

Cement and pulp

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other material to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.



Introduction

Cement was first discovered in England in 1824 AD by Joseph Aspdin. It is essentially a mixture of limestone and clay. Cement is a dry powder substance made by calcining lime and clay, mixed with water to form mortar or mixed with sand, gravel and water to make concrete. Cement was commonly called **portland cement** because in the presence of water it sets to hard stone like mass resembling with famous building stone of England called portland rock.

The most popular cement that are used in Nepal are **Ordinary portland cement** (OPC), **Pozzolana portland cement** (PPC) and white cement. When cement, sand, gravel and appropriate amount of water are mixed, it is called concrete. If the cement and concrete is filled in wire netting and allowed to set, the structure is called reinforced concrete (RCC).

Cement is a product obtained by combining material rich in CaO with other material like clay which contains silica along with the oxide of Al , Fe and Mg .

The average composition of portland cement is CaO (50-60%), SiO_2 (20-30%), Al_2O_3 (5-10%), MgO (2-3%), Fe_2O_3 and SO_3 (1-2%).

Raw materials for cement production: Cement contains four types of essential constituents. They are silicon, aluminium, iron and calcium. One or more may be absent in specific types of cement. For example, no iron is present in white cement.

Types of raw materials: Roughly ,the materials required for the cement production can be classified into three categories:

A. Primary raw materials: The raw materials which forms 85% of clinker are called primary materials. They are limestone, cement rock,clay, shale, sand etc. They supply Ca,Si,Al and Fe.

B. Secondary raw materials: The raw materials which forms less than 15% clinker are called secondary raw materias. They are slag, sandstone,bauxite,iron ore etc.

C. Tertiary raw materials:The substance which are used for other purpose than clinker formation are called tertiary raw materials. They are specially used for reducing water content etc.They are gypsum salt ,borax etc.

The major raw materials for cement is **limestone** (CaCO_3) . The limestone deposited must be identified at first to establish cement factory.

In Nepal, the deposits of limestone is reported between Sindhuli and keyurani near udaypur cement factory. About 73.5 million tons of limestone is reported in that area.

Main steps involved in the production of cement:

The steps of cement production are:

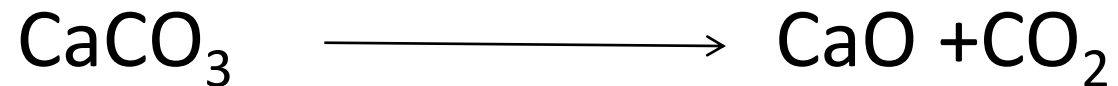
i. Crushing : The raw materials like limestone are extracted from quarries by blasting, drilling, or ripping using heavy machinery equipment. After that it is crushed into smaller pieces by jaw crusher.

ii. Grinding and blending the materials: The crushed limestone is grinded to provide a fine materials for the blending step. Thus obtained grinded material is blended with correct ingredients like clay, silica, and iron ore in required proportion and mix homogeneously to produce clinker of the desired composition.

iii. Strong heating(pyro-processing):

The blended raw materials are stored in silos before being fed into the kiln for pyro-processing operation. The silos store supply of material for several days to provide a buffer against any glitches in the supply of raw material from the quarry. The blended raw material is then heated at the hearth of the pyro-processing system at high temperature up to 1300C- 1500C in a rotary kiln to produce a clinker. The kiln is heated with the help of powdered coke from the lower end of the kiln so that the long hot flames are produced where following changes take place.

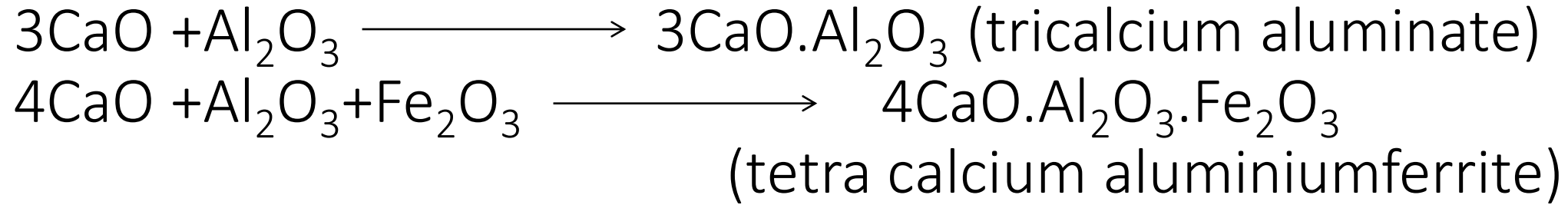
- Evaporation of free water takes place.
- Evolution of combined water takes place.
- Volatile components are escaped out.
- Calcination of limestone to calcium oxide.



