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CRI TECHNOLOGY DIGEST

CEMENT RESEARCH INSTITUTE OF INDIA

CRI VERTICAL SHAFT PRECALCINATOR

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INTRODUCTION

The spectacular technological improvements that have taken place in the cement industry all over the world, have been the outcome of intensive R&D efforts aimed at developing energy-efficient, high-throughput and economically viable systems. The gradual replacement of the wet process by long dry, then by Lepol grate preheater followed by dry SP kiln and lately, by the NSP kilns is the result of such efforts. While the present trend is for large capacity dry process kilns equipped with precalcinators, the old wet process kilns continue to be in operation side by side with the modern kiln systems. However, with rising fuel prices and consequent increase in the operational costs (see Table 1), the production of cement by wet process kilns is becoming more and more uneconomic.

Efforts to improve the situation through reduction in slurry moisture by the application of slurry thinners have not proved adequate as the reduction in moisture content possible was only about 5-6 percent. Simultaneously, mechanical moisture reduction techniques had been developed to achieve substantial reduction in the moisture content of the kiln feed slurry. These techniques use filtration as the first step for removing 18-20 percent of moisture from the slurry followed by suitable treatment of the filter cake before feeding into the kiln.

THE INDIAN SITUATION

In India, there are 72 cement plants with an installed capacity of about 36·5 million tonnes per annum, of which 33 are wet process plants having 96 kilns varying in capacities from 60 tpd to 750 tpd. These together account for about 13·29 million tonnes of the total installed capacity.

Despite the fact that the country has gone for one million tonne capacity plants and a large number of mini cement plants (both VSK and Rotary), there still exists a gap between the projected demand and supply, and this gap can be bridged through modernization of the existing plants.

TABLE 1

ADVANTAGES FROM CONVERSION OF WET TO SEMI-DRY/DRY PROCESS

ITEM	PROCESS			
	Wet	*Semi-Dry*	*Dry*	
			With SP	*With SP and Calciner*
Heat consumption, (k cal/kg clinker)	1300-1600	900-1100	800-950	750-850
Power consumption, (kWh/t of cement)	110-115	115-120	120-125	120-125
Kiln output for given size (%)	100	130-150	130-150	250-300
Investment cost per tonne of annual capacity for conversion (based on 1983 prices, Rs)	—	750-950	950-1050	1150-1250

Note: The above figures give average ranges. Extreme values could, in exceptional cases, be somewhat lower than the lower limits or substantially higher than the upper limits.

The dry process plants can take advantage of precalcinator technology for increasing their capacities. CRI has developed a precalcinator (called "CRI-Precal") suiting to Indian conditions.

In the case of wet process plants, conversion, wherever feasible, seems to be the best way of modernization as it not only substantially reduces the fuel consumption/cost per tonne of cement, but also results in increased production, which together bring down the operational costs. However, the choice of a conversion system is governed by the economics, which is again dependent on the fuel economy and increase in production achievable, in addition to factors like the age and mechanical conditions of the kiln, its tyres and supporting rollers and the strength of the piers, the raw material availability, the surplus capacity in the balancing units and the extent to which these have to be supplemented.

Keeping in view the pros and cons of the available conversion technologies, CRI has been endeavouring to develop economically more attractive alternative technologies and vertical shaft precalcinator (VSP) technology is one such.

CRI's R&D WORK

The VSP is essentially a countercurrent moving bed reactor (Fig 1) wherein the raw mix nodules/pellets entering at the ambient temperature (or preheated in a drier integrated with the system) come in intimate contact with hot gases drawn from the kiln at a temperature of about 900—1100°C. The calcined nodules are discharged into the kiln by means of a vibratory feeder. Pilot experiments were carried out to study the physical and performance characteristics of the reactor.

The gas temperature vis-a-vis the bed temperature has a pronounced effect on the degree of calcination. DTA tests with the raw mix (Fig 2) show that the rate of calcination is maximum when the material temperature is in the range of 900—1000°C. The effects of other parameters may be stated briefly as below:

SOLIDS FLOW RATE

The solids flow rate is an important parameter which controls the retention time of nodules in the reactor and consequently, the degree of calcination. For a given reactor, the bed height could be varied to have the desired residence time. Also, the relative velocity of solids with respect to gas inside the reactor is important. Very high gas velocity may lead to much of pressure drop and entrainment of solids.

