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CRI TECHNOLOGY DIGEST



**CRI VERTICAL SHAFT KILN (VSK)
MINI CEMENT PLANT
TECHNOLOGY**

CEMENT RESEARCH INSTITUTE OF INDIA

CRI VERTICAL SHAFT KILN (VSK) MINI CEMENT PLANT TECHNOLOGY

This Technology Digest places in perspective the vertical shaft kiln technology for mini cement plants, as developed by CRI, and briefly describes the process and the kiln with its essential ancillaries. It also highlights the economics of VSK-based mini cement plants which should clarify doubts, if any, on the economic viability of these plants.

APPROPRIATE TECHNOLOGY

Production of portland cement on a small scale is practised in several parts of the world employing one or the other technology. Each has a distinct set-up for burning, such as vertical shaft kiln (VSK), small rotary kiln, sinter bed-straight (like Lurgi), inverted grate, (like Reba), fluid bed kiln and belt kiln or mechanical grill. The commercial exploitation of the last four being rather limited, vertical shaft kiln and the small size rotary kiln are the only well established ones. Between these two again, since the rotary kiln may not be technically efficient and economically viable in lower capacities, CRI gave special thrust to the VSK technology for its development work in the area of small scale cement production.

By 1974 CRI had developed the basic concepts of the process and design for modern continuously operating vertical shaft kilns suited to Indian condition. On CRI being given the control of the sick plant at Muduvathur belonging to the Government of Tamil Nadu which had been idle for many years, CRI redesigned and restructured the kiln therein and conclusively demonstrated the feasibility of the VSK Technology developed by CRI. Since 1976, this 20 tpd plant has been running successfully, producing cement conforming to IS:269-1976 and has also produced high strength cement conforming to IS: 8112-1976. In addition, it has been utilised for R&D on different fuels like low volatile coal, coke breeze, *Jhama* coal, and on higher grade

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cements as also for studies on different raw materials used in the early mini cement plants set up based on CRI's technology. Having completed the necessary R&D and proving the technology, this plant has been handed over to Tamil Nadu Government (M/s Tamil Nadu Cement Corporation Ltd) since it can run as a viable industrial Unit.

THE PROCESS

CRI technology is based on the black meal process in which all the raw materials, namely, limestones, clay, fuel (coke breeze, *Jhama* coal or any suitable low volatile coal) and other corrective materials are ground together to a fineness of 10% retained on 170 mesh as in dry process and intimately blended to satisfy the chemical requirements for the raw meal. The raw meal is formed into nodules of the desired size by adding water in a pan nodulizer, and fed into the vertical shaft kiln through a revolving feed hopper. As the material passes down the kiln, it is dried, heated and then burnt into clinker. The clinker is then cooled and discharged from the kiln by a rotary grate at the bottom of the kiln through a triple air-lock discharge device. The combustion air to the kiln which is provided by a Roots blower also serves the purpose of cooling the clinker and thus avoids wastage of heat. The clinker then passes on to a cement mill where it is ground with about 5% gypsum to produce cement of standard quality.

As the chemical composition of the raw materials and the fineness of the raw meal are the critical factors in the process control of a vertical shaft kiln, the characteristics of the raw materials including fuel are evaluated with respect to their ability to form nodules of the required size, green strength, porosity, thermal stability, uniformity, etc. Apart from low volatile coal, which is mainly concentrated in Bihar besides small reserves in J&K, CRI has also been exploring the availability of coke breeze all over India. It is understood that coke breeze is available from various steel plants located at Rourkela (Orissa), Bhadravati (Karnataka), Burnpur (West Bengal), etc; FCI, Sindri (Bihar); Coal Chemicals Complex of Singareni Collieries Co Ltd, Mancherial (Andhra Pradesh); and various beehive coke ovens and merchant cokeries. Also, Leco and charfines from Neyveli Lignite Corpn (Tamil Nadu) can be substituted partially. On a rough reckoning, it can be said that fuel from these sources would be available in sufficient quantities to cater to mini cement plants throughout the country.

