

Low Ash Metallurgical Coke (LAM Coke/MET Coke) is solid carbonaceous material obtained from destructive distillation of low ash, low sulphur Bituminous coal. Coke is formed when the coal is heated in the absence of air. The residue obtained from the carbonization of a non-coking coal such as sub Bituminous coal. Lignite or Anthracite is normally called char. Coke contains carbon as its principal constituent, together with mineral matter and residual volatile matter. Coke is used as a fuel and reducing agent in smelting iron ore in blast furnace. Since, it is one of the basic raw materials used to produce pig iron, which in turn is used to manufacture steel. This is the prime reason behind the integral steel plants having their own LAM coke manufacturing plant on premises.

Traditionally, chemistry, size & strength (both cold as well as hot) have been considered the most important properties for use in the blast furnace. The quality of the constituent coal determines the characteristics of the resultant coke.

The volatile constituents of the coal – including water, coal-gas, and coal-tar are driven off by baking in an airless oven at temperatures as high as 2,000 degree Celsius. This fuses together the fixed carbon and residual ash. Most coke in modern facilities is produced in "by-product" coke ovens. Today, the hydrocarbons are considered to be by-products of modern coke-making facilities (though they are usually captured and used to produce valuable products). Non by product coke ovens, burn hydrocarbon off-gases on site to provide the heat needed to drive the carbonization process.

Classification

There are two varieties of coke available in the global and domestic market, both having a diverse set of end use applications. These two varieties are-

- a) Metallurgical Coke (or Met Coke)
- b) Petroleum Coke (or Pet Coke)

Metallurgical coke, also known as "Met" coke or "LAM" coke, is a carbon material manufactured by the "destructive distillation" of various blends of bituminous coal. Met coke has a very low volatile content. However, the "ash" constituents remain encapsulated in the resultant coke. Typical purities range from 82-92% fixed carbon. The different varieties of metallurgical coke include -

- Blast Furnace grade
- Foundry grade
- Ferro alloy coke
- Other chemical industries grade

The consumption of LAM coke in India is generally indicated in Figure given below. From this Figure below, it can be noted that pig iron manufacturers are the major consumers of LAM coke.

Figure consumption pattern of Met Coke

i)Pig Iron Industry	75%
ii)Foundry	15%
iii)Ferro-Alloys	5%
iv)Others	5%

Total 100%

Typical Specification of the LAM coke is given below:-

VM	<1.5% (air dry basis)
Ash	<11.0% (air dry basis)
Sulphur	<0.6% (air dry basis)
Phosphorus	<0.03.5% (air dry basis)
M40	<Min 80%
M10	<Max 7%
CRI	<25 to 30%
CSR	<Min 60%

For medium and high ash coke (MAM and HAM coke), the ash contents shall be Max 18% and 24/25%.

Background

The encyclopedia defines coke as a coherent; cellular, carbonaceous residue remaining from the dry (destructive) distillation of coking coal. It contains carbon as its principal constituent, together with mineral matter and residual volatile matter. The residue obtained from the carbonization of non-coking coal, such as sub bituminous coal, lignite, or anthracite, is normally called char. Coke is used predominantly as a fuel reluctant is the blast furnace to reduce iron ore to iron, and in the furnace it also serves to support the burden of iron ore and fluxes. Coke is classified not only by the oven in which it is made (by product or beehive) but also by the temperature at which it is made. Coke is also classified by its end use, viz., BF coke, foundry coke, water-gas coke, and domestic coke. The most extensive use of coke in the world by far, is the BF grade of coke which has to have certain characteristics of strength to bear the blast furnace burden and have a low reactivity to optimize the reaction in the BF, particularly in these days when the coke rates in the BF have come down due to PCI (pulverized coal injection).

Coke making developed in the British Isles, in France and Germany, from where the technology was brought to the US, first to the Pittsburgh area where its rich coal fields and flourishing iron industry made it a primary center of coke production.

Coke is formed when coal is heated in the absence of air. During the heating in the range of 350-500°C the coal softens and fuses into a solid mass. The coal is partially devolatalised in this temperature range, and further heating at temperatures upto 1100-1150°C reduces the Volatile Matter (VM) to less than 1%. The degree of softening, melting, agglomeration attained during heating and the amount of inerts in the coal determines, to a large extent, the character of coke produced.

In order to produce coke having the desired properties, a number of coals are blended together before charging into the coke oven. Although there are some exceptions, high VM coals of 32-38% VM are generally blended with low VM coals of 15-20%. The VM in the final coal blend desired in the coke ovens is in the region of 21 to 24%. In this way to desirable properties of each of the coals, whether it be an impurity content or in contribution to the character of the coke are utilized. The low VM coals usually improve the strength characteristics of the coke and certainly its yield. In the production of the

foundry coke a small percentage of inert such as ground anthracite fines or ground coke breeze, improve the characteristics of the coke. The temperature of coking also plays a very important role in the character of final coke product. Whereas higher temperatures and longer coking cycles are known to produce higher coke strength after Reaction (CSR) and lower coke reactive index (CRI) for similar coal blends, in the case of foundry coke lower coking temperatures improve its shatter index and raise the CRI which qualities are preferred for foundry applications. High reactivity towards oxygen entails quicker and higher evolution of heat so that the evolution of CO is minimized in the cupola – which is the opposite of what is desired in the blast furnace.

Product Applications

Applications of low ash metallurgical coke (LAM coke) is described here as under -

- ✓ Iron Foundries : Iron Foundries use coke in the Cupola to melt iron for casting it into various shapes as per applications. The iron foundries in India are spread out throughout the country.
- ✓ Steel Foundries : Steel foundries use met coke to provide additional carbon content to the molten metal depending upon the specification of the casting.
- ✓ Non ferrous metal castings : Foundries that make castings of copper and brass use met coke for melting the metal.
- ✓ Lead and zinc Smelters : Coke is a prime ingredient in the process of lead and zinc smelting.
- ✓ Secondary Steel Producers : 'Mini' steel plants that produce steel from recycled steel scrap and sponge irons require coke.
- ✓ Chemical Plants : Some soda ash plants and calcium carbide producers require coke in their process.
- ✓ Ferro Alloy Plants : Ferro alloy producers require coke for their production. Coke is used as a reducing agent in this process.
- ✓ Pig iron Producers : Production of pig iron requires coke. In India small pig iron producers require coke and buy the coke from the open market. Typically larger steel producers have their own plants and therefore, are not in the market to buy coke.