

A CASE STUDY IN LIME PRODUCTION

TRADITIONAL TECHNIQUES IN SRI LANKA

There is a long history of production and use of lime in Sri Lanka. Its main use has been as a cementing agent and as a decorative whitewash in the building industry. In recent years the demand for lime has increased. It is now also used for water treatment, in the sugar industry, for agricultural purposes and in other miscellaneous applications such as road stabilisation. However, traditional methods of lime production are still very much in evidence and few attempts have been made to improve upon these methods, for example by improving the kiln design.

Coral and shell deposits, the raw materials traditionally used for lime production, are mainly confined to the south-western and southern coastal belts of the island. In the central hill country lime is also produced by making use of dolomite deposits. Dolomite is a type of limestone containing a proportion of magnesium carbonate ($MgCO_3$) as well as calcium carbonate ($CaCO_3$).

The demand for lime in Sri Lanka is mainly in the urban areas. Very large quantities of lime are transported to Colombo daily.

This case study illustrates the traditional techniques adopted for the production of lime hydrate in Sri Lanka and compares the methods used with dolomite and coral as the raw materials. The present state of the lime industry has been studied by a number of organisations including Intermediate Technology Development Group, Industrial Development Board, Ceramic Research and Development Centre and Institute for Construction Training and Development. Their findings reveal that coral and shell deposits are being exhausted rapidly and an alternative raw material for lime production has to be identified as well as technologies introduced for the establishment of energy efficient lime kilns due to a scarcity of fuelwood in most areas. The State has also banned the mining of coral within 300m inland of the high water mark on the coast and for a distance of 2km offshore because of severe coastal erosion. The results of studies to improve the efficiency of lime burning in Sri Lanka are described in another case study in this series.

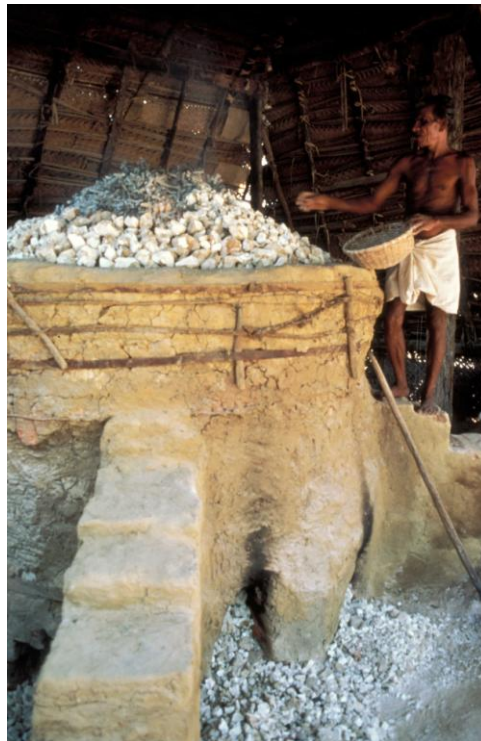


Figure 1: A traditional kiln.
Photo credit: Practical Action

Raw materials and quarrying techniques

In Sri Lanka limestone occurs in various forms, including:

- Miocene limestone (over 95% CaCO_3)
- Coral (over 95% CaCO_3)
- Shell (over 95% CaCO_3)
- Dolomite (MgO (variable 8% -21%))
- Calcite (CaCO_3 (100% pure))

Miocene limestone is mainly consumed in the cement industry. Calcite: is limited in its occurrence and is used in the ceramic industry. Shell, coral and dolomite are used for lime production. However, it is estimated that coral and shell deposits will be exhausted in 8 to 10 years time. Dolomite deposits and the Miocene limestone would eventually have to be the raw materials for lime manufacture.

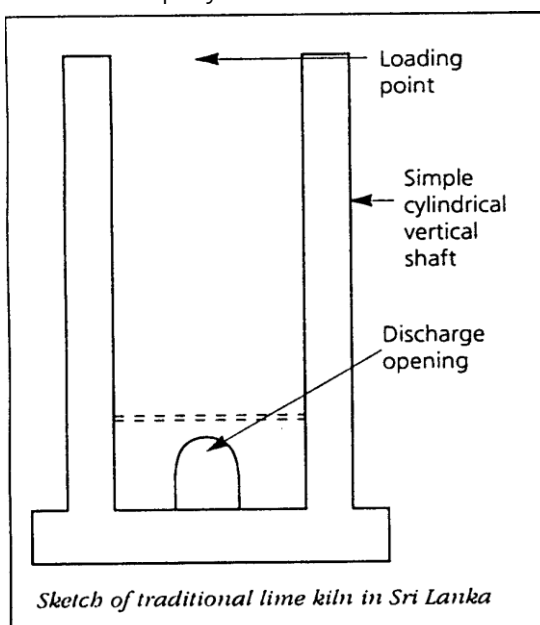
Coral and shell occur in the size range which can be directly used in kilns. Dolomite, which is used in the hill country, is readily accessible, but needs to be quarried and broken down to lumps of the required size. It is extracted manually using crowbars, picks and hammers. Large boulders are blasted by using dynamite. The dolomite is then broken down by hammer to a kiln feed size of 50-80mm diameter. This part of the activity is mostly done by women.

