Lime Sludge, Fly Ash and Cinder - Present Scenario of Utilization by Converting in to Value Added Products

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ABSTRACT

This paper presents the present scenario in the pulp and paper industries for the generation of inorganic solid wastes-lime sludge, fly ash and cinder.

Traditionally, most of the inorganic solid wastes are being land filled, which, in most of the cases extends to dumping of the same on any available land. In the face of increasing environmental awareness, scarcity of available land and possible strict governmental regulations in future, the paper industry is keenly looking for alternate methods for their disposal/use.

In view of this, it is imperative to produce value -added products from these wastes in place of dumping as such. Accordingly, this paper evaluates these wastes for their potential to be used for making value added products. Bench scale trials have been carried out to see the possibility of manufacturing cement, bricks, precipitated calcium carbonate and reclaim lime by MVSK process.

INTRODUCTION

Since the inception of integrated pulp and paper mills having chemical recovery to regenerate costly pulping chemicals by causticizing process and recovery/ coal fired boiler to meet out its energy requirement, the inorganic solid wastes like lime sludge, cinder and fly ash have posed a major solid waste disposal problem as they are being disposed off by dumping/spreading in low lying areas and other fields in and around the paper mills as huge mountains due to many years accumulations, in several cases rendering these infertile. The present generation of lime sludge, cinder and fly ash stands at 0.8, 0.6 and 0.105 MT/Year which may increase to 1.8,1.2 and 0.225 MT/Year with the projected increase of paper production from 4 to 5 million tons.

Lime sludge is a waste by product from the causticizer unit in chemical recovery operations in pulp and paper industry. The green liquor prepared by dissolving smelt, generated in the recovery boiler by burning organics and inorganics present in the black liquor is treated with lime in causticizing plant to produce white liquor, whereas lime sludge is generated as waste.

In order to utilize lime sludge, some six mills have put up rotary lime kilns to reburn lime sludge. However, most of the mills are facing problems of low dryness in the lime sludge due to poor efficiency of

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drum filter and high silica content in lime sludge. This leads to low productivity and low energy efficiency of rotary lime kilns. The problem associated with moisture due to presence of silica is envisaged even more in the light of the fact that due to non-availability of conventional raw material, the industry is increasingly using agro-wastes for capacity enhancements. This, coupled with the fact that even a 100 TPD mill will have to go in for chemical recovery for economic reasons will cause more problems with lime sludge reburning, the studies were planned at CPPRI on the following lines:

1. Conversions of lime sludge, cinder and fly ash in to cement.
2. Conversion of lime sludge, cinder and fly ash in to bricks and other value added products.
3. To improve productivity and energy efficiency of the lime kiln.

MATERIAL AND METHODS

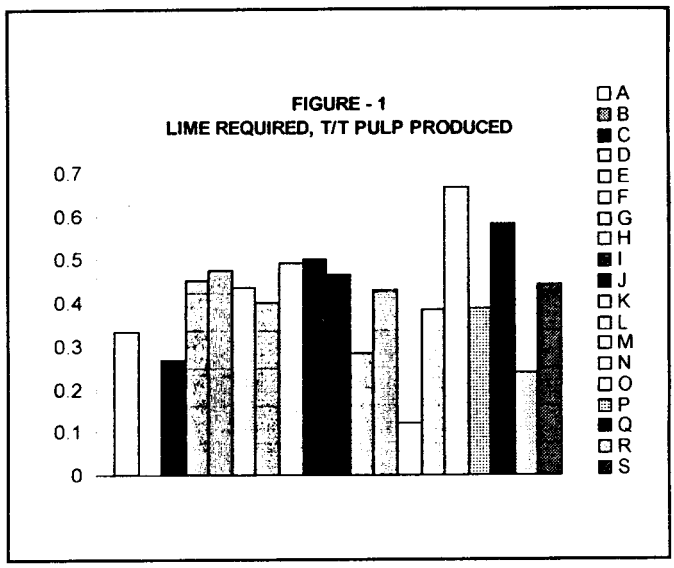
On site data was collected and field measurements of process and operational parameters were carried out using standard portable equipment . The information/ data regarding production and energy consumption, plant and machinery details, quality of raw material, kiln operating conditions etc. were collected. Samples of lime stone, lime sludge, fly ash, cinder, product lime and furnace oil were collected from the mills and analyzed in the lab as per standard procedures prescribed by BIS. (1-4).