- Reaction of CaO with silica to form di and tricalcium silicates.



- Reaction of CaO with the aluminium and iron-bearing constituents to form the liquid phase.



- Formation of clinker.

4. Cooling and final grinding of clinker: The clinker coming out from the burning zone is very hot. To bring down the temperature of clinker, the air is admitted in a counter current direction at the base of the rotary kiln. The cooled clinkers are collected in small trolleys from the cooling pans and sent into mills. The clinker is grinded into powder in a ball mill along with 2-3% powdered gypsum salt to produce cement. The grinded cement is stored in silos from where it is marketed.

Types of cement:

A. Ordinary Portland Cement (OPC): It is the most common cement used in the world because of its low cost production and abundance. A mixture of lime stone and other raw materials like argillaceous, calcareous, gypsum is prepared and then grinded to prepare OPC.

some characters of OPC are:

- It is less durable in aggressive weather.
- It is costlier, and its initial strength is higher than ppc.
- It has lower resistance against alkalis, sulphate, chlorides etc.
- It has higher % of chloride, sulphate, alkalis etc in its composition which makes the concrete less durable.

- The emission of CO₂ occurs during its manufacturing process.
- The hydration process is fast resulting in the high heat of hydration and it is unsuitable for mass concreting. It is suitable where fast construction is required but not suitable for mass concreting as more heat is generated in a hydration.

B. Pozzolana Portland Cement(PPC):

PPC is variant of OPC obtained by adding a mixture of pozzolanic materials namely fly ash and volcanic ash to the OPC. Pozzolana materials are added to the cement in the ratio of 15% to 35% by weight. The addition of pozzolana improves the strength and durability of the cement and even reduces the cost of concrete production. In other words, PPC greatly reduces the amount of OPC used in concrete. PPC is cheaper and has low initial setting strength compared to the OPC but hardness over a period with proper curing. Pozzolana is available in one grade and its strength matches the strength of grade 33 OPC after curing.

Characters of PPC are:

- PPC is the result of adding pozzolana or similar materials such as volcanic ash, clay, slag, silica, fly ash or shale with OPC, so it is cheaper.
- It has a slow hydration process and generates less heat than OPC. Therefore, it is suitable for mass concreting and makes the concrete more durable.
- Setting time of PPC is higher with an initial setting of 30 minutes and 600 minutes for the final set. Its slower setting time helps to get better finishing.
- PPC uses natural and industrial waste thus, reducing environmental pollution.

Manufacture of Portland cement:

The most important raw materials for making cement are limestone, clay and sand (silex) with iron oxide. Manufacture of Portland cement involves the following steps:

- i. **Quarrying:** Raw materials are extracted from quarries by blasting or by ripping using heavy machinery. Wheel loaders transport the raw materials to the crushing installation.
- ii. **Crushing:** The big lumps of limestone are broken into smaller pieces by Jaw crusher and then it is transported with the help of a belt conveyor.

iii. Grinding, blending and homogenization: The crushed limestone is grinded to a fine materials for blending. Thus, obtained enough fine material is blended with corrective ingredients like clay(shale),silica and iron ore in required proportion and mix homogeneously to produce clinker of the desired composition.

iv. Pyro-processing: The blended raw materials are stored in silos before being fed into the kiln for pyro-processing operation's silo stores several days' supply of material to provide a buffer against any glitches in the supply of raw materials from the quarry. The blended material is then heated at high temperature up to the $1300-1500^{\circ}\text{C}$ in a rotary kiln to produce a clinker. The kiln is heated with the help of powdered coke from the lower end of the kiln so that the long hot flames are produced.

v. Storing clinker and grinding: The clinker coming from the burning zone are very hot . To bring down the temperature of clinkers, the air is admitted in a counter -current direction at the base of the rotary kiln. The cooled clinker are collected in small trolleys. The clinker is grinded into powder in a ball mill along with 2-3% powdered gypsum to produce cement. Finally, the grinded cement is stored in silos, from where it is marketed.

