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NCB TECHNOLOGY DIGEST

CRI-MODERN VERTICAL SHAFT KILN (MVSK) CEMENT PLANTS

National Council for Cement and Building Materials

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THIS technology digest places in perspective the modern vertical shaft kiln technology developed by NCB as early as in 1972 and first tried out in 1974. It also highlights the numerous techno-economical advantages of the CRI-MVSK technology for the manufacture of cement in small scale.

APPROPRIATE TECHNOLOGY

The various technologies which have been tried for manufacturing portland cement on a small scale are Fuller Pyzel fluidized bed process, Reba process, Travelling grate (lurgi sinter grate), rotary kiln and vertical shaft kiln.

In all these five technologies, there is an upper and lower threshold of size beyond which either it is technically not feasible or economically not viable. Downscaling of plants under any particular technology even within these threshold results in increase in investment per annual tonne of capacity installed and cost of production per tonne. So when the technical and economical threshold is reached for any given technology line, other line may still give technically feasible and economically viable results. Since the commercial exploitation of the first three being rather limited and the conventional rotary kiln being normally uneconomical below 300 to 600 tpd, NCB gave special thrust to VSK technology and by 1974 had developed the basic concepts of process and design for continuously operating modern vertical shaft kilns suited to Indian conditions. NCB conclusively demonstrated the feasibility of the MVSK technology at the Muduvathur plant belonging to Government of Tamil Nadu, after redesigning and restructuring the kiln. Since 1976, this 20 tpd plant has been running successfully producing OPC conforming to IS: 269-1976. In addition, it has been utilized for R&D on different raw materials and fuels. Since then 26 plants have come up and are under operation in different parts of the country and abroad in the capacity ranges of 20 to 100 tpd producing cement conforming to IS: 269-1976. Fifty plants based on CRI-MVSK technology are at present in different stages of implementation in India and abroad.

THE PROCESS

CRI-MVSK technology is based on black meal process in which all the raw materials namely limestone, clay, fuel (coke breeze, jhama coal or any low volatile coal) and other corrective materials are interground to a fineness of about 10% retained on 170 mesh; and thoroughly homogenised. The raw meal is formed into nodules of 8-10 mm size by addition of water in a pan nodulizer rotating at a suitable speed and inclination. These nodules are fed into Vertical Shaft Kiln lined with suitable refractory inside, through a rotary feeder which also distributes the nodules evenly on the bed. As the material passes down the kiln, it is dried, heated and 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 tripple air lock discharge device or Gamma ray controlled material block tube system. The combustion air provided by a roots blower to the kiln also serves the purpose of cooling the clinker (to about 60°C) and thus avoids wastage of heat. The clinker then passes onto a cement mill where it is ground with about 5% gypsum (preferably of about 85% purity) to produce cement.

RAW MATERIALS

The process of cement manufacture and its quality is primarily controlled by appropriate selection and evaluation of raw materials. The detailed geological investigations and proper designing of raw mix help to ensure successful operation of the plant. Raw materials used in cement manufacture can generally be divided into two groups—calcareous and argillaceous. For CRI-MVSK the calcareous component should conform to the following specifications:

CaO	more than	46%
SiO	less than	8%
MgO	less than	2·5%

Argillaceous component, usually clay, should be plastic in nature to facilitate nodulisation and good green strength of nodules. To satisfy the modulii requirements of raw meal, corrective materials like bauxite, laterite, iron ore etc may be added, if necessary. Low volatile fuel (less than 8% volatile matter) is required for cement manufacturing by CRI-MVSK technology.

The requirement of limestone reserves of different categories for various capacities of CRI-MVSK cement plants are given below:

Category of Reserves	Quantity (million tonnes)				
	30 tpd	50 tpd	100 tpd	150 tpd	200 tpd
Indicated	0·71	1·18	2·36	3·54	4·72
Inferred	0·50	0·83	1·65	2·48	3·30

INSTRUMENTATION AND PROCESS CONTROL

A particular level of instrumentation and control is usually recommended based on considerations like protection of manpower and equipment, smooth operation of plant resulting in increased production, better and more consistent quality of product and socio-economic considerations.

