

# Cement

## Cement:-

The powdery form of calcareous & Argillaceous material in the required comp<sup>n</sup> which can form the concrete by mixing rocks, sand and water is known as cement. For e.g. portland cement, hydraulic cement etc.

## Manufacture of cement:

### (1) Raw materials

Raw materials used in manufacture of portland cement are:-

(a) calcareous material (which supply lime) e.g. limestone, chalk, marl or marine shells,  $\text{CaCO}_3$  & less than 5%  $\text{MgO}$ .

(b) Argillaceous material (which supply silica, alumina & iron, oxides) eg:- clay or shale, blast-furnace, ashes & cement rock.

### (2) Manufacture of cement clinker:

(a) The lime saturation factor,  $\frac{\text{CaO}}{2.8\text{SiO}_2 + 2\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3}$

Should be in the range of 0.85 - 1.02. This will ensure formation of  $\text{C}_3\text{S}$ ,  $\text{C}_2\text{S}$ ,  $\text{C}_3\text{A}$  (Critical Silicate, di calcium Silicate, tri calcium aluminate).

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(b) Silica modulus  $\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3}$  should be 22 to 35

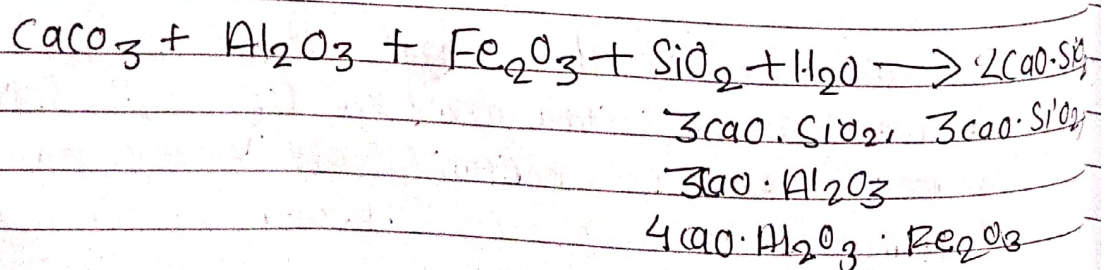
The reqd ratio of lime and silica grined and MgO should be below the specified limits and also alkali choring within the specified limits.

### (3) Methods of Manufacturing:-

Portland of cement is generally manufacture by the following 3 method

#### Wet Process:-

In this process the reqd raw materials are brought into the flowing slurry which contain 30-40% water. The slurry was transferred into rotatory kiln (furnance) in which the raw material was grined into powder form to  $400^\circ\text{C}$ , where it loses all water. After then, the powder was transferred into middle portion of kiln where  $900-1000^\circ\text{C}$  temp was maintained, the lime stone decomposed to form  $\text{CaO}$  and  $\text{CO}_2$ . Then, powder form was transferred into lower portion of rotatory kiln where  $1400-1600^\circ\text{C}$  temp was maintained and limes & clay combined to form calcium silicates and aluminated.





$C_2S \longrightarrow$  Dicalcium silicate  
 $C_3S \longrightarrow$  tricalcium silicate  
 $C_3A \longrightarrow$  Tricalcium aluminate  
 $C_4AF \longrightarrow$  Tetracalcium aluminoferrite

The resulting product is known as clinker which is in the form of small balls or pellets of varying size. The clinker are cooled in rotatory cooler and mixed with 2-3% gypsum and kept in a grinding machine. The resulting powder is known as portland cement.

### Dry Method:-

In this process, the calcareous and argillaceous materials are crushed in gyrator crushers, dried and mixed, pulverised and homogenised with the help of compressed air. This 'raw meal' is introduced into the upper end of the rotary kiln while a blast of burning coal dust is blown from the other end. The rxn taking place and place and rest of the process is same as described under wet process.

### Semi-dry process:-

In this process, the raw materials are initially ground dry, but instead of feeding as a powder the 'raw meal' is humidified with 10-14% water in a pan or



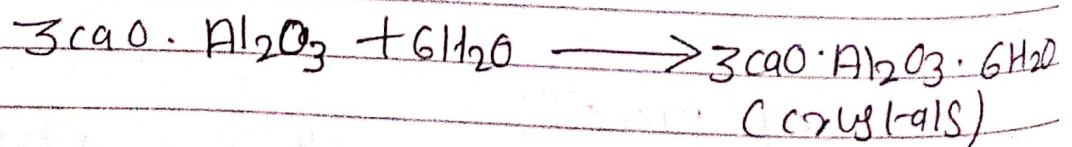
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Drum type noduliser. The nodules are fed on a travelling grate where they get dried and preheated before entering a short rotary kiln where they are burnt to form cement clinker.