THE KILN

The heart of the plant is the kiln section, comprising nodulizer, shaft kiln, rotary grate and discharge gates. The entire plant can be fabricated indigenously. A general arrangement of the kiln section is shown in Figure 1. The efficiency of CRI vertical shaft kilns owes chiefly to the following main design improvements:

- 1) Control of raw meal proportioning
- 2) Nodulisation of raw meal in a nodulizer with addition of approximately 12 to 14% water
- 3) Uniform kiln charging by rotary chute on adjustable mechanism to feed nodules at any desired point
- 4) Taper shaft extension at kiln top—depending on the shrinkage characteristics of raw materials
- 5) Continuous discharge by rotary grate
- 6) Clinker discharge through triple airlock discharge gates
- 7) Higher combustion air pressures through use of totally enclosed blowers, designed for pressures exceeding 1500 mm WG
- 8) Continuous process supervision by appropriate measuring and monitoring devices.

The pan nodulizer at the top rotates at a suitable speed and inclination to form raw meal nodules of 8-10 mm with the help of a water spray. A rotary feeder at the top of the VSK feeds it while distributing the nodules evenly on the bed.

The kiln is lined with suitable refractory inside. Clinker burning takes place in the burning zone (at about 1350°C). Air blown by Roots blower from below, through the rotary grate, cools the clinker moving downwards. The rotary grate is of flat demountable type with cutter segments. Cooled clinker falls into a chute, through the grate, and discharges through a triple airlock gate device. Temperature of the discharged clinker is about 60°C.

