



A CASE STUDY IN LIME PRODUCTION

A TRADITIONAL KILN AT BOU NOURA, ALGERIA.

Introduction

For developing countries the production of their own cementitious binders is of great importance. The binders are essential components in all types of construction, but the cost of some binders represents a very high expense for low-income communities. Countries which need to import Portland cement lose valuable foreign exchange and the import of this cement can make a significant contribution to the building up of a trade deficit.

In Algeria a positive development in recent years has been a large increase in the use of lime in the building industry. This has been especially marked in the south of the country, which represents 70 per cent of the area of the whole of Algeria.

In the Ghardaia region, which is located about 600 kms south of Algiers, traditional methods of lime production are still used extensively. This case study describes an example of the traditional technique for quicklime production. Specific details are given about a plant at Bounoura, which is 10 kms from Ghardaia city.

Raw materials and quarrying techniques

The raw materials come from the Berriane-Metlili Hills situated close to the lime production site. The deposits vary considerably in chemical composition between those with a relatively low calcium carbonate content in Berriane and Metlili, where nevertheless two industrial lime plants have been established, to those of almost pure calcium carbonate rocks at the Bounoura site.

Quarrying at Bounoura is carried out by drilling, and also with picks and crowbars on the surface. The stones are then broken down by hand using hammers. For the smaller size of stones final crushing to the size required is often done in a hammer crusher. Once broken, the stones are taken to the kiln site one kilometre away by a truck.

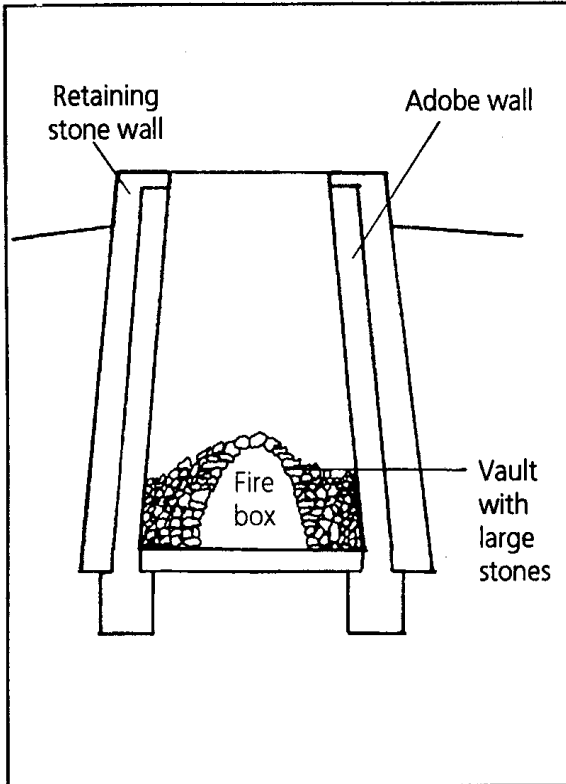
The kiln and firing method

There are three adjacent kilns on the lime production site at Bounoura. They can be fired together but it is more usual to fire them separately. By firing the kilns in rotation it is possible to economise slightly on the amount of fuel used because there is limited heat transfer between the kiln being fired and an adjacent kiln.

The lime kiln is an adobe (mud block) construction. Stone walls surround the adobe to give structural support. The kiln is of the funnel box type and is four metres high.

The diameter at the base is around three to four metres and two to three metres at the top. The wall thickness is approximately 40 cm at the front and the sides.

A stone retaining wall supports the backfilling around the kiln. The backfilling provides additional insulation and acts as a ramp to allow a truck to be driven to the top of the kiln for loading the stone. This wall is constructed in ashlar stone with a clay mortar, its thickness varies between 80 cm at the base to 40 cm at the top, and the height is approximately 4 metres. In the lowest part of the kiln a door of 1.2m width and 1.8m height allows access for the oil burner and afterwards discharge of the burned lime. When loading the kiln an arch of larger stones is made around the opening where the burner will be placed (see diagrams) so that a large empty space exists for the burner flame to pass through.



Once the stones are arranged, the burner is placed at the middle of the door in order to fill the gap, then the firing process begins. This requires 8000 litres of light fuel oil per batch.

Oil is delivered to the burner through a pipe leading from the oil storage container. The pipe leads to a chamber through which compressed air from a compressor is passed.

Figure 1: Building the limestone vault – the first stage of charging the kiln.

This forces the oil out through a narrower pipe or nozzle where it is ignited. The oil comes out of the nozzle at a high velocity so that a flame of good length can be produced. The flash point of light fuel oil is around 65°C compared to 160°C for heavy fuel- oil so no preheating of the burner is necessary. Any lighted material will ignite the burner.

