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COIMBATORE

DEPARTMENT OF CIVIL ENGINEERING

19CEB201 – CONSTRUCTION MATERIALS

II YEAR / III SEMESTER

Unit 2 : Lime – Cement – Aggregates

Topic 3 : Manufacturing process of Cement

Manufacturing Process of Cemnet

- The manufacture procedures of Portland cement is described below.

1. Mixing of raw materials
2. Burning
3. Grinding
4. Storage and packaging

Mixing of Raw Materials

- The major raw materials used in the manufacture of cement are Calcium, Silicon, Iron and Aluminum. These minerals are used in different form as per the availability of the minerals. Table shows the raw materials for Portland cement manufacture.

Calcareous Materials	Argillaceous Materials		
Calcium	**Silicon**	**Aluminum**	**Iron**
Limestone	Clay	Clay	Clay
Marl	Marl	Shale	Iron ore
Calcite	Sand	Fly ash	Mill scale
Aragonite	Shale	Aluminum ore refuse	Shale
Shale	Fly ash		Blast furnace dust
Sea Shells	Rice hull ash		
Cement kiln dust	Slag		

Mixing of Raw Materials

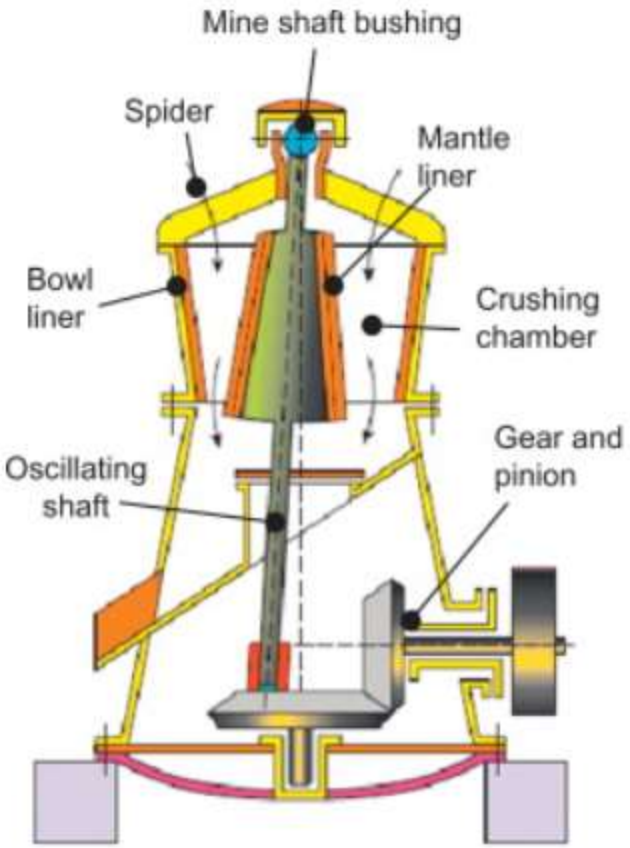
- The mixing procedure of the manufacture of cement is done in 2 methods,

1. Dry process
2. Wet process

Dry Process

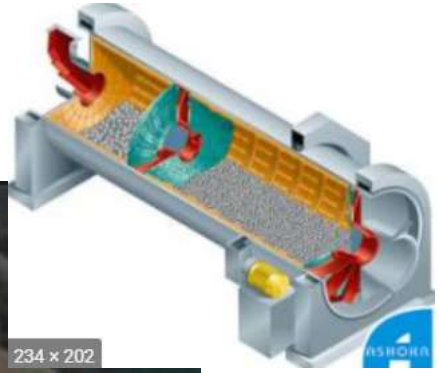
- The both calcareous and argillaceous raw materials are firstly crushed in the gyratory crushers to get 2-5cm size pieces separately.
- The crushed materials are again grinded to get fine particles into ball or tube mill.
- Each finely grinded material is stored in hopper after screening.
- Now these powdered minerals are mixed in required proportion to get dry raw mix which is then stored in silos and kept ready to be sent into rotary kiln.
- Now the raw materials are mixed in specific proportions so that the average composition of the final product is maintained properly.

