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November 1980

# CRI TECHNOLOGY DIGEST

CEMENT RESEARCH INSTITUTE OF INDIA

## PRECALCINATOR TECHNOLOGY AN OUTSTANDING DEVELOPMENT OF SEVENTIES—Part I

# PRECALCINATOR TECHNOLOGY AN OUTSTANDING DEVELOPMENT OF THE SEVENTIES

## 1 WHAT IS PRECALCINATION

In cement making by any of the commercially known processes, calcination or decarbonation of the carbonates in the raw meal is one of the many chemical reactions that occur during its burning to clinker. It is an endothermic reaction requiring about 500 k cal/kg of clinker or about 400 k cal/kg $CaCO_3$.

### 1.1 Relation Between Kiln Size and Output

In long wet and long dry rotary kilns this reaction occurs entirely inside the kiln, and the kinetics of decarbonation govern the kiln speed and its output. Rotary kilns being poor heat exchangers and the quantum of heat to be transferred to the meal for decarbonation being the highest, the L/D ratios of kilns in such systems are high and their specific capacities are low. Therefore, from practical considerations it has not been possible to raise the capacities of such kilns beyond 4500 tpd. Further, their heat consumption per kilogram of clinker is also high.

### 1.2 Development of Preheaters to Achieve Higher Production and Saving in Energy

Investigations on effecting savings in energy consumption and increase in output of kilns without changing the diameter of long wet or long dry kilns led to the development of preheaters, for example, Lepol grate preheater in 1939 and suspension preheater in 1951. These preheaters are independent units although forming integral parts of the entire kiln system. They provide partially calcined meal (with the exception of 2 stage SP) to the kiln. The calcination level generally attained is about 45-50 percent in the case of Lepol grate preheater and 20-40 percent for the 4-stage suspension preheater. In other words kiln with a given capacity could be small having L/D ratios varying between 14 to 16.

## 2 PRINCIPLE OF PRECALCINATION

Normally in a four-stage suspension preheater kiln system, the meal enters the kiln at a temperature of about 800°C with the corresponding gas temperature being around 950°-1000°C. The addition of a fifth stage would no doubt increase the degree of calcination of the meal but the temperature of meal and the gas at the kiln would make the meal sticky on the one hand and the additional stage would increase the power consumption of the preheater fan on the other. A sticky meal is not desirable as it is likely to choke the feed chutes and consequently lead to uneven operating conditions of the kiln, which adversely affect the quality of clinker produced. It has therefore, become necessary to limit the maximum number of stages to four and thereby the maximum temperature of the meal and the gas at the kiln inlet. As the degree of calcination is a function of not only the temperature but also of the time of exposure of the meal at a given temperature and the heat transfer coefficient, an alternative technique to increase the degree of calcination at the limiting temperature is to carry out further calcination by supplying the additionally required heat such that almost isothermal conditions are maintained in the calcinator. This forms the principle used in all the precalcining systems excepting one where the large temperature gradient between meal and gas transfers the heat in a flash and brings down the calcined meal temperature to an acceptable level.

The solution, apparently simple, has achieved two objectives simultaneously. The excess heat that would have normally raised the thermal loading beyond tolerable limits in the event of increased outputs from kilns is utilized at an appropriate location between the kiln inlet and the 4-stage suspension preheater for further raising the degree of calcination of the meal up to a maximum of 90-95 percent before it enters the kiln. Secondly, as a result, the solution has raised the specific capacity of the kilns up to 2·5 times that of the conventional 4-stage suspension preheater kilns. In other words with the same kiln size higher outputs are now possible with the incorporation of a precalcinator.

## 3 DEVELOPMENT OF PRECALCINATOR

While energy conservation has been achieved with the introduction of preheaters, the kiln capacities could not be raised beyond 4500 tpd because of limitation imposed by the accompanying higher thermal loading in the burning zone and the consequent reduction in refractory life and the kiln utilization factor. On the other hand, increased demand for cement and the economic advantages of large capacity single units provided impetus to R&D efforts for finding a solution to the problem of thermal loading in large diameter kilns and thereby removing the constraints in increasing kiln capacities. Investigations conducted in Japan and in some European countries, particularly Denmark and West Germany, resulted in translating the concept of precalcining with secondary firing, ie, burning part of the fuel at the kiln inlet, into an engineering reality in the early seventies. India has recently also developed its first indigenous precalcinator system* through the R&D efforts of Cement Research Institute of India. Thus the development of precalcinators took off much of the kiln load by dividing the burning process between the kiln and the precalcinator and precalcining the raw meal to a fairly high degree entering the kiln proper.

### 3.1 Different Precalcining Systems

The principle of precalcination in all the commercially available technologies being the same, what differentiates them from one another is their system design, each one having its own specific features and advantages. Broadly the different systems may be classified into two categories :

1) The combustion of the precalcinator fuel and the precalcination is carried out in the 4th stage or extended fourth stage duct of the suspension preheater.
2) The precalcination is carried out in a separate chamber located between the 3rd and 4th stages of the suspension preheater with the meal from 3rd stage cyclone forming the feed for the precalcinator as in category (1).

* Technology Digest on the subject, Part II.

3.2 The salient features of the different systems are given in Table 1.

**TABLE 1 VARIOUS PRECALCINING SYSTEMS**

| Sl No | Name of Technology | Salient Feature |
|---|---|---|
| 1 | MFC (Japan) | High retention time (3 to 8 min) in the fluidised bed which ensures complete combustion of any grade of coal |
| 2 | INI-SF (Japan) | Higher heat transfer rate which enables higher throughputs |
| 3 | RSP (Japan) | Efficient heat transfer due to swirling motion of the gases and the meal in the calciner |
| 4 | KSV (Japan) | Accepts raw meal as well as fuel coarser than normal |
| 5 | POLYSIUS (West Germany) | Calcination in modified duct of the 4th stage of the SP |
| | | Hot air from planetary coolers and rotary coolers also can be used |
| 6 | HUMBOLDT-WEDAG (West Germany) | Same as for Polysius |
| 7 | FLS (Denmark) | Higher heat transfer due to thorough mixing of raw meal and gases |
| | | Suitable for raw materials containing alkalies |
| 8 | FCB (France) | Calcination in a cyclone shaped precalcining chamber |
| 9 | CRI-PRECAL (India) | Part of the combustion air drawn through the kiln |
| | | Tangential feeding of the remaining combustion air along with coal |

## ADVANTAGES OF PRECALCINATION

* Reduced thermal loading in the burning zone of the kiln
* Increased refractory life
* Increased specific output up to 2·5 times that of conventional dry SP kilns
* Reduced kiln size for the given output
* Increased kiln utilization factor
* Smoother operation of kiln
* Slight decrease in heat consumption under favourable conditions
* Increase in output of the existing units up to 50 percent with commercially available precalcinator technologies.

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