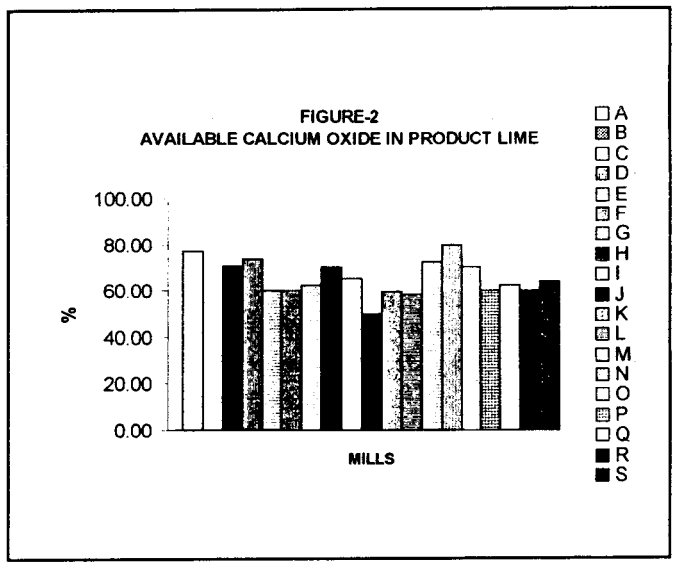
RESULTS AND DISCUSSION

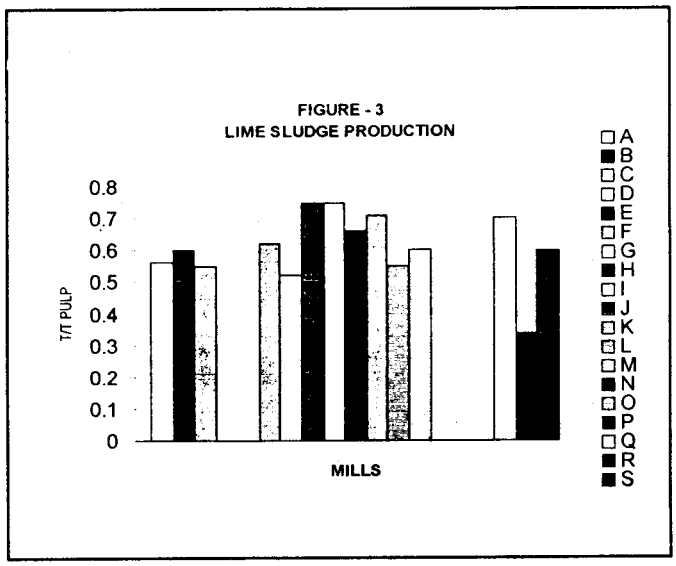
Present scenario

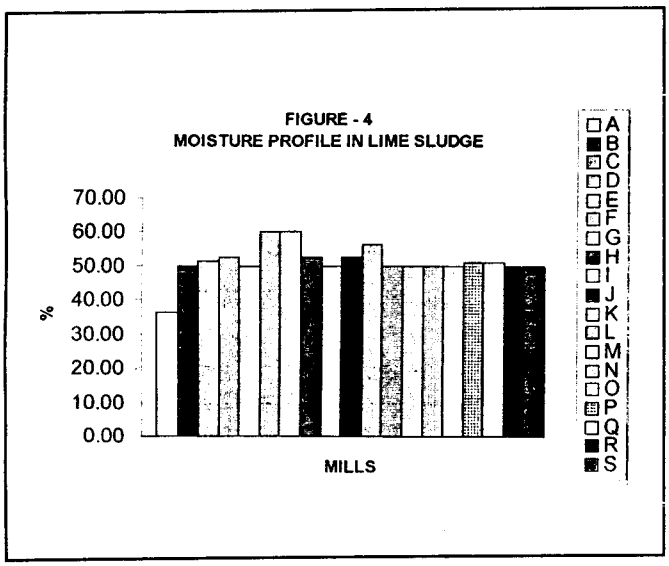
In absence of reliable and authentic information, systematic collection of data was carried out by sending specifically designed questionnaires to various mills having chemical recovery. The present analysis is performed on the basis of data received from nineteen such mills.