GAS VELOCITY

Although the superficial velocity in the system remains practically the same, there is a velocity gradient inside the VSP because of loss in kinetic energy and effect of temperature. With increased gas velocity, the heat transfer coefficient may marginally improve, but there is a possibility of attrition of nodules. As such, the bed pressure drop and heat transfer coefficient may have to be balanced.

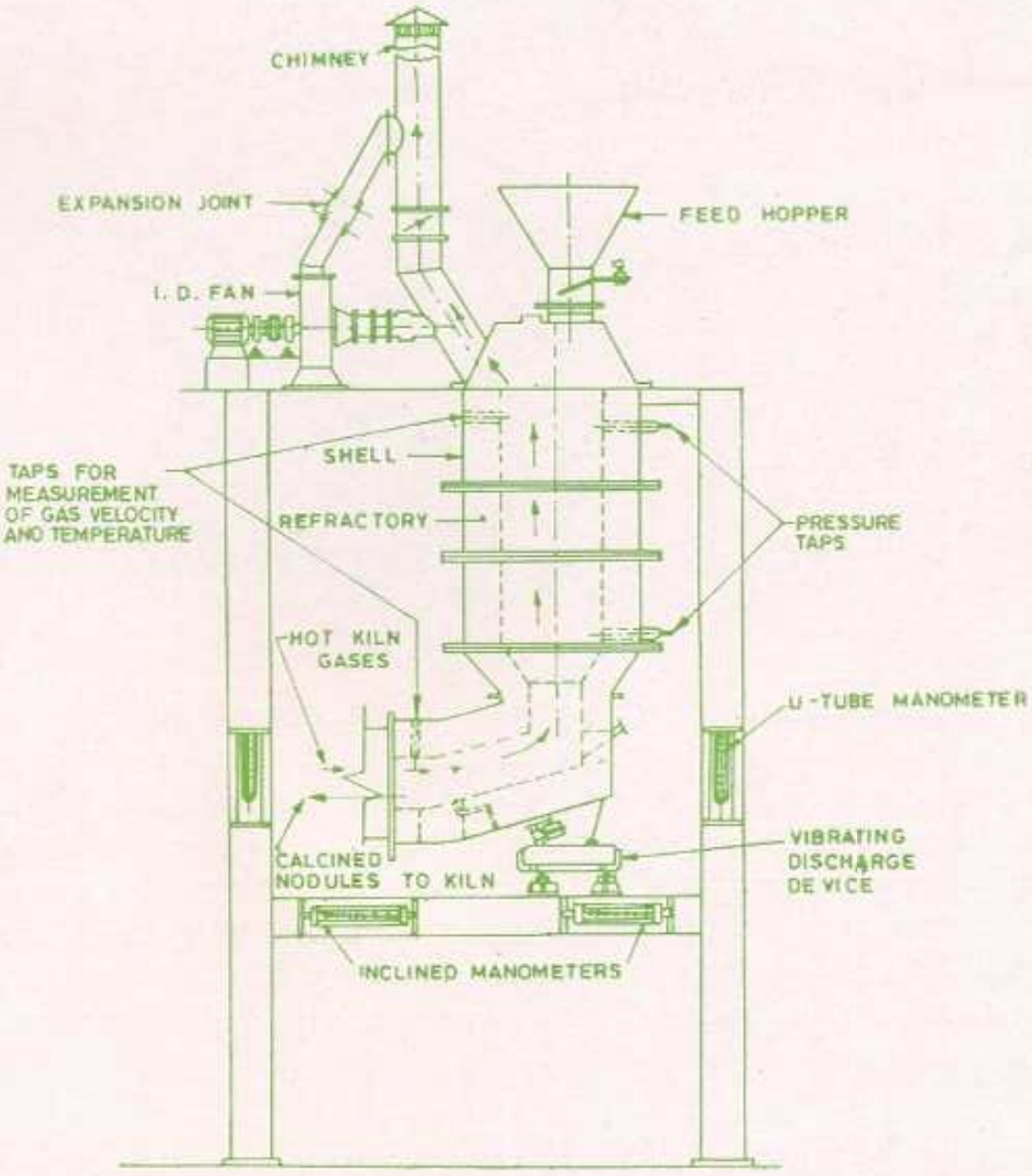

Fig 1 Pilot set-up for VSP

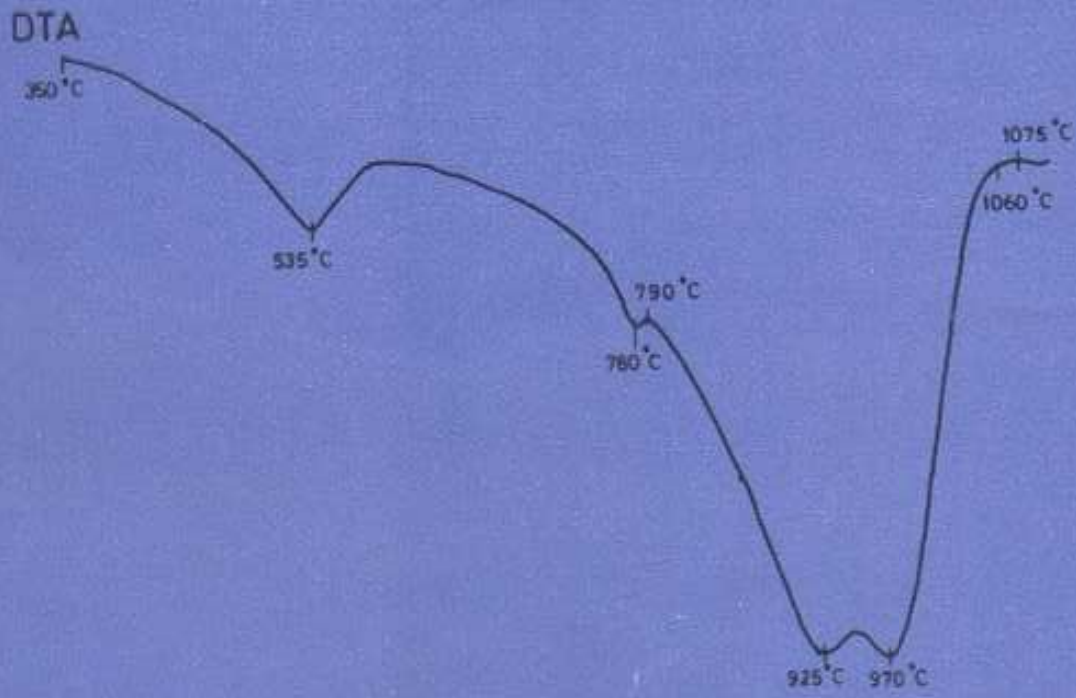

Fig 2 DTA curve for calcination of single raw mix pellet at heating rate of 15°C/min.

BED POROSITY

It is well-known that as the particle size increases, the bed porosity also increases, which evidently would offer less resistance to gas flow and consequently, lead to reduced pressure drop. However, with increased nodule size, the degree of calcination will fall because of reduction in the specific surface. In general, it has been found that for smooth operation the pressure drop is little higher than that predicted by the standard theoretical and empirical correlations. Porosity of individual pellet gives important information about the rate controlling step during the calcination reaction.

Laboratory experimentation, as well as extensive trials on the prototype, showed that decarbonation to the extent of 25 to 30 percent could be obtained without admixing fuel with the raw meal. Calcination to any desired level is achievable by blending coke breeze (or medium volatile coal) with the raw meal and supplying excess air by suitable means. Using this technique, a calcination level of 65 percent was attained in a typical case. The technology has been scaled up to the desired capacities. Figure 3 shows the system arrangement for the rotary kiln with CRI vertical shaft precalcinator.

