CEMENT MANUFACTURING PROCESS

HISTORY OF CEMENT : Cement is a material which is highly compatible to the earth's eco-system and most adaptable to sustainable development. Cement is a fine powder which sets after a few hours when mixed with water, and then hardens into a solid, strong material. Cement is mainly used to bind fine sand and coarse aggregates together in concrete. Cement is a hydraulic binder, i.e. it hardens when water is added to cement powder.

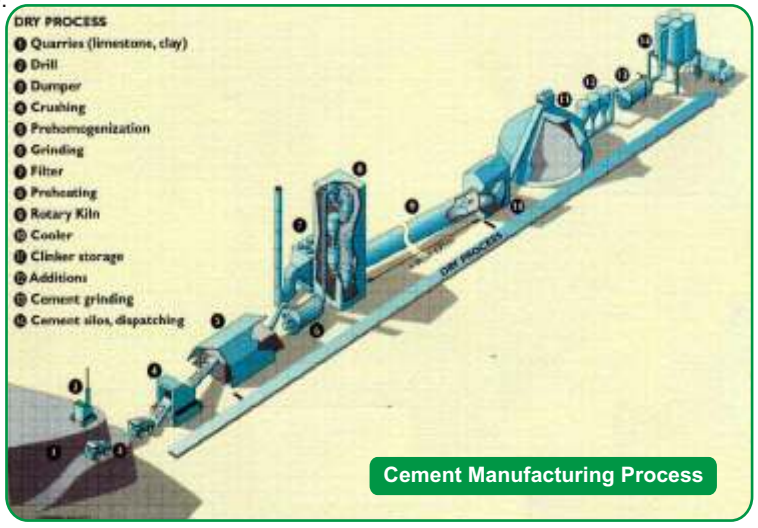
Joseph Aspdin, a Leeds Builder and bricklayer had invented the Portland cement in 1824. In this process,Aspdin mixed and ground hard limestone and finely divided clay into the form of slurry and calcined it in a furnace similar to a lime kiln ,till carbon di oxide was expelled. The mixture so calcined was then ground to a fine powder & was used as Portland cement. The name Portland was given owing to the resemblance of this hardened cement paste to the natural stone available at a place called Portland in England.

In India Portland cement was first manufactured in 1904 near Madras,(Chennai) by South India Industries Limited and later developed by The Indian Cement company limited in 1914.

RAW MATERIALS IN CEMENT MANUFACTURE : (1) **Limestone :-** Contains predominantly calcium carbonate ($CaCO_3$) and to use in cement manufacture, it should have 42-43% lime (CaO) minimum. In cement manufacture it is prime raw material and its usage would be 90-93%. (2) **Clay :-** It contains more of silica (SiO_2) and its usage should be 2 to 3% in cement manufacture. (3) **Bauxite :-** It contains alumina (Al_2O_3) and it's usage should be 2 to 3% in cement manufacture. (4) **Iron Ore :-** It contains mainly iron oxide (Fe_2O_3) and it's usage should be 1 to 2% in cement manufacture.

The raw materials mix composition would be 90-93% limestone, 2-3% clay, 2-3% Bauxite, 1-2% Iron ore in cement making.

FUEL:- ● Coal is used for burning the raw mix in powdered form. ● Normally both imported and indigenous coal are used, coal is being imported from mainly South Africa, Australia etc. because of low ash content. ● Pet coke is also used as alternate fuel while manufacturing of cement.



Cement Manufacturing Process

VARIOUS STEPS INVOLVED IN CEMENT MANUFACTURE :-

1. **Mining of limestone**
2. **Raw material preparation / raw mix preparation :-**
   ● Crushing ● Homogenization ● Proportioning of raw materials ● Grinding ● Storing and Blending
3. **Burning of raw mix**
4. **Clinker grinding along with gypsum**
   ● Grinding ● Storing ● Packing

RAW MATERIAL PREPARATION :- The prime raw material limestone after blasting in mines is broken into big boulders. Then it is transported by dumpers to limestone crusher where it is crushed to 15 to 20mm size.

STACKER/RECLAIMER :- After crushing, the crushed limestone is piled longitudinally by an equipment called stacker / reclaimer. The stacker deposits limestone longitudinally in the form of a pile. The pile is normally 250 to 300 m long and 8-10 m high. The reclaimer cuts the pile vertically, simultaneously from top to bottom to ensure homogenization of limestone.

The crushed limestone from pile is transported through belt conveyor to hopper. Similarly, other raw materials like clay, bauxite, iron ore etc. are also transported by belt conveyor from storage yard to respective hoppers. All raw materials are proportioned in requisite quantity through weigh feeders.

The proportioned raw materials are transported by belt conveyor to Raw Mill for grinding into powder form.

After grinding, the powdered raw mix, is stored in a raw meal-silo where blending takes place.

Blending is done by injecting compressed air. This powdered material (Raw mix) is fed to the kiln for burning and Coal also requires homogenization as it contains different ash.

BURNING :- The powdered raw mix is fed into 4 to 6 stage preheater from top by air pressure. The hot gases from kiln enters preheater from bottom. The powdered raw mix slides down through cyclones and comes in contact with hot air which travels from top to bottom. In preheater the temperature of raw mix rises to 900°C to 1000°C and nearly 90% Calcination (removal of CO_2 from $CaCO_3$) takes place before entering the kiln.

