

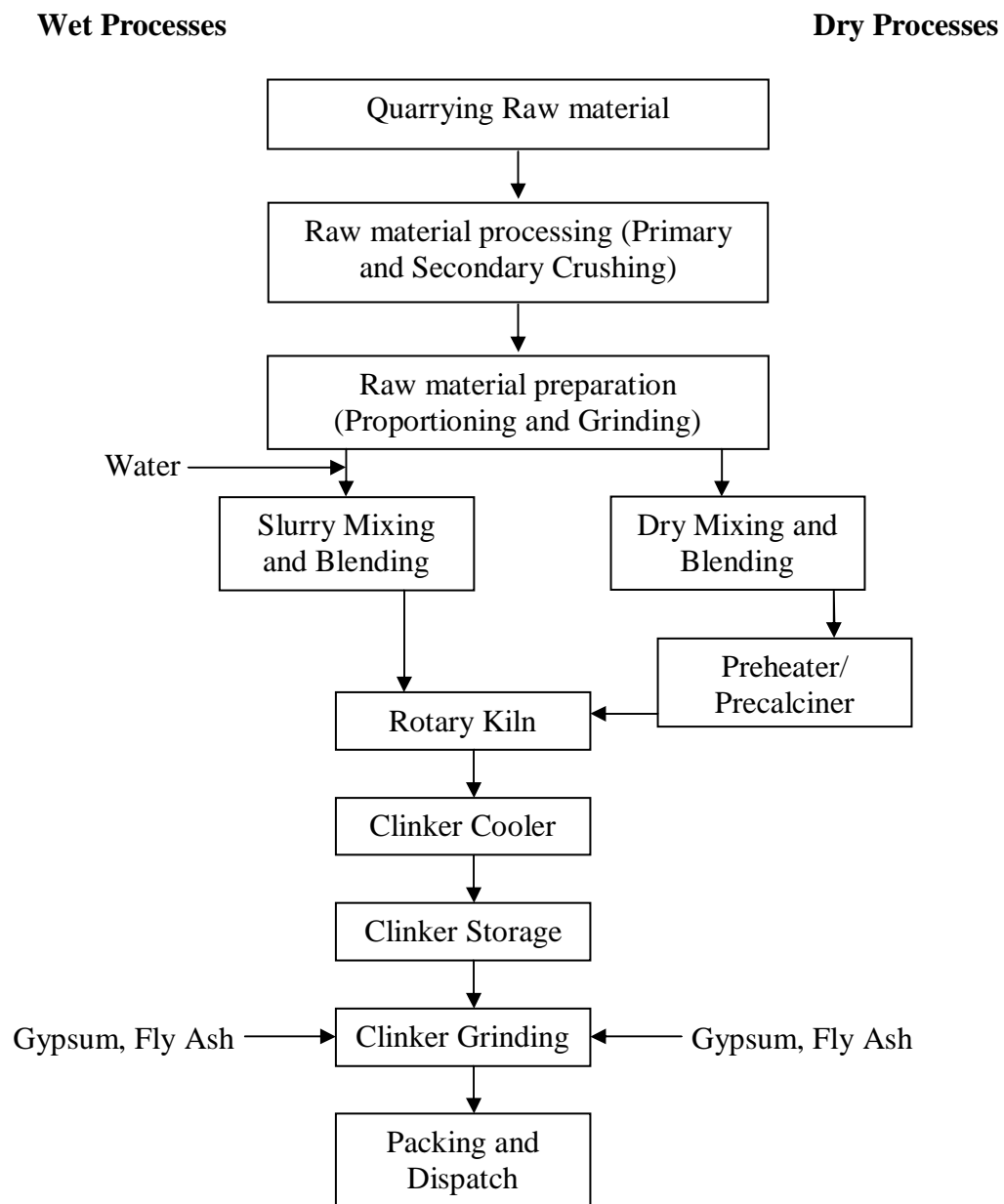
CHAPTER 3.0

CEMENT MANUFACTURING PROCESS

3.1 Manufacturing Process

The cement manufacturing process consist of the following multi stages as explain in the following flow chart.