### Setting & hardening Cement:

According to the colloidal theory of Michaelis, hardening of cement is due to the interlocking of the crystals. It is due to the interlocking of the products formed during hydration of the constitutional compounds. It is generally agreed that setting and hardening of cement are essentially due to the formation of interlocking crystals reinforced by the rigid gel formed by the hydration and the hydrolysis of constitutional compounds.

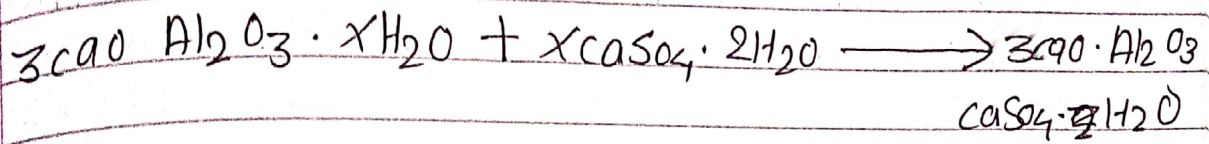
When cement is mixed with water the paste becomes quite rigid within a short time which is known as initial set. This is due to  $\text{C}_3\text{H}$  which hydrate rapidly as follows:



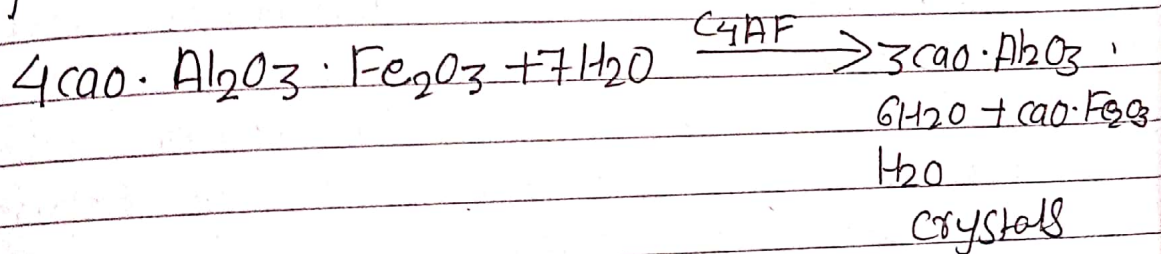
However the crystal prevents the hydration rxn of other constitutional compounds forming a barrier over them. So, gypsum



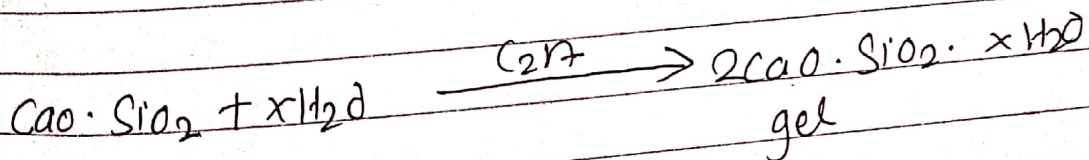
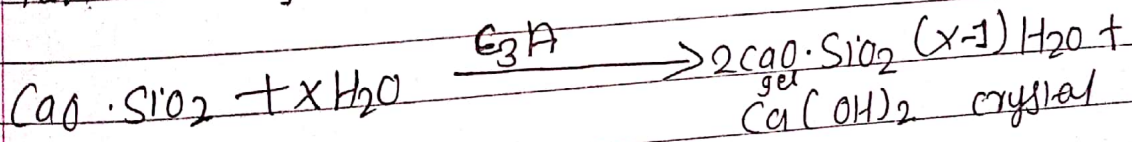
(CaSO<sub>4</sub> 2H<sub>2</sub>O) or, plaster of paris was mixed for hydration rxn.



The tetracalcium aluminoferrite (C<sub>4</sub>AF) then reacts with water forming both gels and crystalline compound.



These gels shrink with passage of time and leave some capillaries for water to come in contact with C<sub>3</sub>S & C<sub>2</sub>S to undergo further hydration & hydrolysis rxn.



The setting and hardening of cement maybe summarized diagrammatically as follow