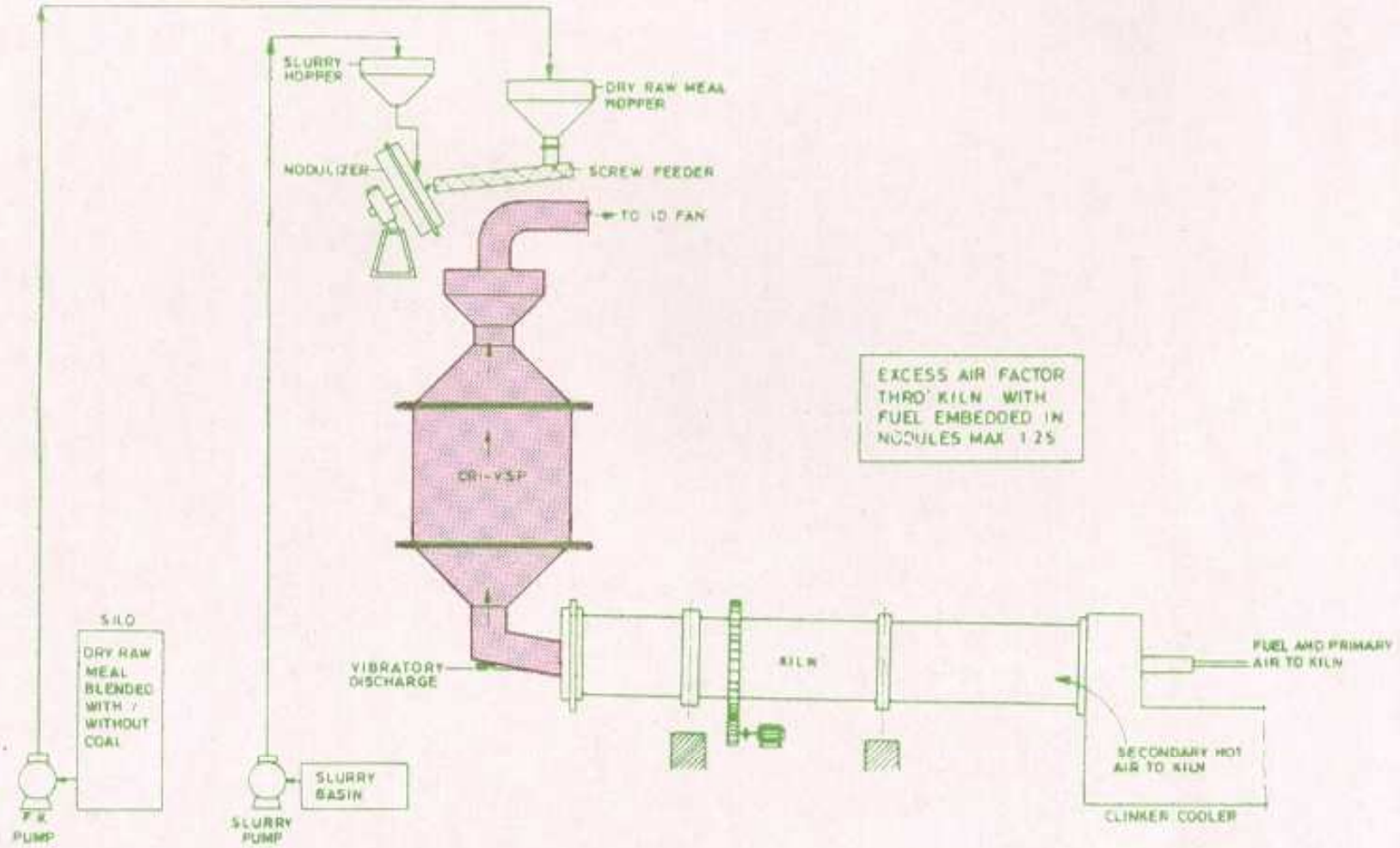

Fig 3 Rotary kiln with CRI-Vertical Shaft Precalcinator

ADVANTAGES

1. The VSP technology is suitable for conversion of wet process kilns to semi-wet/dry process as well as for setting up new semi-dry process plants of small and medium capacities.

2. Flexibility and simplicity in the design makes it possible to operate the unit as a preheater or as a precalcinator.

3. If the process is used for wet to dry conversion, the wet method of raw mix preparation can be retained.

4. Equipment used does not have any moving part except the feeding system and the vibratory discharge device, thereby reducing the maintenance and repair problems.

5. VSP needs less floor space as compared to other methods.

6. The problem of alkali deposition is practically absent; this makes the process suitable for alkali-bearing raw materials.

7. Low capital investment.

CRI renders all the necessary technical and technological assistance to those who may like to incorporate the vertical shaft precalcinator in the cement manufacturing system of their cement plants.

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