Gyratory Crusher



Gyratory crusher

Ball Mill



Hopper

Silos

Rotary Kiln

Wet Process

- The raw materials are firstly crushed and made into powdered form and stored in silos.
- The clay is then washed in washing mills to remove adhering organic matters found in clay.
- The powdered limestone and water washed clay are sent to flow in the channels and transfer to grinding mills where they are completely mixed and the paste is formed, i.e., known as slurry.
- The grinding process can be done in ball or tube mill or even both.
- Then the slurry is led into collecting basin where composition can be adjusted.
- The slurry contains around 38-40% water that is stored in storage tanks and kept ready for the rotary kiln.

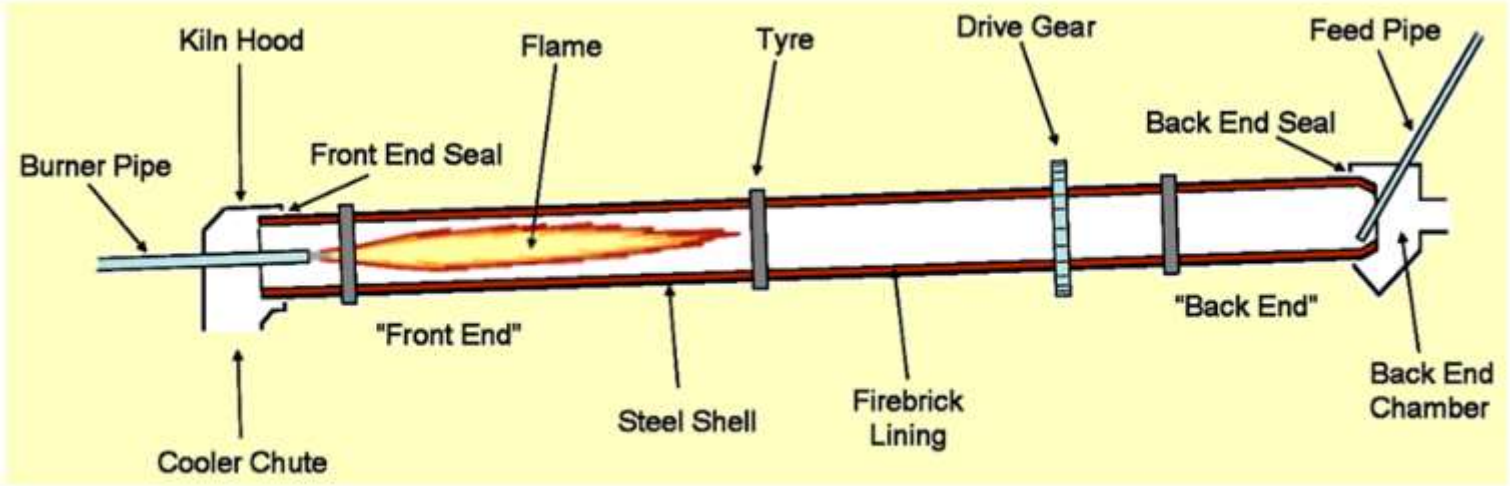
Comparison of Dry Process and Wet Process of Cement Manufacture

Criteria	Dry process	Wet process
Hardness of raw material	Quite hard	Any type of raw material
Fuel consumption	Low	High
Time of process	Lesser	Higher
Quality	Inferior quality	Superior quality
Cost of production	High	Low
Overall cost	Costly	Cheaper
Physical state	Raw mix (solid)	Slurry (liquid)

Burning of Raw Materials

- The burning process is carried out in the rotary kiln while the raw materials are rotated at 1-2rpm at its longitudinal axis.
- The rotary kiln is made up of steel tubes having the diameter of 2.5-3.0 meter and the length differs from 90-120meter.
- The inner side of the kiln is lined with refractory bricks.
- The kiln is supported on the columns of masonry or concrete and rested on roller bearing in slightly inclined position at the gradient of 1 in 25 to 1 in 30.
- The raw mix of dry process or corrected slurry of wet process is injected into the kiln from the upper end.

