Lime sludge reburning and reuse - A practical experience

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ABSTRACT

Lime is an important chemical being used in integrated pulp and paper industry. It is very significant not only because of cost but its impact on overall Recovery Plant operations. Lime obtained from sludge reburning in Kilns instead of procuring from other external sources shows various techno-commercial benefits, such as elemination of the disposal of solid mass and the conservation of natural resources. These benefits are critically analysed in this paper through various plant studies carried out at Century Pulp & Paper, (CPP), Lalkua where both type of lime are being used.

Lime Sludge Generation and Disposal

In paper industry lime sludge is generated in Chemical Recovery plant as shown in fig 1.

Lime sludge generated from above process can either be burnt and recycled as shown in Fig. 1 or alternatively it can be disposed off and fresh lime is to be used from other sources. A simplified lime and lime stone cycle is shown in Fig. 2.

Most of the time in closed circuits, complete lime sludge recycling is achieved except the "Purging Operations".

The frequency of purging operation basically varies with the cellulosic raw material used for pulping. In orde to get the maximum benefit the lime circuit should be totally closed as shown in Fig. 2. If the dotted line path is followed, it has many disadvantages which are explained later in this paper.

As shown in Fig.2, lime is normally used in a pulp and paper industry at three places :

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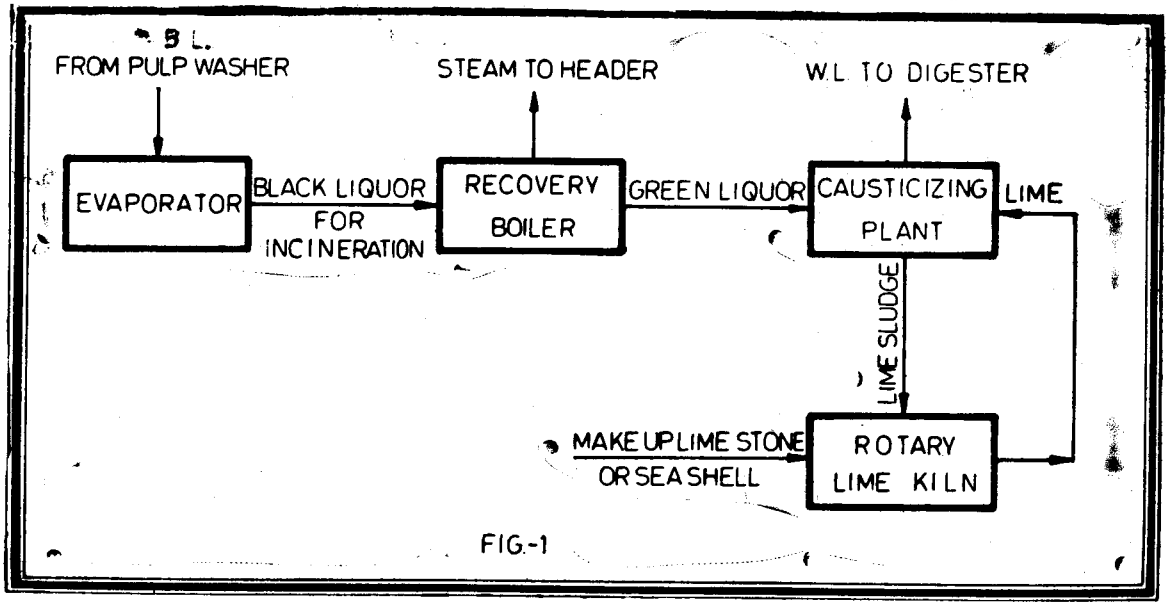