Keeping the above in view, the CRI-MVSK cement plants have been incorporated with simple microprocessor based instrumentation and process control system wherein all the important process parameters are continuously measured/monitored and automatic closed loop controls makes the VSK operation more efficient.

ENVIRONMENTAL ASPECTS

One of the remarkable features of CRI-MVSK cement plants is very low pollution due to its inherent design. CRI-MVSK cement plants do not cause any water pollution as no effluents are involved in the process. Even the dust emission is very low and well within the standards stipulated by the Pollution Control Board due to the very low velocities of the exit gases and the bed of moist nodules at the top of the CRI-MVSK. Moreover, a part of the CRI-MVSK chimney is designed to act as an **Emission Limitator,** which limits the dust emission conforming to even the most stringent standards under stable operating conditions.

SALIENT FEATURES OF CRI-MVSK CEMENT PLANT

Modern CRI-VSK cement plant as a compact unit incorporates the following features:

1. Efficient process control backed up by quality control measures and a fully equipped laboratory for physical and chemical analysis.

2. Microprocessor based instrumentation system has been provided to monitor all important process parameters on a continuous basis. All major system parameters are indicated and recorded.

3. In order to improve the burning process inside the VSK and to achieve higher output and better quality of product, automatic closed loop process control has been incorporated in the noduliser and VSK section.

4. Safety measures including carbon-monoxide alarm system and electrical interlocking of drives have been provided in order to protect the manpower and equipment which include a special alarm for combustion air failure to prevent any flame shoot out due to carbon-monoxide formation.

5. Continuously operated rotary feeder drive with adjustable tilt angle and adjustable height in order to achieve the desired bed profile in the VSK.

6. Automatic accurate raw material proportioning with electronic weighfeeder as optional feature.

7. Specially designed Double-Collar Noduliser with automatic closed loop control results in nodules of higher green strength due to extra-rolling action and desired size, porosity and moisture content.

8. The material block tube for clinker extraction from the VSK along with 'Gamma ray level control device' has the advantages of less air leakage, less dust and noise, lower maintenance and more efficient burning process due to reduced fluctuations in the combustion air supply.

A general arrangement of the CRI-MVSK is shown in Fig 1.