Rotary Kiln



Rotary kiln terminology

Burning of Raw Materials

- The kiln is heated with the help of powdered coal or oil or hot gases from the lower end of the kiln so that the long hot flames is produced.
- As the kiln position is inclined and it rotates slowly, the material charged from upper end moves towards lower end at the speed of 15m/hr.
- In the upper part, water or moisture in the material is evaporated at 400oC temp, so this process is known as Drying Zone.
- The central part i.e. calcination zone, the temperature is around 1000oC, where decomposition of lime stone takes place.
- The remaining material is in the form of small lumps known as nodules after the CO2 is released.

$$CaCO3 = CaO + CO2$$

Burning of Raw Materials

- The lower part i.e. clinkering zone has the temperature around 1500-1700oC.
- In the region lime and clay reacts to yield calcium aluminates and calcium silicates.
- This products of aluminates and silicates of calcium fuses together to form hard and small stones known as **clinkers**.
- The size of the small and hard clinkers varies from 5 to 10mm.

Clinkers

Burning of Raw Materials

$2CaO + SiO_2 = Ca_2SiO_4$ (diclaim silicate (C2S))

$3CaO + SiO_2 = Ca_3SiO_5$ (tricalcium silicate (C3S))

$3CaO + Al_2O_3 = Ca_3Al_2O_6$ (dicalcium aluminate (C2A))

$4CaO + Al_2O_3 + Fe_2O_3 = Ca_4Al_2Fe_2O_{10}$ (tetracalcium aluminoferrite(C4AF))

- The clinker coming from the burning zone are very hot.
- To bring down the temperature of clinkers, air is admitted in counter current direction at the base of the rotary kiln.
- The cooled clinkers are collected in small trolleys.

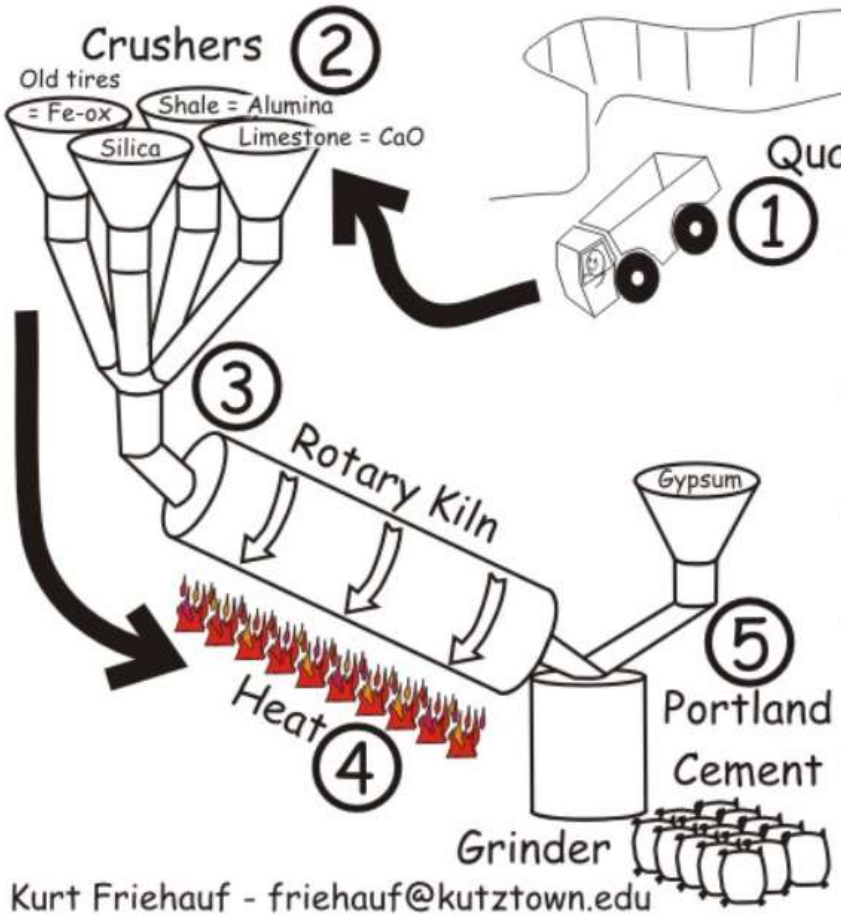
Grinding of Clinkers

- The cooled clinkers are received from the cooling pans and sent into mills.
- The clinkers are grinded finely into powder in ball mill or tube mill.
- Powdered gypsum is added around 2-3% as retarding agent during final grinding.
- The final obtained product is cement that does not settle quickly when comes in contact with water.

