

### Differentiation of coking & non-coking coals:

From physical appearance it is very difficult if not impossible to differentiate between non-coking & a coking coal.

**A non – caking coal** is that coal which when heated in the absence of air for e.g. as in the determination of VM, leaves a powdery residue. A non-caking coal is always a non-coking coal. A non-coking coal may not be non-caking coal. (Reason : a non-coking coal can also produce coke which is never suitable for steel industry). A non-caking coal is that coal which on heating in absence of air doesn't form a coherent mass of residue.

**A Caking coal**, when heated in a similar way, leaves a solid coherent residue. The caking coal might give a coke which may not be accepted by the steel plants as it does not possess the requisite physical and chemical properties of the coke. A coking coal is that coal which on heating in absence of air leaves a solid residue.

**A non-coking coal** also leaves a solid coherent residue which may not possess the physical & chemical properties of the coke. The non-coking coals are those coals which may form a solid-residue but may not be suitable for manufacture of coke. This coal may form a coke which will not meet the physical & chemical properties as laid down by the steel industry, the primary coke consumer.

**A Coking coal** is that coal which when heated in absence of air leaves a solid coherent residue possessing metallic grayish luster & which possesses all the physical & chemical properties in the coke when manufactured commercially. Coking coal are those coals which after heating in absence of air leaves a residual coke. This coke when satisfies all the physical & chemical characteristics such as CSR, CRI, Shutter Index, Micum 10 & 40 & Porosity, are accepted by the steel plants. The coal which produces such coke is termed as coking coal.

### Various properties of coals which gives rise to the manufacture of coke

#### **A) Chemical properties :-**

- (1) **Carbon :-** The elements carbon expressed on dry mineral matter free (DMMF) basis should vary between 85-88%.
- (2) **Hydrogen :-** The hydrogen DMMF basis should vary between 3.7 to 4.5%.
- (3) **Sulphur :-** In the sulphur both organic & inorganic should not exceeds 0.75% on DMMF basis.
- (4) **Phosphorous :-** The Phosphorous present in the coking coal should not exceeds 0.15 – 0.25%.
- (5) **Other elements :-** Such as Nitrogen, Iron & Other rarer elements must be present in traces.

#### **B) Mineral Matter :-**

The mineral matter in the coking coal normally should not exceed 20% under any circumstances since the mineral matter constitute a portion of inert matter hence its quality should not exceeds 20%. There are 2 kinds of MM in the coal. (i) Inherent MM and (ii) Extraneous. It has not yet been possible to reduce the extraneous MM, that too, upto a certain extent.

**C) Physical Properties:** The development of coking property is an intrinsic property. The reason for development of coking property has not yet been clearly established. By physical tests it can be determined whether the coal is coking or non-coking. The following destructive physical test is used for finding the coking propensity of coal.

**1. Geisler Plastometer :-** Equipment should give a reading between 500 to 2000 dial divisions per minute. Higher the fluidity of coal mass, better will be the dial division per minute.

**2. Caking Index :-** In this test certain amount of powdered coal is thoroughly mixed with graded and sized sand. The total quantity of sand and coal should not exceed 25 grams. This mixture when heated at  $925^{\circ}$  in the absence of air, after cooling down should form a coherent residue. This coherent residue should be able to withstand a weight of 500 grams without generating more than 5% of powder out of the residue. If the solid residue is more than 5% then the proportion of coal in the mixture of sand and coal should be increased and vice versa. Normally caking index for coking coal should vary from 20-24 for a bee-hive oven the minimum index should be 13 and maximum 24.

**3. Swelling Index :-** During determination of volatile matter in coking coal a solid residue is left, comprising of fixed carbon and mineral matter. The solid residue, that is the coke bead is viewed horizontally at the same level of the eye. It will be observed that the top surface of the bead has developed some amount of swelling. This swelling is compared with a standard chart indicating the quantum of swelling and a number indicating swelling index. Swelling index varying between 2-5 is ideal for coke manufacturing. The high swelling coal is not charged for coke making as it would create unnecessary pressure on the side wall of the oven which will also produce a coke porous structure.

**4. Volatile Matter :-** The volatile matter of coking coal should vary between 19-26% on DMMF basis. A coal with less VM than 19% will give rise to a coke which will not have proper physical properties. A coal with VM higher than 26% will give rise to coke with more porosity and physical strength, such as CSR and CRI. The VM in coal consists of various gaseous products which are generated when the coal is heated in the absence of air at a temperature more than  $900^{\circ}\text{C}$ . The gases consist of a combination of carbon and hydro-aromatic compounds. The gases are mainly methane, Acetylene, gaseous Amino-compound. The gases are mainly Methane, Hydrogen and Carbon and some other hydrogen-aromatic compounds such as phenol and benzene. Some amount of tar is also generated in gaseous form.

**5. Petrographic Analysis and Reflectance:** Another most important non-destructive test of coal which is used for determining of coking coal is the petrographic analysis & reflectance. The coking coal should have a minimum of 60% vitrinite (active constituents) and maximum of 40% Inertinite (non—reactive constituent). For finding out the physical strength of the coke, reflectance studies on coking coal are also done. In this study the ideal value of reflectance will be within 1.3 – 1.5. Generally the coking property develops in coal if its reflectance is between 0.9 – 1.3.