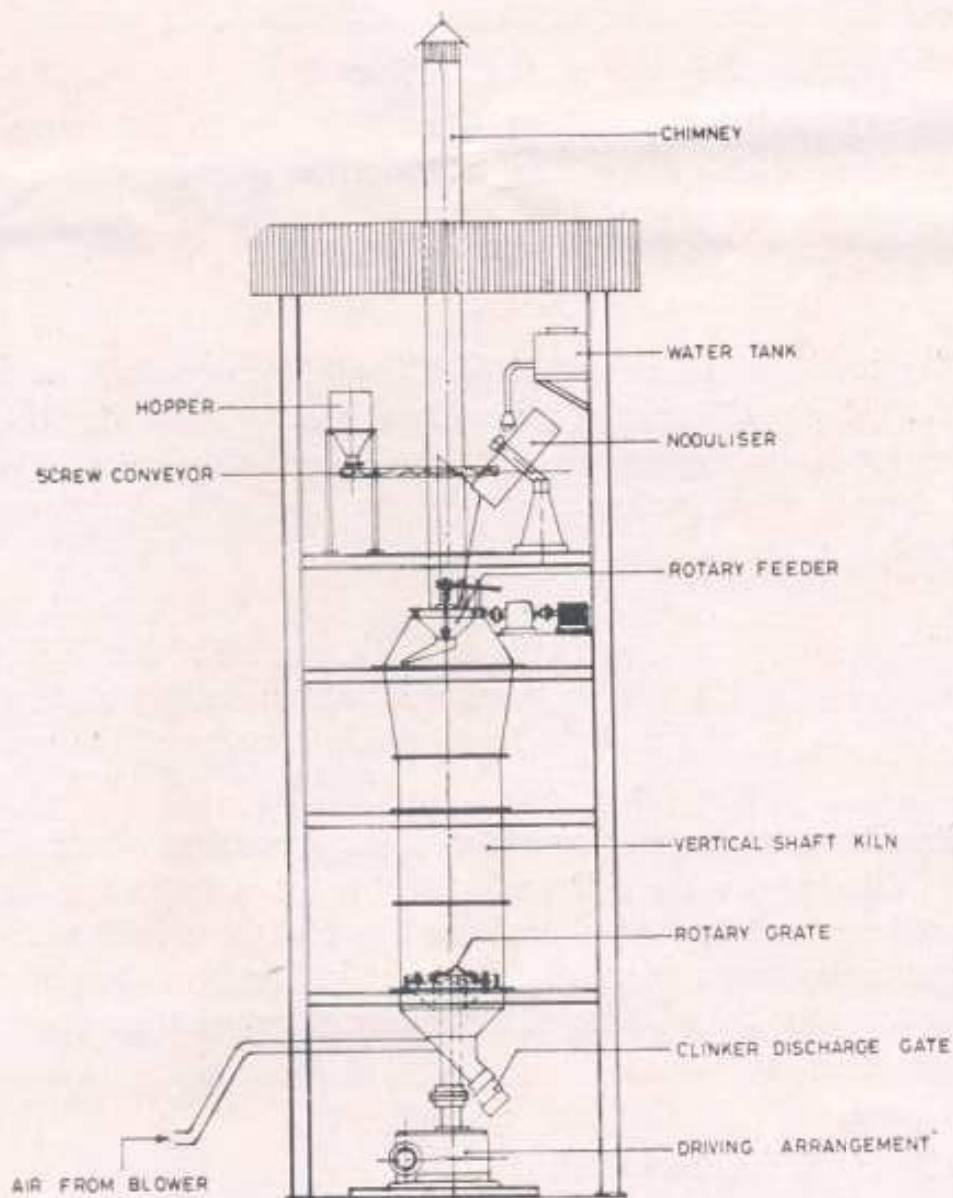


Fig 1 CRI type vertical shaft kiln

The vertical shaft kiln offers the following advantages:

- i) Low maintenance
- ii) High refractory life
- iii) Less floor space requirement
- iv) Elimination of separate coal mill and clinker cooler
- v) Porous and easy-to-grind clinker
- vi) Possibility of temporary shut downs up to 48 hours without appreciable loss of heat and material in process.

ECONOMICS

The total capital cost of CRI-VSK mini cement plants of 50, 100 and 200 tpd capacities are of the order of Rs 150 lakhs, Rs 230 lakhs and Rs 430 lakhs, respectively. CRI-VSK plants which went into commercial production further confirmed the level of capital investment required to set up such units.

The post-tax return on equity capital in respect of CRI-VSK plants varies from 40 to 60% if the cement is sold ex-factory at a price of Rs 55 per bag, and 25 to 45% if sold within a radius of 100 km.

The above figures have been worked out keeping in view the *Cement Control (Amend) Order, 1982* and other press notifications of Government of India and the Guidelines issued by the Industrial Development Bank of India to various State financial institutions. Costing norms followed are similar to those of the national financial institutions and the cement industry.

TECHNOLOGY TRANSFER

The CRI has been engaged in the development of mini cement plant for a number of years. Eleven plants based on the CRI-VSK Technology have already been set up in various parts of the country. These plants have been producing cement conforming to IS : 269-1976. The list of such plants is given in Table 1. 58 plants based on CRI-VSK technology are at present in different stages of implementation in various parts of the country.

TABLE 1**CRI-VSK Mini Cement Plants in Operation**

<i>Sl No</i>	<i>Company</i>	<i>Location</i>	<i>Capacity (TPD)</i>
1	Tamil Nadu Cement Corporation Ltd	Muduvathur Tamil Nadu	20
2	Veda Cement Industries Ltd	Hosadurga Karnataka	90
3	Lokapur Cements Pvt Ltd	Lokapur Karnataka	90
4	Sri Durga Cement Co Ltd	Ramgarh Bihar	100
5	Sandip Cements Pvt Ltd	Mahuva Gujarat	100
6	Penden Cement Authority	Gomtu Bhutan	50
7	Parasuram Cements Ltd	Tezu Arunachal Pradesh	30
8	Prominent Cement Pvt Ltd	Malanpur Madhya Pradesh	100
9	Katwa Cement Co	Yadwad Karnataka	30
10	Kalinga Cement Ltd	Birmitrapur Orissa	100
11	Alagappa Cements	Kilapaluvur Tamil Nadu	30

CRI's RANGE OF SERVICES

CRI assists interested entrepreneurs right from the preparation of feasibility reports to commissioning of the plant. It has tied up with

a number of machinery manufacturers throughout the country for supply of CRI-VSK mini cement plants on turnkey basis. Except for administrative formalities, which are left to the entrepreneur to complete, CRI provides technical assistance at all stages covering plant location, raw materials investigations, layout finalization, equipment selection, inspection of fabricated equipment, erection and start-up and trouble shooting, setting up of laboratories, and training of personnel for VSK mini cement plants.

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