FIG.-1

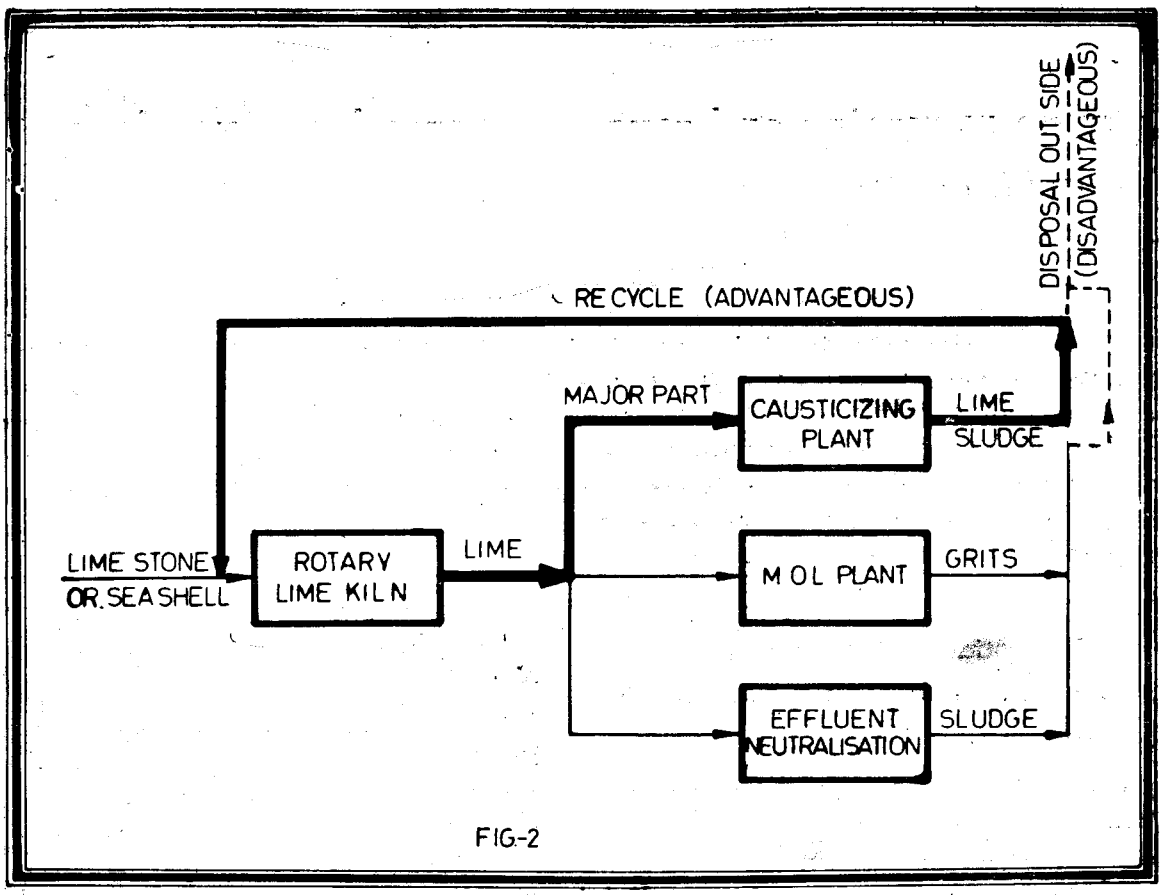


FIG-2

a) Causticizing Plant :

In this plant, the major quantity of lime is used for converting Na_2CO_3 in green liquor to NaOH. The following reactions are involved.

$$CaO + H_2O \rightarrow Ca(OH)_2, \quad \Delta H = + \qquad \ldots\ldots$$

$$Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3 \qquad \ldots\ldots$$

$CaCO_3$ generated in above reactions is normally called lime sludge and only this lime sludge can be re-burnt and reused. The quantity of lime sludge generated is about 200 tons (with 40% moisture) per day at Century pulp and paper, Lalkua.

b) Calcium Hypo Chlorite Preparation :

Lime is converted into Milk of lime (MOL) and then, with the addition of Chlorine gas, Hypo Chlorite solution is prepared.

c) Prehydrolysis Liquor Neutralisation :

The pH of Prehydrolysis Liquor from Rayon Grade pulp digesters remains around 3.2. - 3.4. This liquor is sent to the effluent treatment plant.

Due to its high acidity, it is a very toxic effluent. In Century pulp and paper, about 280 m³/day of 3 2—3 4 pH liquor is going to effluent treatment plant. Therefore, it is essential to neutralize this liquor in effluent treatment. Lime being alkaline in nature is used as MOL fot this purpose.

There are following methods for handling/disposal of Lime Sludge generated in causticizing plant.

i. Lime sludge reburning and recycling.

ii. Land filling near the industry,

iii. Draining after dilution in the nearby rivers/Nalas.

