Combustion of Coal

Combustion is the rapid high temperature complicated chemical reaction of oxygen with carbon, hydrogen and sulphur of coal. These reactions follow mainly four steps.

1 - Formation of coal-oxygen complexes with evolution of heat.

2 - Decomposition of these complexes with the generation of CO_2 and H_2O molecules and formation of carboxyl (COOH), carbonyl (C=O) and phenolic OH groups along with more heat generation.

3 - Decomposition of these groups to produce CO, CO_2, H_2, H_2O and hydrocarbons such as ethane, ethylene, etc.

4 - Decomposition of these hydrocarbons with the formation of CO, CO_2 and H_2O.

Coal Combustion Methods

The basic coal combustion technology can be classified on the basis of the particle size of burning coal and coal-feeding methods, which mainly include:

- fixed-bed combustion,
- coal fluidized-bed combustion,
- coal suspending combustion (Pulverized coal).

Pulverized coal

The rate of combustion of solid fuels is slow because of the difficulty of contact between the fuel and the oxygen. **The combustion rate can be increased** by increasing the rate at which air is forced in but this means a supply of excess air resulting in waste of heat. The combustion rate can also be increased by pulverising (i.e. powdering) the fuel so that air and fuel come in close contact easily.

In combustion processes, pulverized coal is preferably used, as finely ground coal has more surface area per unit weight than larger particles. Coal is finely ground so that 70 to 80 percent by weight passes through a 200-mesh screen. Coal powder is burned in a combustion chamber in a flow of air. The resulting energy is used to generate steam which is used to turn large turbines and generate electricity. On heating of pulverized coal sample in presence of air, the following changes occur:

1 - Loss of entrapped gases inside the coal, such as, methane, ethane, carbon dioxide, nitrogen etc., at or below 1000 °C.
2 - Escape of moisture between 100 to 1500 °C.
3 - Evolution of gaseous products and vapours due to the decomposition of organic components of coal at different temperatures for different coal types.

The disadvantages of this mode of combustion are
1 - Cost of drying and grinding to fine size is relatively higher, 2 - Fine dust is discharged into atmosphere along with the chimney gas.
3 - There is a tendency for slagging on refractory walls and furnace linings.

Uses of Coal

1- Directly burning and getting heat.
2- Generating steam for producing electricity (nearly 0.5 kg of coal is burnt to generate 1 KWh of electricity).
3- Driving railway locomotives.
4- Manufacturing coke and coal gas (e.g. coke oven gas, producer gas, water gas etc.).
5- Manufacturing synthetic liquid fuels.
6- Gasification to produce nitrogenous fertilizer from synthesis gas.

Coke

Coke is a grey, hard, and porous coal-based fuel with a high carbon content and few impurities, made by heating coal or oil in the absence of air. It is an important industrial product, used mainly in iron ore smelting in a blast furnace, and also as a fuel in stoves.

The term "coke" usually refers to the product derived from low-ash and lowsulphur bituminous coal by a process called coking. A similar product called petroleum coke is obtained from crude oil in oil refineries.

Coke Making

Coke is the solid carbonaceous residue that remains after certain types of coal (bituminous coal) are heated to a high temperature in the absence of air. The process of heating coal in this manner is referred to as carbonization or coke making. High-temperature carbonization, is practiced to produce a coke having the requisite properties for metallurgical use, as in blast furnaces.

Coal is crushed and blended prior to being charged in a coke oven. In hightemperature carbonization, coal is heated to temperatures 900–1,200 °C (1,600– 2,200 °F) for up to 18 hours. During that time, practically all the volatile matter is driven off as gases or liquids, leaving behind a residue that consists principally of carbon with minor amounts of hydrogen, nitrogen, sulfur, and oxygen.

The coke, when exposed to oxygen, will immediately ignite and begin to burn. When the coke is pushed from the oven into a railcar, it is quickly quenched to cool the coke and stop the burning process. The cooled coke is then dumped onto a coal wharf where it is taken to a facility to be screened and sized prior to being charged into the blast furnace.

By-products (Coal chemical)

Another important and expensive part of the coking plant is the by-product plant. The coking process generates the following main volatiles as byproducts: coke oven gas, benzol, tar, Creosote, xylene, benzene, toluene and naphthalene.

Uses of Coal Chemicals

Coal chemical recovered from coke oven gas in by-product plant are subjected to various uses. Important uses of the chemicals are described below.

1. Clean Coke Oven Gas.

During the production of coke by coal carburization in a coke oven battery a large amount gas is generated due to the vaporization of volatile matter in the coal.

It is a fuel for steel plant furnaces mainly. Besides it is a source of H_2 for ammonia production.

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2. Benzol.
It is used for the manufacture of photographic material as solvent, for rubber manufacture. Benzol is also a source of benzene, toluene and xylene which are obtained by its distillation and are valuable chemicals.

3. Tar.
It is used
-for road making purposes
-as a fuel in furnaces
-for recovering various chemicals by its distillation.

4. Phenol.
It is used
-for making the plastic.
-for the manufacture of perfumes and detergents.
-for making medicines like aspirin.

5. Naphthalene.
It is used for manufacture of Beta-naphthol which is used for making dyes and perfumes.

6. Benzene.
It is used for -for making detergents.
-for making nylons.

7. Toluene. It is used
-for making dyes, phenol, benzoic acid, benzene etc.
-as a solvent and diluent in coatings.
-for making the explosive' Trinitrotoluene' (TNT).

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