Flow Diagram of Cement Manufacturing Process



The various stage can be describe as under:

3.1.1 Mining, Transporting and Crushing

The principal raw material required for cement manufacturing is Limestone. Limestone is mined from the mines by blasting explosives and is transported from the mining area to the process plant and then fed into a primary hopper from where the limestone bolder is fed to the primary crusher (Jaw Crusher) with the help of a reciprocating feeder. The crushed limestone pieces are discharged to the vibrating screen. The muddy limestone particles are removed by the vibratory screen action and is conveyed and rejected with the help of belt conveyor. This vibratory screen action removes the mud particles of the limestone and the same is conveyed and rejected with the help of belt conveyor. The belt conveyor conveys the mud free limestone to the Intermediate hopper. The limestone from the Intermediate hopper is fed into the belt conveyor with the help of a vibrating feeder and is fed to the Secondary Crusher (Impactor) for further size production. The crushed limestone is discharged to the belt conveyor and the same is conveyed to the loading bunker. A lot of dust particles are also produced while crushing and discharging limestone. While crushing and discharging limestone, a lot of dust particles are also be produced which pollutes the surrounding atmosphere. To prevent the dust pollution, bag filters are also employed in the discharge points of the Primary and Secondary crushers. The dust is collected by the dust collector in the bags and the dust free air is vented out. The bags inside the dust collector, collect the dust and the dust free air is vented out. The collected dust particles are retrieved with the help of a compressed air purging. Electronic sequential timer panel and solenoid valves are used for air purging to be done in a sequential manner. The air purging is done sequentially using an electronic sequential timer panel and solenoid valves.

3.1.2 Stacker and Reclaimer

Limestone from the unloading hopper is extracted and conveyed to the stacker with the help of a vibrating feeder and belt conveyors. This material is dropped on the table feeder at the top of stacker and then to the Boom conveyor. The stacker and the boom conveyor are capable to move 360 degree. The property of the mined limestone may vary day by day. So the limestone is stocked in the stocker in a

circular manner, layer by layer every day. The limestone is retrieved by cross-sectionally cutting stockpile. Thus, a homogeneous mixture can be obtained after getting deposits from multiple days. So, a pre-lending limestone can be obtained on the stacker. The limestone is stored in a circular or longitudinal manner in the stacker using a stacker and a Boom conveyor. The boom conveyor can move up or down according to the material level.

In the cement plants of Chittorgarh, the Longitudinal (Longitudinal Bridge Scraper store) stacking method is the most commonly practiced stacking method. Basically this method consists of stacking a large number of layers on top of each other in the longitudinal direction of the pile. In this method, the stacker moves to and fro over the centre line of the pile and deposits the material. This method segregates the material with fine particles at the center of the pile and coarse particles on the surface and at the bottom of the pile. In order to ensure proper blending, a stock pile must be reclaimed from the face of the pile by working entirely in a cross sectional pattern.

Figure 3.1: Stacker and Reclaimer



The reclaimer system consists mainly of a chain conveyor which can be moved on the rails through 360 degree. A harrow drive is used to regulate the quantity of the material to be extracted by adjusting the cutting angle. The extracted limestone is conveyed to limestone hopper by using a belt conveyor. After crushing, several additives like sweetener limestone and laterite are also fed to the respective hoppers.