Storage and Packaging

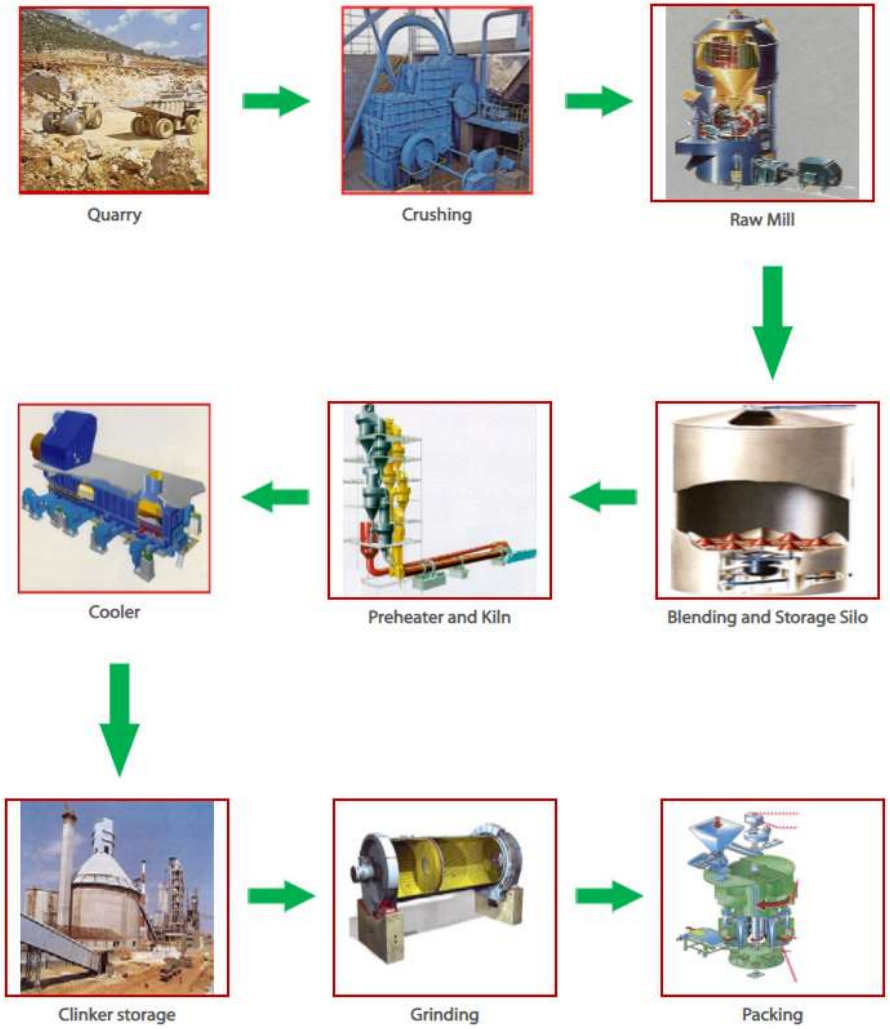
- The grinded cement is stored in silos, from which it is marketed either in container load or 50kg bags.

Cement Manufacturing



1. Limestone, shale, silica, and iron oxides are quarried from the ground. (Some limestones already contain enough silica).
2. Rock materials are run through a crusher that turns rock into smaller pieces.
3. Crushed limestone + silica + shale + iron oxides are mixed together and run through a rotary kiln.
4. Rotary kiln continuously mixes ingredients and "calcines" limestone so that CO_2 is driven off, forming clinker.
5. Clinker is ground to fine powder and mixed with gypsum (helps moderate how fast the cement "sets), then bagged for sale.

Cement Manufacturing



Thank You!!