If lime sludge is disposed as per point (ii) and (iii) mentioned above, it creates many problems in present context. Few of them are listed below :

i. If requires large areas for dumping the sludge which is not feasible as a long term measure. Moreover, the area can not be used for agricultural purposes.

ii. If disposed off in rivers and Nalas, it creates water pollution and reduces depth (effective) of the rivers and nalas due to settling characteristics.

iii. In case of dumping this solid effluent, heavy non-productive expenses for transporatation occurs.

Scheme of Reburning Lime Sludge :

Most pulp and paper mills which are having lime sludge reburning kilns adopt the process shown in Fig. 3.

Rotary Lime Kiln at CPP, Lalkua is having following important technical specification & operating conditions ;—

1. Make : GRASIM
2. Capacity : 70 T.P.D.
3. Product Lime Purity : 80 ±2%
4. Make up lime stone consumption : 15%
5. Kiln speed :
   a) Minimum : 0.43 rpm
   b) Maximum ; 0.9 rpm
6. Lime sludge composition : (Average Fig)
   a) Moisture : 35 ± 2%
   b) $CaCO_3$: 86 ± 2%
   c) R_2O_3 : 2 ± 0.5%
   d) Free Alkali : ∠ 1%
   e) Free CaO : ∠ 1%
7. Lime Stone composition
   a) $CaCO_3$: 92 ± 2%
   b) MgO : 2 5 ± 0.5%
   c) Acid Insoluble : 1 ± 0.5%
   d) R_2O_3 : 2 ± 0.5%
   e) Inerts : 1.5 ± 0.5%
8. Specific oil Consumption :205kg/Ton product lime.
9. Specific power consumption : 35 Kwh/Ton product lime.

Performance Comparison of Fresh Lime V/S Recycled Lime

The current practice in most of the large pulp and paper mills, has been to dispose off the lime sludge as it is considered more economical than to burn for recycling. The present investigations have been made to analyse the impact of use of reburnt lime as against fresh lime and establish the techno economic advantages and disadvantages. The comparison is based on the following aspects ;—

1. Slaker and Causticizers
2. Clarification

For above comparisions, the studies at plant level were carried out with both type of limes being used.

Lime Quality

The process evaluation shows that the purchased lime quality is quite non-uniform. Surprisingly, the quality changes from time to time even for the same lot. Normally CPP is getting lime purity in the range of 60% to 76% as available CaO. Non-uniformity in lime quality badly affects the causticizing process in

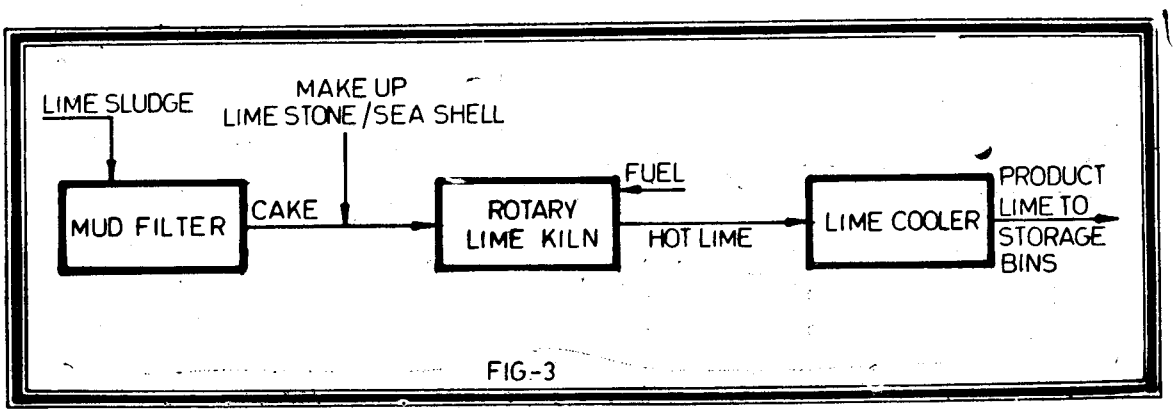


FIG-3

terms of chemical losses, sharp variations in white liquor quality, higher consumption of lime and equipment breakdown etc.

Except few instances, normally CPP is getting reburnt lime purity in the range of 80± 2% available CaO. The higher purity with uniform quality offers greater operational advantages with lesser equipment breakdown.