3.1.3 Raw Material Grinding and Storage

Material from the limestone and additive hoppers are fed to respective weigh feeders which weigh and feed the material as per the set ratio and quantity, which is then fed to the raw mill inlet with the help of belt conveyors. Two types of Raw Mills are used for grinding raw material i.e. ball mill and vertical roller mill (VRM). The VRM combines the drying, grinding and separation processes into just one unit. In VRM, raw material from the feed mouth falls into the center of millstone, which moved to the edge of mill under the action of centrifugal force and is ground by roller; after raw meal grinding, it overflows from the edge of a millstone, and at the same time it is carried by the high speed up stream to efficient classifier grinding mill, which is a unit with vertical mill and coarse powder returns to be grinded until reaching to qualified granularity; qualified fine powder comes out mill with airflow, and becomes products after collection of dust collecting device. Since VRM operates at a low noise level, therefore, outdoor installation is feasible. The VRM can produce better or equivalent cement quality. The Ball mill consists of three chambers, one drying chambers and two grinding chambers. Hot gas vent out from Kiln is used in raw mill to drive out the moisture present in the raw material. The dried material is gradually transferred to the grinding chamber. In the grinding chamber the material is grinded with the help of grinding media balls. The powdered material is centrally discharged and the same is conveyed to the Air Separator with the help of Air slides and bucket elevators. The Air Separator separates the powdered material into fine and coarse particles. The fine particles are conveyed to blending silos with the help of Air slides and belt bucket elevators whereas the coarse particles are again fed to the other end of the mill for further grinding. An exhaust fan (vent fan) is used to control the material and hot gas flow inside the mill. A grit separator and a cyclone are employed in the suction line vent fan to collect the dust particles. The collected dust is fed back to the process. The outlet gas of the vent fan is fed to electro static precipitator (ESP). The outlet gas from the fan contains large amount of fine particles of raw material, Inside the ESP, electrodes of positive and negative potentials are arranged by applying high voltage direct current. The strong electrical fields in the ESP ionize the gas passing through it. The positive ionized particles are attracted and collected in the negative ionized electrodes and

the negative air is vented out to the atmosphere. The collected fine powder is retrieved with the help of rapping mechanism and the same is fed to the process.

3.1.4 Blending and Storage

After filling the powdered materials from raw mill to a certain level in the blending silos, this materials is blended for 2 to 3 hours with compressed air after blending, the material sample is collected and analyzed in the laboratory. If the composition of the filled material is not appropriate, the required quantity of corrected material is again filled to the blending silo after changing the ratio to the raw mill. Again the material is blended for 2 to 3 hours and the sample is analyses in the laboratory. After correcting the composition, the material is dropped to the bottom part of the silo. The bottom part of the silo is called storage silo.

3.1.5 Kiln Feed Section

The material from the storage silo is extracted, and the same is fed to the weighing hopper by using air slides and bucket elevators. The material flow to the weighing hopper is controlled with a variable speed rotary feeder. If the set quantity of material is filled in the hopper, the rotary feeder stops feeding. The balance material is fed to the overflow hopper and back to the process. The material from the weighing hopper is fed to the electronic weigh feeder and the same is conveyed to the preheater top with the help of air slides and belt bucket elevators or pneumatic pumps.

3.1.6 Clinkerisation

The clinkerisation section consists of a 4 to 7 stages of Suspension Preheater / Pre-calcinator and a Rotary Kiln. Generally used 4 stage suspension Preheater consists of 7 cyclones. There are two cyclones each in the 1st, 3rd and 4th stages whereas the 2nd stage has only one cyclone. The discharge points of the first cyclones are connected to the Rotary Kiln. The Kiln has a hollow cylinder with refractory lining inside. The discharge end of the Kiln is connected to the Air/Grate cooler. The pulverized coal is weighed in an electronic weigh feeder and pumped to the Kiln through a burner pipe, positioned concentric to Kiln at the outlet. At the outlet end of the Kiln an intensive flame is formed which imparts the thermal energy for this entire process.

