Coal in the cement industry

Cement manufacturing consists of raw meal grinding, blending, pre calcining, clinker burning and cement grinding. Limestone, CaO, SiO_2, Al_2O_3 and Fe_2O_3 are crushed and milled into a raw meal. This is blended and preheated in a preheater cyclone. Preheating of raw feed increases the energy efficiency of the kiln as the material is 20-40% calcined at the point of entry into the kiln. At 700oC water is removed from the raw feed and in the preheating section calcination reaction, $CaCO_3 = CaO + CO_2$ takes place. The initial combination of alumina, ferric oxide and silica with lime also occurs. This reaction is initiated between 7000C to 900oC depending on the composition of raw feed.

The material is then fed into a rotary kiln for further heating. At 15000C elements fuse together to from predominantly calcium silicates and aluminates crystals, which is termed as clinker burning. The molten cement clinker is then cooled as readily as possible. The air used to cool the clinker is fed into the kiln as combustion air to ensure high utilization of the heat produced. The cement clinker is ground with about 5% gypsum. Other materials like slag, fly ash, ash of coal etc may also be added in required proportion to get the final cement powder.

The main fuel used for firing preheater cyclone and rotary kiln is coal. Therefore, coal plays an important role in the manufacturing process of cement. Based on the composition of raw feed a wide range of coal is used. In a cement plant two systems of coal firing are used, namely, a) Direct firing and b) Indirect firing.

In direct firing system, coal is milled on line and is directly fed to the kiln. The primary air is used to dry the coal. High moisture coal is not suitable for direct firing, as this has the effect of lowering the flame temperature and therefore the process efficiency. Excess of primary air should not be allowed, as this has also a similar effect like high moisture.

In indirect firing system, coal is milled off line and stored in a bunker from where it is fed to the kiln as per the requirement. During storage of coal the propensity for spontaneous heating should be kept in mind.

Coal fineness has a direct relationship with its reactivity. Hence in the cement plant a special significance has been given to the milling behavior of coal. It has been observed that low volatile matter in coal can be co mpensated by finer grinding. It is also desirable that coal must have a high Hardgrove Grindability Index (HGI)

For production of cement the temperature of clinker should be around 1500oC, which can be achieved when flame temperature is maintained at 1700oC. This is achieved by providing preheat to the secondary air. If high moisture coal is used in direct firing system, there may be an excess of moist primary air and required temperature may not be obtained. However, in indirect firing system using dry primary air a satisfactory flame temperature can be achieved even with low energy coal.

During the production process of cement it is normal to have some build up of deposits in the clinkering zone of the kiln, but excessive deposits can hinder the movement of solids through the kiln. The deposit formation is commonly associated with the presence of chlorine, sodium, potassium and sulphur. Coal with high chlorine or sulphur is not favoured in the cement plant.

The selection of coal for cement industry should be judiciously done. The temperature vis-à-vis heat required in the rotary kiln depends on the composition of raw feed. Hence the coal should be selected in such a way that it should be able to generate requisite gross calorific value. In direct firing system, high moisture coal is not suitable. The presence of chlorine or sulphur in coal is never favourable.

One advantage of using coal as a fuel is that the ash left after burning coal may be utilized in cement production. When cement clinkers are finally milled the ash may be mixed in requisite proportion.