Powdered raw mix enters the kiln at one end and the burner is situated at the opposite end. The rotary kiln rotates at the speed of 1 to 3 revolution per minute (RPM). The raw mix in the kiln melts first into liquid form and then transforms into nodules due to the effect of the rotation of the kiln. There are two zones inside the kiln, namely calcining zone and burning zone. The zone where raw mix enters into the kiln is called calcining zone. Where temperature would be 950-1000°C. Burning zone starts after this zone where temperature would be 1350-1450°C.

The hot clinker from kiln discharge is cooled very quickly/ quenched in air with the help of efficient coolers. The temperature of clinker is brought to 80-90°C from 1350°C. Fast cooling is very essential to get good quality clinker. If cooling is not quick, the compound stability in clinker will be adversely affected resulting in lower strength of cement after grinding.

Clinker from clinker silo is transported to clinker hopper by belt conveyor. Similarly, gypsum, fly ash or any other additive are transported to their respective hoppers by belt conveyors.

CEMENT MANUFACTURING PROCESS

All operations of feeding of raw meal, coal, burning, temperature control and cooling are automatic through fuzzy logic / computer control. These operations are controlled from Central Control Room (CCR) which is the nerve center for any cement plant.

CEMENT GRINDING :- The proportioning of clinker, gypsum and fly ash is done by electronic weigh feeders. In modern plants, clinker and gypsum are precrushed in a Roller press and subsequently fed into ball mill for fine grinding. The installation of roller press technology is very beneficial in terms of both quality and energy conservation. The cement produced from roller press is showing better particle size distribution in cement (and hence good strength development) and consumes less power. The resultant product is called cement and stored in a Multi compartment silo. This avoids intermixing of products.

PACKING OF CEMENT :- Cement is packed in HDPE bags having capacity of 50Kgs. Electronically controlled, High efficiency rotary packers are used for Packing. Packers are highly precise with tolerance of +/- 0.5%. It displays the weight of each bag before discharge. It ensures the weight of packed bag is 50kg. Electronic balances are installed for random cross check of packed bags. The packed bags are loaded into trucks / Railway Wagons.

TRANSPORTATION OF CEMENT :- Cement is transferred to various locations as per the market requirement and stored in godowns or the distribution points, this is distributed through trucks and by rail or by cement Bulkers from the plant.

CEMENT CHEMISTRY

OXIDE CONTENT IN CEMENT :-

NAME	PERCENTAGE
MAJOR	
1. CaO	59 - 64
2. SiO2	19 - 24
3. Al203	3 - 6
4. Fe2O3	1 - 4
MINOR	
1. MgO	3 - 5
2. SO3	1 - 3
3. Alkalies	0.2 - 1.3

COMPOUND CONTENT IN CLINKER :-

1. C3S - Tri Calcium Silicate	30% - 50 %
2. C2S-Di Calcium Silicate	20% - 45%
3. C3A-Tricalcium Aluminate	8% - 12%
4. C4AF-Tetra Calcium Alumino Ferrite	6% - 10%

QC PLAN &QUALITY ASSURANCE FOLLOWED AT HEIDELBERG CEMENT PLANT :- (1) Computerised mine planning and prospecting (2) Methodical storing and reclaiming from Pre blended stock piles in blending silo (3) Thorough checks and monitoring of incoming materials (4) Kiln scanning, heat, temperature control (5) Online Quality control by Computer and X ray (6) Storing of raw materials in covered shade (7) Continuous supervision in CCR by qualified and dedicated professionals

QUALITY CONTROL PLAN

Process State	Materials	Type of Sample	Test Parameters	Frequency
Mining	Limestone before Blasting	Drill Hole Sample	Chemical Analysis	As and when required
	Limestone after Crushing	Crushed Limestone	Chemical Analysis	Hourly
Incoming Raw Material	Limestone (Sweetener)	As received Basis	Chemical Analysis	Rake wise,
	Raw Coal	As received Basis	Moisture, Ash and CV	Rake wise,
	Petcoke	As received Basis	Moisture, Ash and CV	Rake wise,
	Laterite	As received Basis	Chemical Analysis	Daily
	Gypsum	As received Basis	SO3 & Purity	Rake wise,
	Fly Ash	As received Basis	Chemical Analysis + Physical (Parameters)	Weekly (as per IS 3812 Part-1)
Raw/Fuel Grinding	Raw Mill	Raw Meal	Fineness & Chemical Analysis	Alternate Hourly
	Coal Mill	Fine Coal	Moisture, Ash and CV	Alternate Hourly
Pyro-Processing	Kiln Feed	Kiln Feed	Fineness & Chemical Analysis	Twice in a shift
	Kiln	Clinker	Liter weight, Free Lime & Chemical Analysis & Physical Testing	Liter weight on Hourly basis, Chemical Analysis on Alternate Hour, Free Lime Twice in as shift Physical Testing on daily basis
Grinding	Cement	Ground Powder	Fineness, Lime, SO3, Setting time, Chemical Analysis and Physical Testing	Fineness, Lime & SO3 on Hourly basis, Chemical Analysis and Physical Testing on daily basis.
Packing	Cement	Ground Powder	Fineness, Lime, Complete Chemical Analysis and Physical Testing	Fineness & Lime on Hourly basis, Chemical Analysis and Physical Testing on daily basis.

CV- Calorific value