Effect on Lime requirement

The study was carried out in the plant with various lots of purchased lime. There are two combination type EIMCO-KCP make Slakers at CPP. Table 1 and 2 show the results obtained with purchased and reburnt lime.

The trend of bath the studies is shown in Fig. 4 where the lime quantity required has been plotted as function of green liquor (G.L.) flow rate. For accuracy in comparision, the data were collected at a causticizing efficiency which was nearly constant. Fig 4 clearly indicates that the lime consumption is higher in case of purchased lime for a given green liquor processing rate.

Effect on Chemical losses with Grits and Stones

During above trials, various stones and grits from the discharge of cambination slaker were evaluated. Table 3 and 4 give the results with purchased lime and reburnt lime respectively.

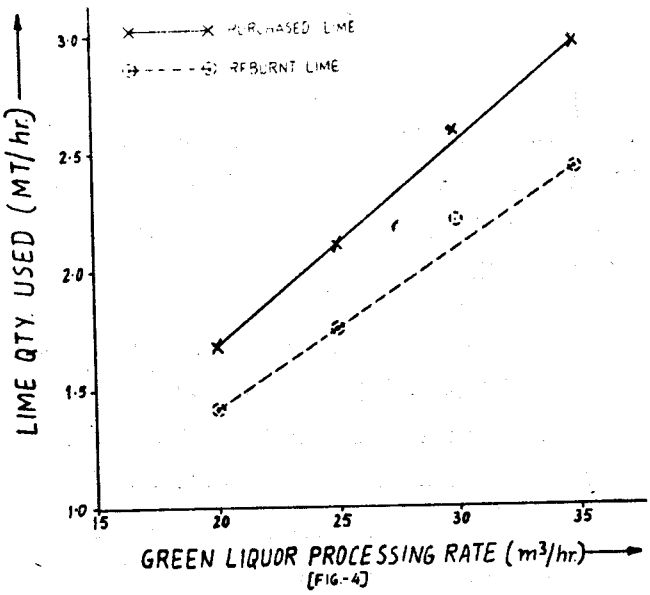
Table—1. Results obtained with purchased lime.

Sr. No.	Lime purity at Table feeder (%)	GL Concentration Slaker inlet (°TW)	Slaker outlet (°TW)	GL processing rate (m^3/hr)	GL Temp (°C)	Lime Qty. (MTPH)
1.	73	24	34	20	92	1.680
2.	74	23	32	25	96	2.100
3.	69.5	23	34	30	95	2.584
4.	70.1	23	34	35	95	2.950

Table—2 shows the results of data collected with reburnt lime.

Table—2 Results obtained with reburnt Lime.

Sr. No.	Lime purity at Table feeder (%)	Slakar inlet (°TW)	Slakar outlet (°TW)	GL Processing rate (M3/hr)	GL Temp (°C)	Lime Qty (MTPH)
1.	80.4	23	30	20	94	1.420
2.	79.0	24	32	25	96	1.760
3.	82.0	23	31	30	95.	2.200
4.	81.0	23	31	35	95	2 420



(FIG.-4)

The quantity of Grits/Stones produced is higher in case of purchased lime in comparison with the reburnt lime. However, the Plant trials revealed that free alkali and free CaO in grits and stones produced in both the cases are more or less the same.

The quantity of stones and grits produced as a function of GL processing rate is shown in Fig. 5 which indicates that the amount of stones and grits produced in case of purchased lime is significantly higher and also carries with it free alkali and free CaO. This factor is attributing to the higher chemical losses in spite of approximately similar grits and stones analysis in both the cases-