This area of the Kiln is called the Burning zone where the temperature is about 1400-1500°C. The hot gas generated in the burning zone of Kiln is sucked through a preheater cyclone by a fan called Preheater Fan which also creates a cyclonic effect on the preheater cyclones. Due to cyclonic effect and gravitational force, the material is gradually discharged into the Kiln inlet after sometimes. In the 1st stage and 2nd the material temperature is about 800 to 900°C and 700 to 800°C respectively. In the 3rd stage the heat and 4th is about 500 to 600°C and 350°C to 400°C. The preheater material from the preheater is discharged to the Kiln inlet. The feed that enters the Kiln at the inlet gradually travels towards the outlet due to the rotation of the Kiln and slope at which it is mounted. The feed entered at the temperature of 850°C moves towards the burning zone at the outlet mentioned at around 1450°C. The partially calcined material that have entered the Kiln undergo complete calcinations liberating carbon dioxide (CO₂) to form (CaO) during this travel from a region of low temperature to that of a high temperature. This oxide reacts with silica, alumina and iron oxide present in the “Raw Meal”, at high temperatures forming the clinker compounds, namely Di-calcium Silicate, Tri-calcium Silicate, Tri-calcium Aluminate and Tetra Calcium Alumino-Ferrite. This process within the preheater and the kiln is called calcination and the product so formed is called clinker. The clinker is dark green in colour and for the best fit clinker it should contain 30% nodules of the total output. The clinker is then discharged in the Grate cooler for cooling. Some part of the exit hot gas from the preheater is diverted back to the raw mill for drying the raw material. The balance part of the hot gas is venting out to the atmosphere. This gas contains lot of fine material and has a temperature around 400°C.

This dust particle in the exit gas pollutes the environment. To prevent the dust pollution, an ESP or bag house is employed. After cooling, the hot and dusty gas in Gas Conditioning Tower (GCT) is allowed to pass through the ESP or bag house to collect the dust particles. Within the ESP, a large number of Positive and negative charged plates are arranged to ionize the air and dust. Due to high potential in the electrodes inside the ESP, the dust particles get ionized. The positive particles are collected in positive potential plates. With the help of a rapping mechanism, the

collected material is retrieved, and the same is again fed to the process. Inside the bag house dust containing gases passes from bags. Dust collects inside the bags and the dust free air is vented out to the atmosphere. The collected dust particles are retrieved back with the help of a compressed air purging. The air purging is done sequentially using Electronic sequential timer panel and solenoid valves. The collected material is again fed to the process of manufacturing.

3.1.7 Cooler

The hot clinker from the Kiln is cooled with the help of atmospheric air in the grate cooler. Inside the cooler, fixed and movable rows of plate with holes are arranged. The to and fro movements of the cooler plates are carried out by two variable speed DC drives. The atmospheric air is blows through the holes of the cooler plates, and cools the hot clinker accumulated over the plates. This blowing of the air is carried out with the help of cooler fans. The to and fro movements of the cooler plates pushes material to the discharge end. The cooled clinker is discharged to the Deep Bucket Conveyor (DBC) after breaking (if big size is present) with the help of clinker breaker. The DBC conveyed the cooled clinker to the clinker stockpile. Part of the air, used to cool the clinker is sucked by the Pre-Heater fan, and it is used as secondary air for burning the coal inside the Kiln. Another part of the air is used to dry coal in the coal mill. The balance part is sucked by induced draught fan through the ESP/multi cyclone/bag house. Useful collected product is transferred to clinker stockpile with the help of Deep bucket Conveyor.

3.1.8 Coal Grinding and Storage

Coal from the coalaries is transported through wagon and is unloaded at the coal stockyard from where it is transported to Raw Coal Hopper and then conveyed to the mill hopper after crushing it into the required size. The coal is conveyed from the Raw Coal Hopper by using a vibrating feeder and belt conveyors. From the hopper the coal is fed to the mill inlet with the help of by using a table feeder. The coal is then dried with the hot gas from either Hot Air Generator or hot gas from the cooler. After drying, the coal is ground using grinding media balls. The fine powder is sucked with the help of circulating air fan which is connected through a grid separator. The grid separator separates the coal powder sucked by the circulating air

fan into fine and coarse. The fine coal powder is stored in a fine coal hopper whereas the coarse coal powder is again fed back to the mill inlet for further grinding. One part of the delivery side of the circulating air fan is connected to the primary air fan suction side and the other part of the delivery side is connected to multi Cyclone or Bag filter or ESP on the basis of process methodology to collect the fine dust of coal. The air containing coal powder along with fine coal is pumped to kiln. The collected material is again fed back to the system. The dust free air is vented out to the atmosphere.

