
3.	Annual expenditure on generated lime						
3.1	Lime stone	541.4 MT	832.00	4.50	840.1 MT	832.00	6.99
3.2	Furnace oil	318.6 KL	6.39	20.36	429.9 KL	6.39	27.47
3.3	Power	60 MWH	3.55	2.13	82 MWH	3.55	2.91
3.4	Steam	277.0 MT	521.00	1.44	429.8 MT	521.00	2.24
3.5	Maintenance and consumables	-	-	.69	-	-	.69
3.6	Manpower	-	-	1.04	-	-	1.04
3.7	Total for generated lime		2177.30	30.16		1923.33	41.34
4.	In case equivalent amount of lime 70% purity had to be purchased	1543.5 MT	2423.00	37.40	2395.0 MT	2423.00	58.03
5.	SAVINGS						
	- Due to generated lime	-	-	7.24	-	-	16.69
	- Due to sludge handling	-	-	.71	-		- .71
	- Net monthly savings			7.95			17.40
6.	Net savings per MT lime produced (Rs)			574			810

OUR EXPERIENCE WITH KILN OPERATION

At the initial stage, we had to face a number of problems in achieving the desired results which were investigated & finally with all efforts, we could achieve our goal.

One problem was related with furnace oil. Furnace oil consumption per ton of lime production was sometimes coming very high. It was investigated and we found that furnace oil was containing various type of contamination and having very low calorific value. The transporters were playing mischief. They were charged for this. Now all the furnace oil tankers are tested before unloading for calorific value and contamination.

Likewise there was a problem with make-up lime stone. Presently lime stone is also tested before it is unloaded & higher MgO, Silica containing lime stone are rejected to overcome the problem of MgO and Silica build-up in the system.

Uneven feed rate of sludge feed & higher moisture of sludge cake was causing higher oil consumption and uneven quality of product lime. Following steps were taken to overcome this problem:

i) One L.P. Steam (40 PSI) line was provided in sludge filter vat to raise the filter vat sludge temperature to 75°C.

ii) Density Controller was provided in mud feed line tc filter vat so as to ensure constant solid content in the lime mud feed to filter.

iii) Filter vat level reduced from 33% submergence to 25% submergence to get better dryness.

iv) Cake cutting & snap blowing cycles were modified.

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

vi) Purity of sludge was improved by reducing MgO & Silica content and residual Na_2O Content was also reduced by better washing of sludge.

With all the above steps we could achieve sludge dryness upto 69-70% & a constant feed rate.

By improving lime stone quality, furnace oil quality and filter operation, we could improve product lime quality from 72% available CaO to 80% available CaO and furnace oil consumption was greatly reduced from 250 Lit./ton to 219 Lit./ton.

ECONOMICAL ASPECT

Earlier it was considered that the product lime generated from sludge reburning kiln costs much higher than the purchased lime. But with advancement in technology and modification in kiln design, it has been possible to reduce the fuel consumption per ton of product lime to a great extent. This has lowered the cost of product lime in comparison to purchased lime of the same purity. A case is illustrated in **Table II** which indicates that the cost of product lime of 78% purity is about Rs. 574.00 per ton less than the cost of purchased lime when only 58% capacity utilisation was there. At 90% capacity utilisation, saving in running cost per ton of product lime comes to Rs. 810.00.

CONCLUSION

Our experience with lime kiln shows that reburning of lime sludge is not only economical but following advantages also accrue:

i) It serves in a greater way to reduce solid waste generated by Causticizing Plant & thus resulting in pollution abatement.

ii) Lime consumption at Causticizing Plant reduces due to increased lime purity.

iii) Reduction in Lime inventory.

iv) Conservation of natural resources of lime stone.

ACKNOWLEDGEMENT

The authors are very much thankful to the management of Star Paper Mills Ltd. to inspire us to present this paper and also grateful for their valuable suggestions and guidelines in writing this paper.