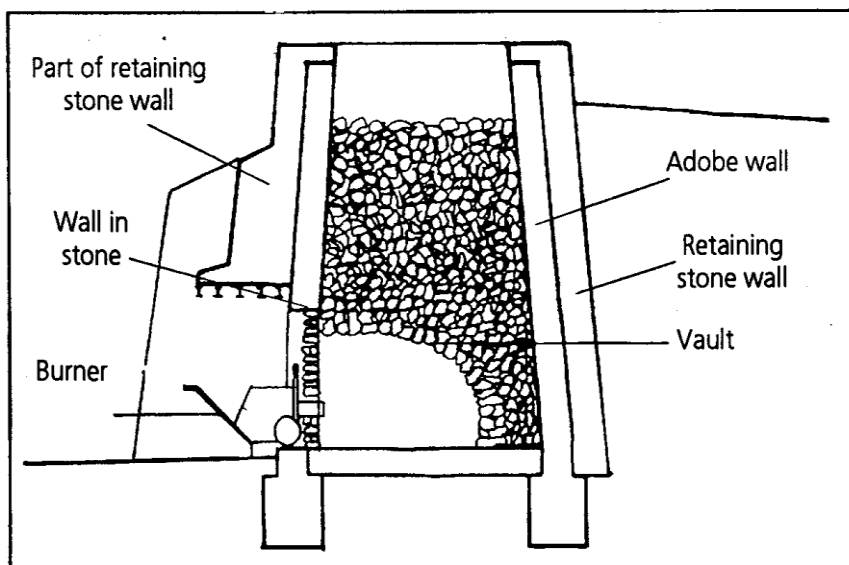


Figure 2: Kiln filled, ready for firing

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Mode of operation

Production is carried out on a batch basis with each cycle averaging 15 days. The cycle is as follows:

- 3 days for loading
(4 *persons required*);
- 3 days for calcining;
- 4 days for cooling;
- 3 days for discharging;
- 1 day for cleaning the kiln.

On average 20 batches are produced per kiln per year. Each batch consists of 22 to 25 tons of quicklime which is sold in units of 40 kgs or 50 kgs (in powder or crushed). A diesel-powered hammer mill is used to crush the quicklime to improve the efficiency of hydration. It is worth noting that little lime is produced during the hot season (summer) due to the high temperature which reduces the pace of work.

Hydration is normally done manually at the construction site. Because Algeria is a relatively hot and dry country the risk of premature hydration of the quicklime is reduced.

Comments

The present technique has the following disadvantages:

- The burner is of basic design which does not allow any control or adjustment of the flame. It concentrates the flame on the central part of the kiln, so lime in this part of the kiln tends to be overburnt and that from the sides underburnt. The temperature distribution across the kiln is far from uniform.
- With improved burner design the present efficiency of the kiln of 32 per cent could be improved.
- The quarrying methods employed are very labour intensive.
- The frequent breakdown of the truck holds up production and wastes the labourers' time.

However, there are also some advantages:

- This technique provides both permanent and casual employment opportunities.
- The capital cost is low.
- Operation of the kiln is very simple.

A fuel efficiency of 32 per cent is relatively high for a batch kiln because the kiln is well-insulated. With small improvements, such as an improved oil-burner, and by improving airflow through the kiln using measures such as addition of a chimney, the efficiency could be improved further.

Light fuel oil is clean burning and leaves no ash or soot residue on the quicklime. Unlike solid fuel, there is no solid residue from burning the oil so there is no need to have a grate at the bottom of the kiln. This makes the kiln easier and less costly to construct and simplifies kiln operation.

Information at a glance

Type of kiln	Traditional, open topped
Capital costs	Low
Mode of production	One batch per 15 days; 20 batches a year; 25 tonnes quicklime output per batch
Running costs	Medium
Type and quality of limestone	Calcium, approximately 95% CaCo ₃
Type and quantity of fuel	Light fuel-oil, 8000 litres/batch, 3072 Kcal/kg
Fuel efficiency	32%
Hydration	Manual, on construction site
Sieving/classification	Manual
Milling	Diesel powered hammer mill
Quality of lime produced	Good (average 80% available lime)
Principal market	Building construction
Number of persons employed (including quarrying)	9 full time

References and further reading

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- [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
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- [Lime Production: Traditional batch techniques in Patará](#), Costa Rica, Practical Action Technical Brief
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- [Lime Production: Traditional batch techniques in Chenkumbi](#), Practical Action Technical Brief
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