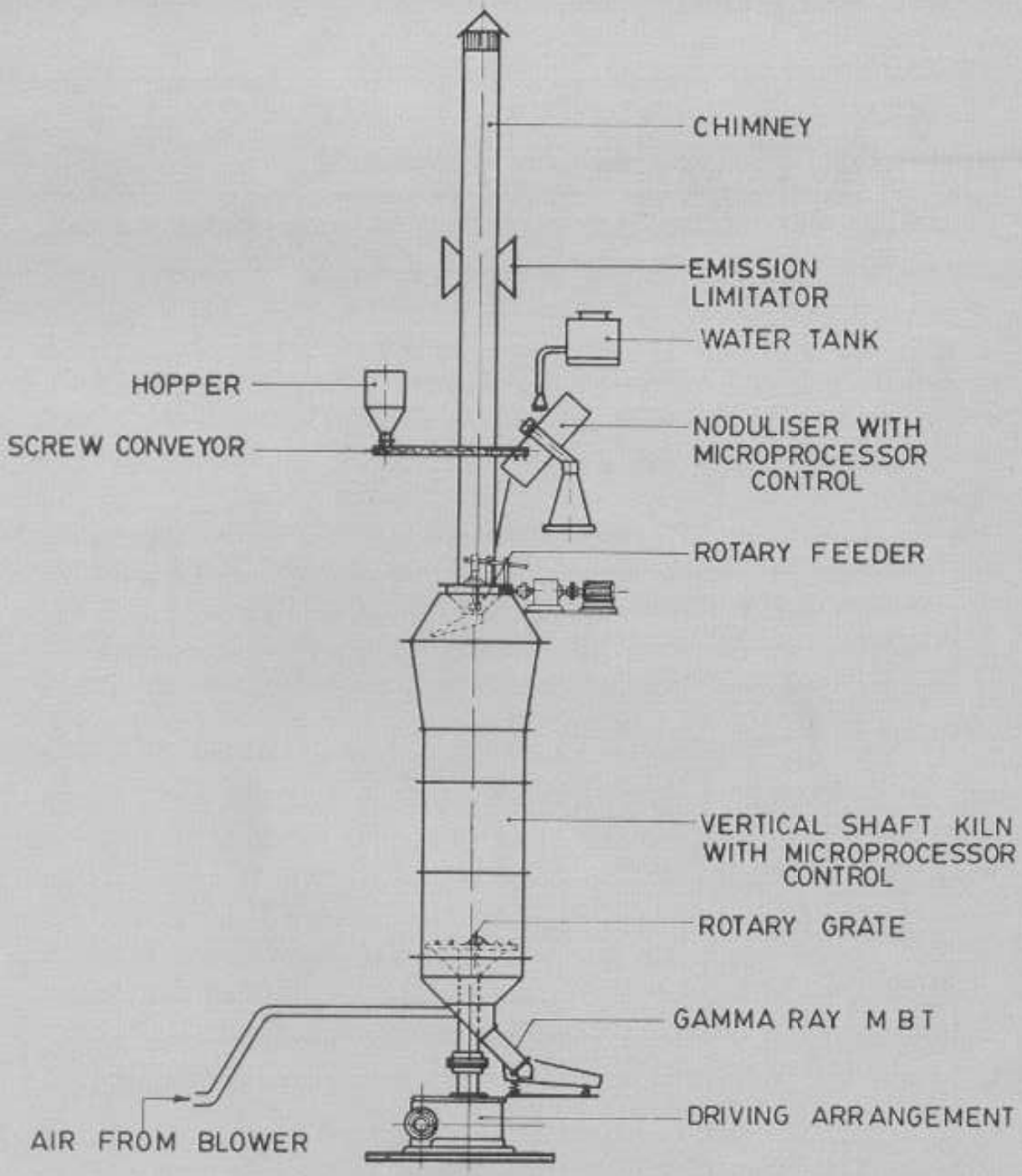

Fig 1 Modern CRI Vertical Shaft Kiln

ADVANTAGES

1. Bringing cement industry within the financial access of smaller entrepreneurs;

2. Contributing to uplifting local economy and development of remote rural areas;

3. Creating employment opportunities in rural areas on a well dispersed basis;

4. Enabling development of cement industry in terrains where movement of heavy machinery and cement is difficult;

5. Making it possible to exploit small deposits of limestone as well as limited quantities of calcarious industrial wastes;

6. Avoiding wasteful movement and thus helping to bring down the average unit cost of transportation of cement in the country as well as strain on nation's transport system;

7. Eliminating packing charges where the utilization point is localised by resorting to bulk supply;

8. Lowering the capital investment per unit of production without sacrificing quality of either the plant or the product;

9. Helping to achieve quicker return on capital invested because of lower gestation period;

10. Being completely indigenous there is no dependability whatsoever on import by way of know-how or machinery and equipment.

ECONOMICS

The total capital cost of CRI-MVSK cement plants of 50, 100 and 200 tpd capacities are of the order of Rs 170 lakh, Rs 270 lakh, and Rs 460 lakh respectively. The post tax return on equity capital varies from 20 to 54% if the cement is sold Ex-Factory at a price of Rs 60/- per bag, and 14-45% if sold within a radius of 100 kms depending upon the local situations.

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

TECHNOLOGY TRANSFER

NCB has been engaged in the development of CRI-MVSK cement plants for a number of years. NCB assists the interested entrepreneurs right from the preparation of feasibility report to the commissioning of the plant. NCB also helps in training of manpower, setting up of laboratories and trouble shooting. In addition to the above, NCB also undertakes the preparation of detailed geological maps, topographical surveys, assay plans, vertical sections, guiding in implementation of the mining legislation, safety measures and preparation of mine plans etc. With regard to the supply of plant and machinery NCB has already tied up with a number of machinery manufacturers throughout the country for the supply of CRI-MVSK cement plants on turn-key basis. In order to ensure the trouble-free operation of the CRI-MVSK cement plants over their entire life-cycle, NCB, in consultation with its licencees, has worked out detailed specifications for various plant and machinery including the quality of materials of construction to be used for fabrication, methods of fabrication etc, which are obligatory on the part of every NCB licencee to strictly adhere to. Moreover, NCB has set out standard inspection norms for all important equipment and machinery for CRI-MVSK cement plants to ensure strict quality control at every stage of manufacture.

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