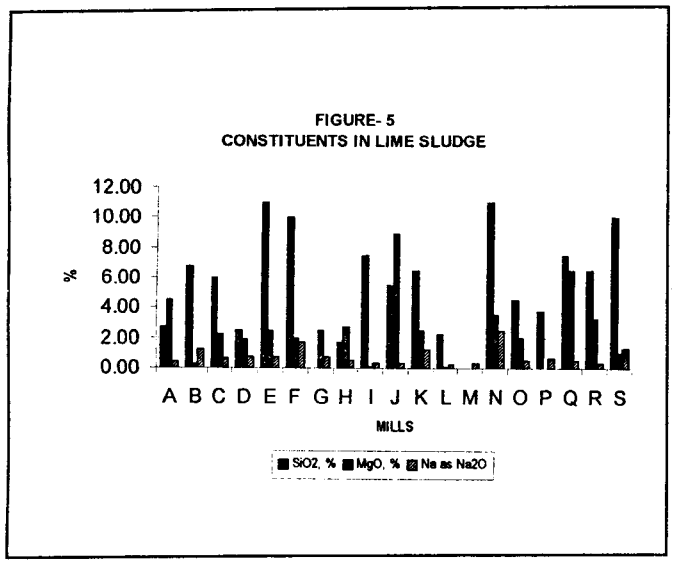
Generally, most mills have reported the use of 0.45-0.5 T of lime per ton of pulp produced (figure-1) Most mills seem to prefer use of average quality lime with available CaO content of 65-70%. The quality of reburnt lime sludge of mills with rotary lime kiln was marginally better with available CaO content of around 75% (figure-2). Lime sludge production per ton of pulp (figure-3) lies between 0.55-0.7 T on OD basis. Moisture profiles in lime sludge are given in figure 4. Mills











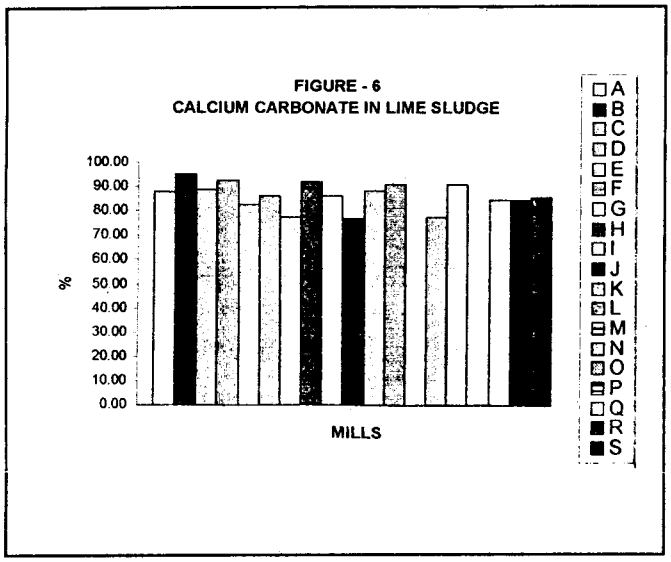


Table-1

Chemical Analysis of Lime Sludge of Various Mills

S.No.	Particulars	Units	Value
1	Moisture	%	35-60
2	L.O.I.	%	35-42
3	Silica	%	1.5-12
4	Acid Insoluble	%	0.3-2.0
5	R_2O_3	%	0.3-3.5
6	Fe_2O_3	%	0.01-0.3
7	Al_2O_3	%	0.2-3.2
8	Mg as MgO	%	0.2-3.0
9	Ca as $CaCO_3$	%	80-94.0
10	Free CaO	%	Traces-1.5
11	Free Na_2O	%	0.2-2.6
12	K_2O	%	0.07-0.1
13	Cl_2	%	0.004-0.009
14	SO_3	%	0.04-0.4

A,B,C and H which use rotary lime kilns report around 50% moisture in lime sludge. This observation translates in to a major problem in productivity enhancement of lime kilns. Likewise, the presence of high Silica (8-10%) in some cases clearly underscores the problems that would be associated with installation of lime sludge reburning units (figure-5). On the other hand, with average Ca (as $CaCO_3$) of around 85% (figure-6) lime sludge of most mills seems a suitable substrate for production of lime.

ANALYTICAL EVALUATION OF LIME SLUDGE, CINDER AND FLY ASH

Table 1 and 2 present the chemical analysis of lime sludge, fly ash and cinder from various pulp and paper mill. Generally, these values agree with composition of raw mix for cement thus indicating potential application of lime sludge for the manufacture of the same. As already stated, moisture in lime sludge tends to rise up to 50% because of high silica in some cases. In such conditions use of lime sludge may result in more fuel consumption in the kiln. This problem