In recent years lime and brick producers have experienced very great difficulties in obtaining suitable fuelwood for burning in their kilns. The State has imposed a series of rules and regulations on the transport of fuelwood due to rapid deforestation in all parts of the island. The scarcity of fuelwood and calcareous raw materials (coral and shell) has resulted in considerable increases in the price of lime.

The kiln and firing methods

The main type of fuelwood used is the trunk of the coconut palm cut into lengths of about 75cm. Coconut palm leaves, husks and coconut shells are normally used to start the fire in the kiln.

One of the largest concentrations of the lime industry is at Akurala located 88 km south of Colombo. Coral is used as the raw material. A typical kiln at Akurala has a cylindrical inner wall which ranges in diameter from about 1 to 1.5 meters. The height ranges from 2.5 to 3.0 meters. The kiln is constructed with normal cottage type clay engineering bricks set in a lime clay mortar. The firing openings are at the bottom of the kiln. The kiln is charged with alternate layers of fuelwood and limestone (coral). At the base are placed fuelwood and other materials to rapidly initiate a fire. For each batch about 1.5 to 3 tons of coral are used



together with around 0.75 to 1.5 tons of fuelwood. The kiln is ignited and allowed to burn for approximately 48 hours and then cooled to recover about 0.75 to 1.5 tons of quicklime (CaO). Discharging is carried out from the bottom. Batch type kilns are normally used to burn coral and shell. Depending on capacity, the output of the kilns varies considerably.

In the hill country the greatest concentration of the lime industry is in the Matale area, with dolomite as the raw material. The kilns are of the continuous type and are taller than the kilns in the coastal area. They are 3.0 to 3.5 metres high with an inner diameter of 1 to 1.5 metres. About 2 tons of dolomite is loaded into these kilns alternating with fuelwood (coconut palm trunks), and daily a ton of

quicklime is recovered from the bottom with stone and fuelwood continuously being replenished at the top.

Although lime producers in the Akurala and Matale areas claim that the percentage of unburnt material is around 5 per cent, observations reveal that it could be as much as 10 per cent or more. The amount of fuelwood used also varies considerably and observations made reveal that the quantities used are much more than is claimed.

Hydration of quicklime

Most of the quicklime taken from the kiln is of a reasonable particle size for hydration. In any case there is a fair amount of air slaking before the actual slaking operation is carried out, which is done by pouring water over a fairly large pile of quicklime which is then mixed manually with a shovel. The hydrated lime is then sieved to remove the larger lumps of lime which have not hydrated properly before the product is bagged.

No milling is undertaken because the building industry and other users of lime are satisfied with the product in this state, and to keep the processing costs low. The average calcium oxide content by mass in lime samples from the Akurala area is 58 per cent and in dolomitic lime samples 43 per cent. The magnesium oxide content by mass in the Matale dolomitic samples of lime is around 26 per cent.

Mode of operation

Production in the Akurala area is on a batch basis with the recovery of about a ton of lime each day. Kilns are fired depending on the availability of coral, which is getting more scarce each day. Lime is normally sold by the ton, although units of 50kg and 25kg are also available. In the Akurala area there are over 40 families producing lime. In recent years, due to non-availability of coral the number of lime producers has been decreasing fast.

With production of dolomitic lime it should be noted that in dolomite the magnesium carbonate (MgCO_3) components dissociates to magnesium oxide (MgO) at around 775°C . The dolomite when heated to 900°C , the lowest temperature normally used to break down the calcium carbonate (CaCO_3) component to calcium oxide (CaO), will produce MgO which is over-burnt and not readily converted to the hydroxide, $\text{Mg}(\text{OH})_2$. If this material is used without allowing the hydration to be completed, blistering of plasters can occur if used for plastering walls. If the dolomite lime is to be used for mortar it need only be kept for about three days after slaking. Masons and plasterers claim that dolomitic lime should be added to water and not water to dolomitic lime for satisfactory results and kept for as long a period as possible.