Effect on steam consumption

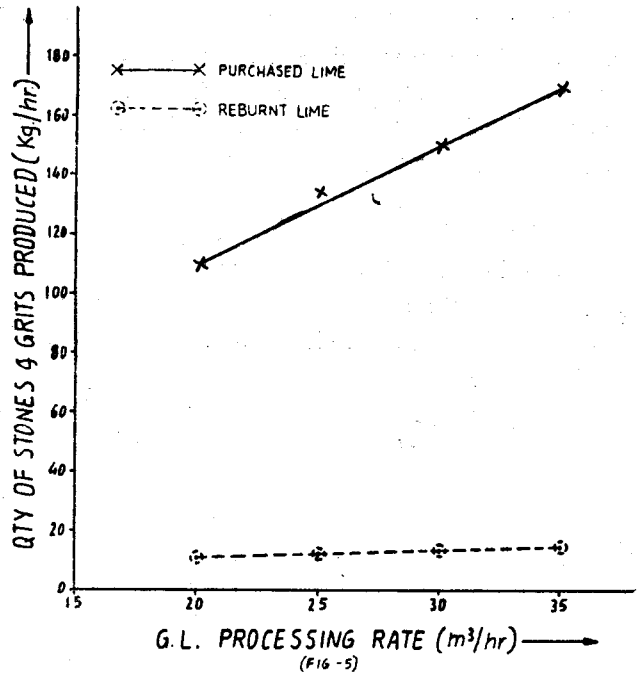
In order to compare steam consumption data in both the cases attempts were made to maintain simi-

Table–3. Results with purchased lime.

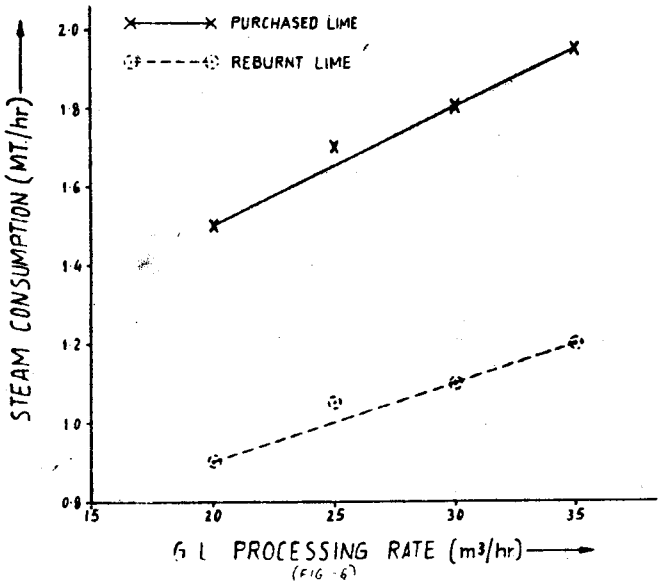
Sr. No.	GL processing rate (m^3/hr)	Quantity of Grits & Stone produced (kg/hr)	Alkali in Stone and Grits (%)		Free Cao in Stone & Grits (%)	Moisture (%)
			Total	Free		
1.	20	110	1.86	0.82	1.21	29.0
2.	25	135	2.24	1.01	0.98	20.36
3.	30	150	2.17	1.12	0.96	24.81
4.	35	170	2.11	0.92	0.84	20.12

Table–4. Results with reburnt lime.

Sr. No.	GL processing rate (m^3/hr)	Quantity of Grits & Stone produced (Kg/hr)	Alkali in Stone and Grits (%)		Free Cao in Stone & Grits (%)	Moisture (%)
			Total	Free		
1.	20	11	2.42	1.20	0.95	31.7
2.	25	13	2.19	1.04	1.02	26.1
3.	30	14	2.31	0.96	0.90	23.2
4.	35	15.2	1.81	0.80	0.80	24.1



(FIG -5)



(FIG -6)

lar conditions. In terms of causticizing efficiency, GL temperature etc. Steam flow was measured by a steam integrator. Table 5 shows the results obtained with purchased as well as reburnt lime.

Steam consumption as a function of GL Processing rate is shown in Fig. 6. Normally GL Temp. at slaker inlet was maintained at about 95°C during trials. Steam consumption for both the studies may not be same due to temperature difference in reburnt lime and purchased lime at Table feeder.

Clarification

The clarification which is dependent on setting rates was also studied. During the above trials the over flow from 3rd. stage causticizer going to clarifier was collected. These samples were subjected to batch sedimentation studies in the laboratory. The results are given in Table 6. in measuring cylinder.

