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CRI TECHNOLOGY DIGEST

CEMENT RESEARCH INSTITUTE OF INDIA

CRI VERTICAL SHAFT KILN (VSK) MINI CEMENT PLANT TECHNOLOGY

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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 developmental 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 In addition, it has been utilised for R&D on different fuels like low volatile coal, coke breeze, *Jhama* coal, J&K coal, and on higher grade cements as also for studies on different raw materials used in the early mini cement plants set up based on CRI's technology.

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 (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 of 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.

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.

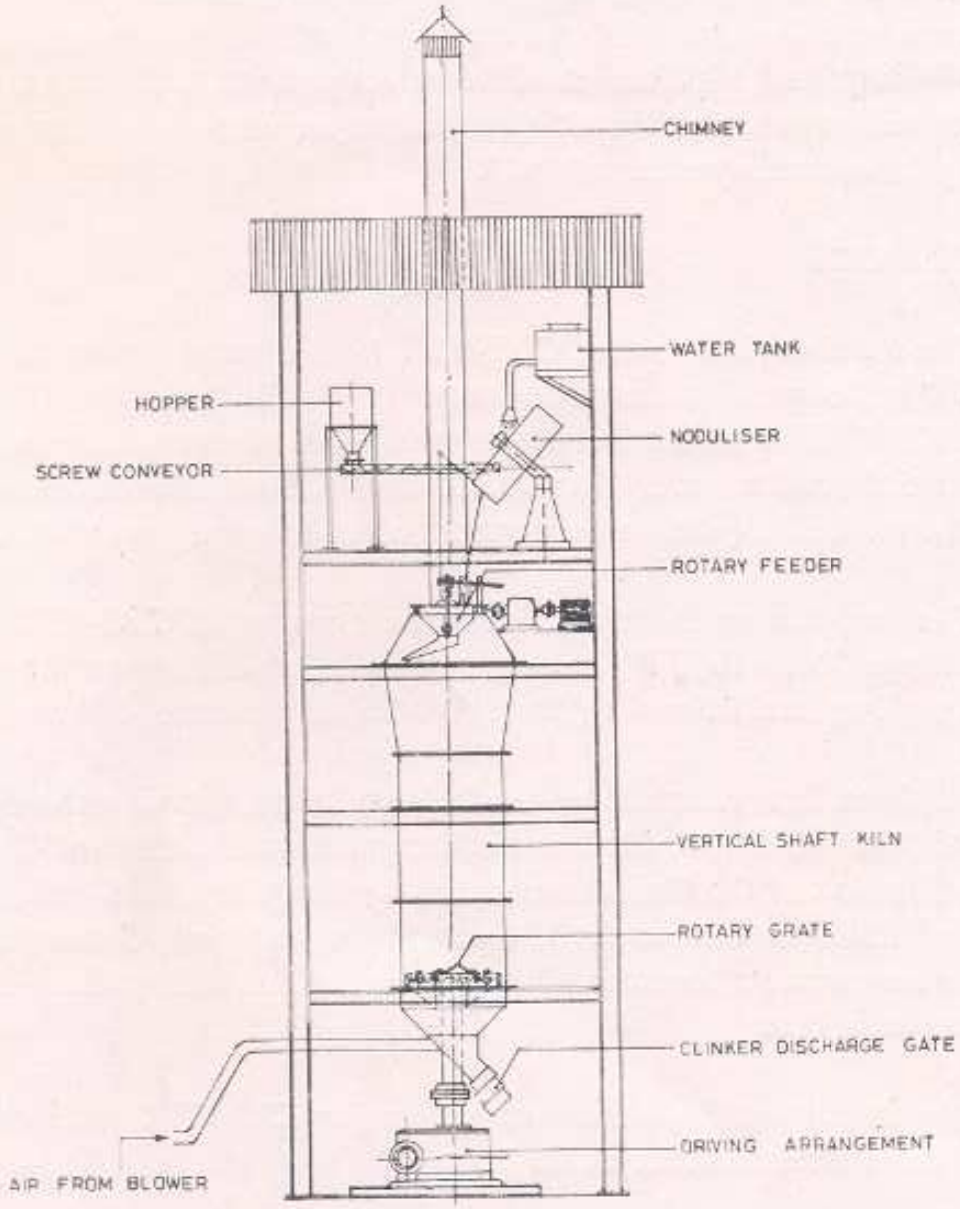

Fig 1 CRI type vertical shaft kiln

CRI TECHNOLOGY PACKAGE

The technology proven, CRI went ahead with improving the basic layout and unit operations for optimising a plant in a commercial situation. Accordingly, CRI designed VSK plants of capacities 30, 50, 100 and 200 tpd. The technology was implemented in two commercial plants of 30 tpd capacity, decisively proving its economic viability under Indian conditions. At present, VSK plants of 50 tpd capacity are under installation and expected to be commissioned during the second quarter of 1983.

ECONOMICS

The total capital cost of CRI-VSK mini cement plants of 50,100 and 200 tpd capacities are of the order of Rs 136 lakhs, Rs 199 lakhs and Rs 380 lakhs, respectively. The two VSK plants which went into commercial production in Karnataka during 1981 have 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 30 to 50% if the cement is sold ex-factory at a price of Rs 50 per bag, and 25 to 49% for sale 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.

Some important financial parameters for CRI-VSK mini cement plants are summarised in Table 1.

TECHNOLOGY TRANSFER

Two plants were set up with CRI technology under CRI's supervision in September and November 1981 respectively at Hosadurga (60 tpd) and Lokapur (30 tpd) in Karnataka. Both have been operating successfully producing cement conforming to IS: 269-1976. Further, both are in the process of expanding the plant capacity to 90 tpd. Three

Table 1

MINI CEMENT PLANTS AT A GLANCE

1)	Capacity	Less than 200 tpd or 66000 tonnes per annum
2)	Project duration	2 years
3)	Debt: Equity	65 : 35
4)	Margin money *vs* short term loan	40 : 60
5)	Interest on long term loan	14%
6)	Interest on short term loan	19·5%
7)	Loan repayment schedule	10 annual instalments
8)	*Production level*	
	1st year	70%
	2nd year	80%
	3rd year	90%
9)	Net sales realization if sold @ Rs 50/bag	Rs 634·46/tonne
10)	Net present value if discounted @19·5% (for a 100 tpd plant)	Rs 122.19 lakhs

projects—one each at Mahuva (Gujarat) and Ramgarh (Bihar) of 100 tpd (2 x 50 tpd VSK's) and one at Tezu (Arunachal Pradesh) of 30 tpd are at advanced stages of erection and commissioning. Five more projects of 100 tpd capacity each are coming up in Gujarat, Karnataka and Rajasthan; turnkey plant orders for these have already been finalized.

CRI's RANGE OF SERVICES

CRI assists interested entrepreneurs right from the preparation of feasibility reports to commissioning of the plant. It has worked out arrangements 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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