Table-2

Chemical Analysis of Fly Ash and Cinder Collected from various Mills

S.No.	Particulars	Units	Fly ash	Cinder
1	L.O.I.	%	4.5-35.0	0.1-0.15
2	Silica	%	35.0-60.0	58-67
3	Fe_2O_3	%	3.0-8.0	5.0-7.0
4	Al_2O_3	%	14.0-28.0	14.0-30.0
5	Mgo	%	0.06-2.0	0.5-1.5
6	CaO	%	1.5-4.0	1.5-3.5
7	Na_2O	%	0.1-0.3	0.7-0.9
8	K_2O	%	0.04-0.5	1.0-1.4
9	SO_3	%	0.1-1.1	-
Proximate Analysis				
11	Moisture	%	0.2-2.0	0.8-40
12	Ash	%	63.0-95.0	70.0-95.0
13	Volatile Matter	%	4.5-8.0	2.0-4.0
14	Fixed Carbon	%	0.1-25	10.0-20.0
15	Calorific value	kcal/kg	500-2500	500-2000

can be tackled by desilication of black liquor and/or with proper design and operation of the rotary drum vacuum filter. This problem is not envisaged when accumulated lime sludge is used for the manufacture of lime/cement. The chief argument in favor of use of lime sludge comes from the fact that the inferred reserves of cement grade limestone are 60,000 million tons (1991 estimate). The measured reserves for the same are even lower at 16,000 million tons. This data clearly indicates a limit of availability of cement grade lime in the country from natural resources. As compared to the requirement of raw material for large cement manufacturing units, the amount of lime sludge generated is rather small and it may not be feasible to transport the same over long distances for cost-economic reasons. However, use of lime sludge will be more feasible in small/medium scale cement manufacturing units after suitable nodulation/pelletization using MVSK system designed by NCB, which is versatile and can operate at higher percentage of sodium hydroxide.

Fly ash and cinder (table -2) do not have such problems and can be used as such for raw mix design. The use of 15% fly ash in cement is well known for making pozzolona cement. The high calorific values in some cases will translate in to fuel economy during manufacture of cement. The chemical and mineralogical characteristic of lime sludge, cinder and fly ash generated in pulp and paper industry show that they can be excellent raw material for making of ordinary Portland cement (OPC). Further, the fly ash from fluidized bed boilers exhibits classical pozzolonic properties for use as raw mix for the manufacture of PPC.

MANUFACTURE OF CEMENT AND BRICKS

The quantity of cement produced by using 60% lime sludge with clinker is given in table -3. As can be seen, the bench scale trials give excellent cement which exhibits the compressive strengths of 63.8 which is 10 points higher that the best cement being marketed in the country. Currently, efforts are on to translate bench

Table-3

Performance of OPC Prepared from Clinker

S.No.	Particulars	Units	Value
1	Fineness	m^2/kg	307.3
2	Setting time	minutes	
	Initial		50
	Final		235
3	Compressive Strength	MPa	
	3 days		33.2
	7 days		44.3
	28 days		63.8
4	Soundness		
	Lechatelier Expansion	mm	1
	Autoclave Expansion	%	0.05

scale results to industrial scale by making plant trials.

At present, two types of bricks have been made in the lab and evaluated for their properties. Table -4 gives the evaluation of water cured bricks using 60% fly ash and 10% lime sludge along with clay whereas table-5 presents properties of burnt clay bricks using 10% lime sludge. Even though the studies are still in progress, these pointer results go to indicate possibility of manufacture of suitable building material from paper mill wastes.

MANUFACTURE OF PRECIPITATED CALCIUM CARBONATE FROM LIME SLUDGE

The bench scale trials have shown that good quality of precipitated calcium carbonate can be produced by burning lime sludge at a controlled temperature of 950°C (instead of the conventionally used temperature of 1100°C) to produce lime, hydrolyzing it and then passing flue gases through the same (utilizing its carbon dioxide content) as in conventional method. The precipitated calcium carbonate thus produced can be used in the paper industry as filter and also in the manufacture of goods related to cosmetics and medicine.

CONCLUSIONS

Table-4

Properties of Bricks Prepared Using Fly Ash and Lime Sludge

S.No.	Particulars	Units	Value
1	Compressive Strength	N/mm^2	8-10
2	Water Absorption	%	15-20
3	Efflorescence		Negligible

Table-5

Properties of Burnt Clay Bricks Using Fly Ash

S.No.	Particulars	Units	Value
1	Compressive Strength	N/mm^2	6-7
2	Water Absorption	%	16-20
3	Efflorescence		Negligible

Though the studies under the project are still underway, the following conclusions can easily be made from the data collected and the observations made so far:

1. Lime sludge, fly ash and cinder obtained as wastes from pulp and paper industry can be used for the manufacture of cement, bricks, precipitated calcium carbonate and reclaim lime by MVSK process.

2. Use of inorganic solid wastes of the pulp and paper industry as indicated above will not only solve the solid waste disposal problem but also will translate into conservation of natural resources.

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