



# SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution



DEPARTMENT OF MECHANICAL ENGINEERING

19MEB203 - THERMAL ENGINEERING

UNIT 1-Fuels & Combustion

Determination of Properties

## Physical Properties

### Heating Value:

The heating value of coal varies from coal field to coal field. The typical GCVs for various coals are given in the Table 1.4.

TABLE 1.4 GCV FOR VARIOUS COALS				
Parameter	Lignite (Dry Basis)	Indian Coal	Indonesian Coal	South African Coal
GCV (kCal/kg)	4,500*	4,000	5,500	6,000

\*GCV of lignite on 'as received basis' is 2500 – 3000

### Analysis of Coal

There are two methods: ultimate analysis and proximate analysis. The ultimate analysis determines all coal component elements, solid or gaseous and the proximate analysis determines only the fixed carbon, volatile matter, moisture and ash percentages. The ultimate analysis is determined in a properly equipped laboratory by a skilled chemist, while proximate analysis can be determined with a simple apparatus. It may be noted that proximate has no connection with the word "approximate".

### Measurement of Moisture

Determination of moisture is carried out by placing a sample of powdered raw coal of size 200-micron size in an uncovered crucible and it is placed in the oven kept at  $108 \pm 2^\circ\text{C}$  along with the lid. Then the sample is cooled to room temperature and weighed again. The loss in weight represents moisture.

### Measurement of Volatile Matter

Fresh sample of crushed coal is weighed, placed in a covered crucible, and heated in a furnace at  $900 \pm 15^\circ\text{C}$ . For the methodologies including that for carbon and ash, refer to IS 1350 part I:1984, part III, IV. The sample is cooled and weighed. Loss of weight represents moisture and volatile matter. The remainder is coke (fixed carbon and ash).

## Measurement of Carbon and Ash

The cover from the crucible used in the last test is removed and the crucible is heated over the Bunsen burner until all the carbon is burned. The residue is weighed, which is the incombustible ash. The difference in weight from the previous weighing is the fixed carbon. In actual practice Fixed Carbon or FC derived by subtracting from 100 the value of moisture, volatile matter and ash.

### Significance of Various Parameters in Proximate Analysis

#### (a) Fixed carbon:

Fixed carbon is the solid fuel left in the furnace after volatile matter is distilled off. It consists mostly of carbon but also contains some hydrogen, oxygen, sulphur and nitrogen not driven off with the gases. Fixed carbon gives a rough estimate of heating value of coal.

#### (b) Volatile Matter:

Volatile matters are the methane, hydrocarbons, hydrogen and carbon monoxide, and incombustible gases like carbon dioxide and nitrogen found in coal. Thus the volatile matter is an index of the gaseous fuels present. Typical range of volatile matter is 20 to 35%.

Volatile Matter

- Proportionately increases flame length, and helps in easier ignition of coal.
- Sets minimum limit on the furnace height and volume.
- Influences secondary air requirement and distribution aspects.
- Influences secondary oil support

#### (c) Ash Content:

Ash is an impurity that will not burn. Typical range is 5 to 40%

Ash

- Reduces handling and burning capacity.
- Increases handling costs.
- Affects combustion efficiency and boiler efficiency
- Causes clinkering and slagging.

#### (d) Moisture Content:

Moisture in coal must be transported, handled and stored. Since it replaces combustible matter, it decreases the heat content per kg of coal. Typical range is 0.5 to 10%

Moisture

- Increases heat loss, due to evaporation and superheating of vapour
- Helps, to a limit, in binding fines.
- Aids radiation heat transfer.

#### (e) Sulphur Content:

Typical range is 0.5 to 0.8% normally.

Sulphur

- Affects clinkering and slagging tendencies
- Corrodes chimney and other equipment such as air heaters and economisers
- Limits exit flue gas temperature.