3.1.9 Cement Grinding and Storage

The ingredients required for manufacturing Ordinary Portland Cement (OPC) are Clinker and gypsum whereas Clinker, gypsum and pozzalona material like Fly ash are used for manufacturing Pozzlon Portland Cement (PPC). Clinker from the stockpile is extracted and stored in the clinker hopper near the cement mill. Gypsum is extracted from the stockyards and is stored in the hoppers. The respective material of required ratio and quantity is fed into the mill from the hoppers using electronic weigh feeders and belt conveyors. This material is ground inside the cement mill using the grinding media balls. The ground powder is discharged through the mill outlet and is fed to the belt bucket elevator. The dry fly ash from the power plant is transported to the plant through roads. The dry fly ash is then conveyed to the silo with the help of compressed air from where it is extracted and fed to the weighing bin with the help of pneumatic control gate and the air slide. The required quantity of the dry fly ash is then fed to mill discharge belt bucket elevator by using air slides. Weighing and controlling the dry fly ash done by a solid flow meter and a pneumatic control gate from where the cement is conveyed to separator. A variable speed separator and recirculating fan is used to separate the coarse and fine material. The fine powder is conveyed to cement silos by using air slides and belt bucket elevators/pneumatic pumps whereas the coarse material is again fed to the cement mill inlet for further grinding. The gas inside the mill is suck by fans of ESP and bag filter. After de-dusting the dust free gas is vented to the atmosphere. The collected powder is fed back to the process. Heat is generated inside the mill at the time of grinding due to friction of grinding media balls and clinker. The formed temperature

of the cement should not exceed beyond 140°C. If the temperature exceeds the limit, the characteristic of the cement may be affected and to regulate this cement temperature, a water spray system is generally used.

3.1.10 Packing and Dispatch

Cement from silo is extracted and fed to the rotary screen with the help of air slides and bucket elevators. The rotary screen removes the foreign particles present in the cement, and is fed to the packer hoppers from where the cement is then fed to the respective packers for weighing and packing. Two types of packers are in use. One is mechanical type rotary packer and other is electronic type rotary packer. The cement is packed in 50 kg bags and is conveyed to lorries or wagons for dispatch.

3.2 Types of Processes

Two types of process are used for manufacturing of cement i.e. Wet Process and Dry Process. Generally, dry process is preferred rather than wet process in the cement industries.

3.2.1 Wet Process

During the wet process, the raw mix is fed into the kiln in the form of slurry that may contain water up to 30 to 40%. In the wet process, the kiln is a very long tube in comparison to dry process, and the slurry that is easy to blend and homogenize due to the water, is directly being fed into the kiln. Wet process could be selected as manufacturing technology is when raw materials have natural high moisture content. The amount of moisture in mineral sometimes can be even more than 12%, as in case of chalk and in marlstone. The use of wet process is also essential when relatively poor grade limestone needs to be enriched through the beneficiation process. In this process, water is required as a process media. Until 1950, most of the cement processing kilns were wet kilns due to the ease of blending and homogenizing the components of the raw mix. In the wet process, the fuel consumption is in the range of 1300 to 1600 Kcal/Kg of clinker. Power consumption in manufacture process is about 110-115 kWh/ton of cement (Cement Industry, India, 2004).

3.2.2 Dry Process

To reduce the moisture content of minerals below 1%, which is required for dry process, the raw materials are dried in a combined drying and grinding plant. This drying of materials is reached by using exhaust gases coming from the kiln. The raw ground mix is homogenized in large silos. Development of appropriate blending and homogenizing systems, in general, is crucial for making the dry process practicable. The blended and homogenized raw mix is then fed into dry kiln with air suspension preheater where partial calcination of the raw mix starts to take place. Dry process is mostly limited to the use of air suspension preheater. This provides maximum benefits since the heat consumption is an important issue. Development of the dry process, using air suspension preheaters, is being integrated with pre-calcinators. Pre-calcinators ensure complete calcination of the raw mix before its entry to the kiln. The advantage of this process is that the fuel consumption is lowest in the existing technologies. In the dry process, the fuel use in this process is in the range of 750-950 Kcal/Kg of clinker and the power consumption is in the range of 120-125 kWh/ton of cement (Cement Industry, India, 2004).