Flow chart diagram for the manufacture of portland cement:

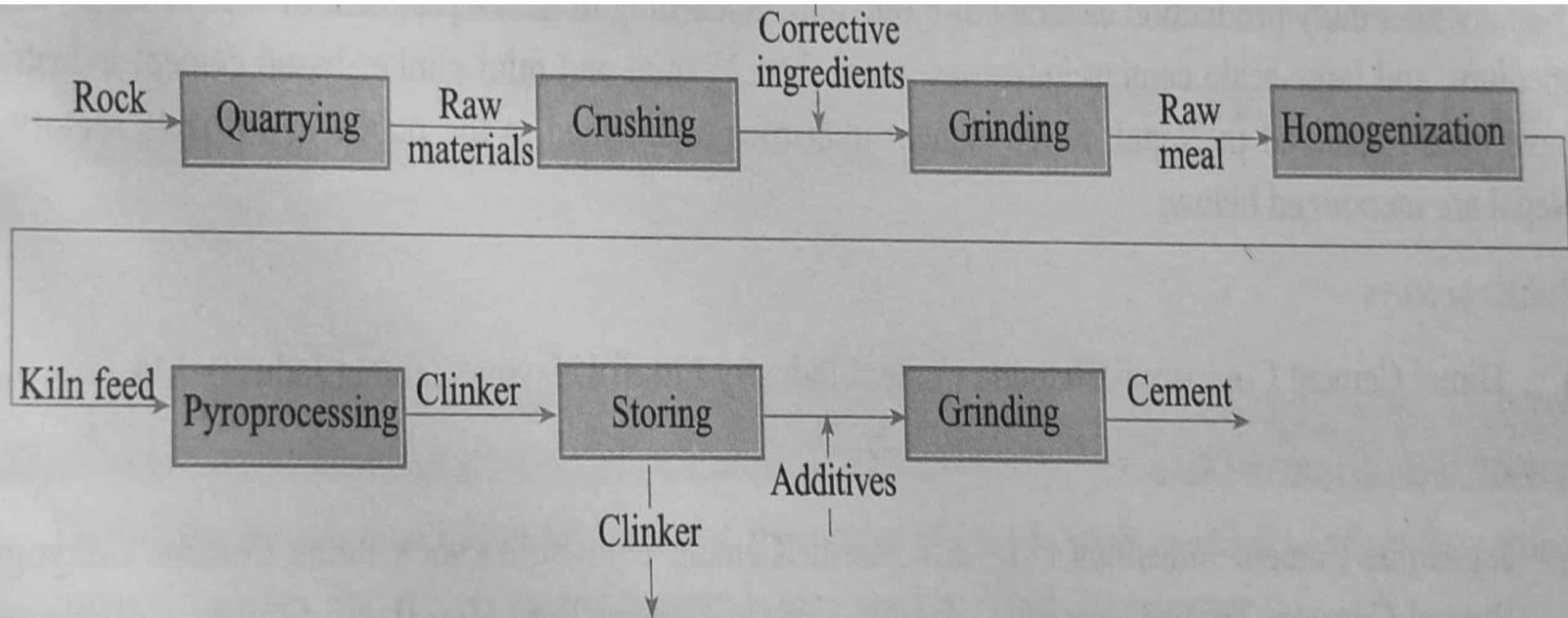


Fig: Portland cement flow sheet diagram

Cement industry in Nepal:

In Nepal, cement was used in the 1950s, and its supply was diversified in 1965. Himal cement company was the first cement plant established in 1975 had a production rate of 160 tons per day but it was later shutdown in 2002. After this, Hetauda cement industry and Udaipur cement industry limited were established. Nepal's domestic cement production has been growing steadily over the past few years as the demand for the cement continues to reanneal cement producers are producing OPC, PPC of which OPC is widely used by consumers. Hongshi-Shivam Cement private limited, a China- Nepal Jion venture company, has start cement production in March 2018. It is the largest cement factory in Nepal with a daily production capacity, 6000 tons.