Comments

Traditional small-scale artisanal techniques of lime production have the following advantages.

- Small-scale lime industries of the traditional type form a significant segment of the economy. Collectively they represent the entrepreneurial ability of the local people.
- The capital costs involved in production are minimal; they are labour intensive and geared to supply local requirements.
- The batch method as practised in the coastal areas is flexible and suited to availability of raw materials and to the fluctuating market demand.

The disadvantages may be listed as follows:

- Due to coastal erosion the State has banned the mining of coral close to the coasts for lime burning and so this is difficult to obtain. Removal of inland coral deposits, which is still being done, has resulted in large areas becoming flooded with water. These ponds are now a serious environmental hazard.
- The batch method of production in the Akurala area in traditional type kilns is not energy efficient. This practice of lime burning dates back over 80 years.

- The difficulties of obtaining fuelwood continue. The requirement of a permit to transport wood of any kind has resulted in appreciable price increases including an artificial scarcity of wood for lime burning.
- Although lime producers claim that the calcining efficiency of their kilns are fairly satisfactory (over 85% being converted to quicklime) observations reveal that fuelwood used for burning is considerably in excess of what is required.
- Due to inefficient slaking methods the quicklime is not fully hydrated. Because of a high demand for the product the hydration stage is often rushed to get the product to the market as quickly as possible and so is not allowed to run to completion.

There seems to be an attitude among lime users that availability is more important than quality. Although the quality of lime produced from coral is usually fairly satisfactory, it in no way approaches that required for the chemical and other industries. The bulk of the lime produced by traditional lime producers is consumed by the building trade.

Information at a glance

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| Type of kiln | Traditional, vertical shaft, cylindrical |
| Capital costs | Very low |
| Mode of production | Akurala area – small batches of coral $\frac{3}{4}$ to 1 $\frac{1}{2}$ tons per batch Hill country – continuous 1 $\frac{1}{2}$ tons a day quicklime |
| Running costs | Very low |
| Type and quality of limestone | 42% of available lime |
| Type and quantity of fuel | Trunks of the cocoanut palm and other types of wood about $\frac{1}{2}$ ton per batch of 1 ton of coral |
| Fuel efficiency | Low |
| Conversion rate CaCO_3 TO CaO | 58% |
| Hydration | Manual |
| Sieving/classification | Manual |
| Quality of lime produced | 42% of available lime |
| Principal market | Mainly building construction |
| Number of persons employed (including quarrying) | 2 full-time, 3-4 casual at Akurala Hill country (dolomite) – 2 full-time, 8-10 casual |

References and further reading

- [Lime - An Introduction](#) Practical Action Technical Brief
- [Hydraulic Lime - An Introduction](#) Practical Action Technical Brief
- [Methods for testing lime in the field](#) Practical Action Technical Brief
- [How to calculate the Energy Efficiency of Lime Burning](#) Practical Action Technical Brief
- [Testing methods for pozzolanas](#) Practical Action Technical Brief
- [Lime Kiln Designs: Small & Medium Scale Oil Fired Lime Kilns](#) Practical Action Technical Brief
- [A Small Lime Kiln for Batch and Continuous Firing](#) Practical Action Technical Brief
- [The Small Scale Vertical Shaft Lime Kiln: A practical guide to design, construction and operation](#), Kelvin Mason, Practical Action Publishing, ISBN 9781853394652
- [Small-scale Lime-burning: A practical introduction](#) Michael Wingate, Practical Action Publishing, ISBN 9780946688012
- [A Case Study in Lime Production No2 Improved Techniques at Chenkumbi, Malawi.](#) Practical Action Technical Brief
- [Lime and Alternative Binders in East Africa](#) Elijah Agevi et al, Practical Action /ODA, 1995
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- [*Building with Lime: A practical introduction. Revised Edition*](#) Stafford Holmes & Michael Wingate, Practical Action Publishing, 2002/3 ISBN 9781853395475
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- [*How to Build a Small Vertical Shaft Lime Kiln*](#) Practical Action Technical Brief
- [*Pozzolanas - An Introduction*](#) Practical Action Technical Brief
- [*Pozzolanas - Calcined Clays & Shales, and Volcanic Ash*](#) Practical Action Technical Brief
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- [*Lime Production: Traditional batch techniques in Pattará, Costa Rica*](#), Practical Action Technical Brief
- [*Lime Production: Traditional batch techniques in Chenkumbi*](#), Practical Action Technical Brief
- *Lime in Industrial Development -a UNIDO guide to its uses and manufacture in developing countries*, Sectoral Studies Series No. 18, UNIDO, Vienna, 1985.
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