Table—5

Sr.	GL Processing rate (m³/hr)	GL Temp. at Slaker inlet (°C)	Steam consumption Purchased lime (TPH)	Steam consumption Reburnt lime (TPH)
1.	20	94	1.5	0.9
2.	25	96	1.7	1.05
3.	30	95	1.8	1.1
4.	35	95	1 95	1.20

Table–6

Sr. No.	Time (Minutes)	Height of interface from bottom in measuring cylinder	
		Purchased Lime (ml)	Reburnt Lime (ml)
1.	1	970	880
2.	2	930	790
3.	3	910	710
4.	4	860	630
5.	5	820	600
6.	6	790	565
7.	7	760	520
8.	8	730	505
9.	9	715	480
10.	10	700	460
11.	11	670	440
12.	12	665	400
13.	13	650	390
14.	14	640	370
15.	15	630	360
16.	16	615	350
17.	17	610	335
18.	18	605	330
19.	19	605	330

The setting 'characteristics have been compared in Fig.7

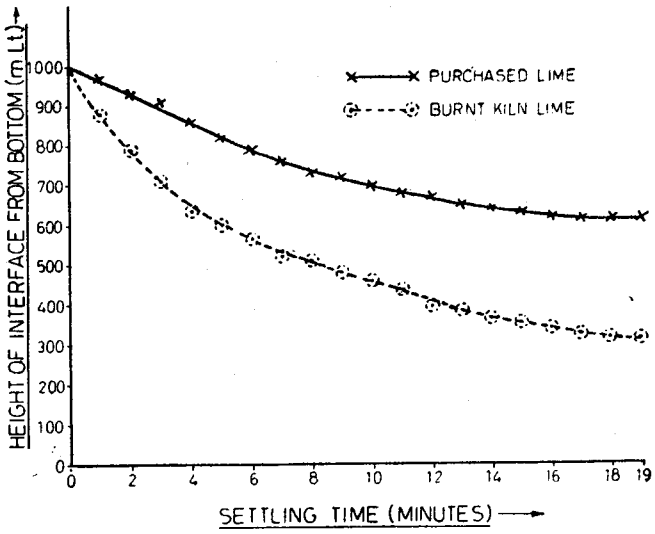


FIG. 7

The nature of curve clearly indicates that the settling characteristics in WL slurry with reburnt lime are superior to those of purchased lime.

Economic Evaluation of both the Alternatives

Case I — Use of Fresh Purchased lime

Basic - 1 Tonne lime		**Amount (Rs.)**
i) Purchased cost	;	Rs 925.00
ii) Packing & forwarding	:	Rs 125.00
iii) Transportation cost	:	Rs 513.00
iv) Taxes and duties	:	Rs 42.00
v) Unloading and feeding	:	Rs 30.00
vi) Overhead cost due to disposal of sludge	:	Rs 42 00
Total	:	1,677.00

Case - II – Use of Reburnt lime with Make up

Base - 1 Tonne lime

a) Manufacturing cost	**Amount (Rs.)**
i) Cost of fuel (RFO)	840.50
ii) Cost of power	75.00
iii) Cost of make up lime stone	110.00
iv) Cost of labour	8.00
v) Cost of maintenance	90.00
vi) Overhead cost due to disposal of purge.	6.00
b) Capital Investment	
i) Depreciation @ 11.31%	122.50
ii) Interest on Capital @ 18%	195.00
Total	1,447.00

The above cost camparison shows that the lime obtained after lime sludge reburning is approx. Rs 230/— per tonne cheaper as compared to the purchased lime on the basis of current prices at Century Pulp & paper.

This analysis does not include the advantages obtained by Lime sludge reburning in terms of better environmental management and conservation of resources.

Conclusion

From the above study and experience, following are the advantages in favour of Lime sludge reburning in a kiln.

1. Natural resources conservation.
2. Elimination of major solid effluent disposal problem.
3. Assured lime availability with better quality.
4. Reduction in lime requirement.
5. Lower Chemical losses and steam consumption.
6. Lime availability at a cheaper price.
7. Better white liquor quality even with lesser clarifier areas.
8. Better environmental management.
9. Sustainable lime production in future can only be assured by conserving non-renewable natural resources.

The success of recycling lime sludge depends essentially on purity of lime obtained after reburning. It is expected that in an efficient system, lime quality should improve after each recycle.

Any deterioration in purity particularly with respect to increased silica is an indication that silica is entering into the system at some points other than the reburning of lime sludge. The catch to this is primarily in the preparation of raw material and to some extent in the quality of make up lime stone.

Acknowledgement

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