

# CLASSIFICATION OF COAL

## TERMS USED

- V (VM) → Volatile matter content
- C → Carbon content
- A → Ash content
- M → Moisture content
- O → Oxygen
- N → Nitrogen
- H → Hydrogen
- S → Sulphure
- daf → Dry Ash free basis
- dmmf → dry mineral matter free basis
- BTU → British Thermal Unit.

## Classification of coal

- Coal is a naturally available heterogeneous organic matter mass. So very difficult to classify.
- Hence for last 150 years many attempts have been made.
- Since then many system of classification have classified coals according to different classification basis.

• Following are examples of such classification system -

(1) Classification by Visual characters

| Category           | Attributes                    | Flame               |
|--------------------|-------------------------------|---------------------|
| Brown coal/Lignite | Brown Colour, woody structure |                     |
| Bituminous coal    | Black and banded              | Smoky yellow flame  |
| Anthracite         | Black and lustrous            | Burns without flame |

(2) Classification based on their source of Genesis :-  
Humic and Sapropelic Coal.

Humic Coal :

- These developed from terrestrial plant debris that was exposed to atmosphere and passed through heat stage.
- Higher plant kingdom is source.

Sapropelic Coal :-

- Developed from planktonic, algae, terrestrial plant - but in anaerobic or lacustrine conditions.
- E.g. bog head coal, Cannel coals.

(3) Classification by Ultimate Analysis :-

(1) Regnault - Grouner - Broquet System

- first attempt in 1837
- Based on the C, H, O content.
- only includes coal with more than 75% Carbon on d.a.f basis.
- Initially Regnault gave a system considering only O+N but later modified.

Percent mean (O+N)

|                                |       |
|--------------------------------|-------|
| Anthracite                     | 2.62  |
| Lean or short flame bituminous | 4.47  |
| Bituminous (Smithy) Coal       | 5.7   |
| Long flame bituminous          | 8.89  |
| Dry long flame                 | 16.39 |

These developed from the earliest plant debris that was exposed to atmospheric and microbial through heat and light. Higher plants have been developed from these. The coal is a solid fossil fuel. It is a hydrocarbon compound. It is a solid fossil fuel. It is a hydrocarbon compound. It is a solid fossil fuel. It is a hydrocarbon compound.

# Classification Tables of Renault - Gruner - Broquet System

| Genus                 | Class                                 | Chief Use                                  | Percentage Composition |            |             | % Volatile at 900°C | % Fixed Carbon | Character of Carbonaceous Residue |
|-----------------------|---------------------------------------|--|------------------------|------------|-------------|---------------------|----------------|-----------------------------------|
|                       |                                       |  | C                      | H          | O + N + S   |                     |                |                                   |
| A<br>Lignite          | Non-caking                            | ...  | 60 to 70               | About 5.0  | 20 to 35    | Above 45            | below 55       | Non-coherent                      |
|                       | 1. Non-caking long flame              | Reverberatory furnace                      | 75 to 80               | 4.5 to 5.5 | 15 to 20    | 40 to 45            | 55 to 60       | Non-coherent                      |
|                       | 2. Caking, long flame                 | Gas making                                 | 80 to 85               | About 5.6  | 10 to 15    | 32 to 40            | 60 to 68       | Very porous coke                  |
|                       | 3. Hard caking                        | Coke manufacturing                         | 84 to 89               | 5.0 to 5.6 | 5.5 to 11.0 | 26 to 32            | 68 to 74       | Dense coke                        |
| B<br>Bituminous       | 4. <del>Hard</del> Caking short flame | Coke manufacturing and steam raising       | 88 to 90               | 4.5 to 5.5 | 5.5 to 6.5  | 18 to 26            | 74 to 82       | Very dense coke                   |
|                       | Non-caking short flame                | Steam raising                              | 90 to 92               | 4.0 to 4.5 | 4.0 to 5.5  | 15 to 20            | 80 to 85       | Weakly caking or non-coherent     |
| BC<br>Semi Bituminous | Anthracitic non-caking                | Steam raising                              | 92 to 94               | 3.0 to 4.5 | 3.0 to 4.5  | 8 to 15             | 85 to 92       | Suberulent                        |
|                       | Anthracitic and Anthracite non-caking | Domestic and Central heating Melting Kilns |                        |            |             |                     |                |                                   |

## Q(9) Tyler's classification

- The complete system was published in 1899
- % age of C, N, O and H is considered in dry ash sulfur free basis.
- His classification divided coal into 7 carbon planes and 2 hydrogen planes.
- The 7 carbon planes are

(i) Anthracite ( $>93.3\% \text{ C}$ )

(ii) Carbonaceous ( $91.2 - 93.3\% \text{ C}$ )

(iii) Bituminous

(1) Meta ( $91.2 - 89\% \text{ C}$ )

(2) Ortho ( $87 - 89\% \text{ C}$ )

(3) Para ( $84 - 87\% \text{ C}$ )

Lignitons

1. Meta ( $80 - 84\% \text{ C}$ )

2. Ortho ( $75 - 80\% \text{ C}$ )

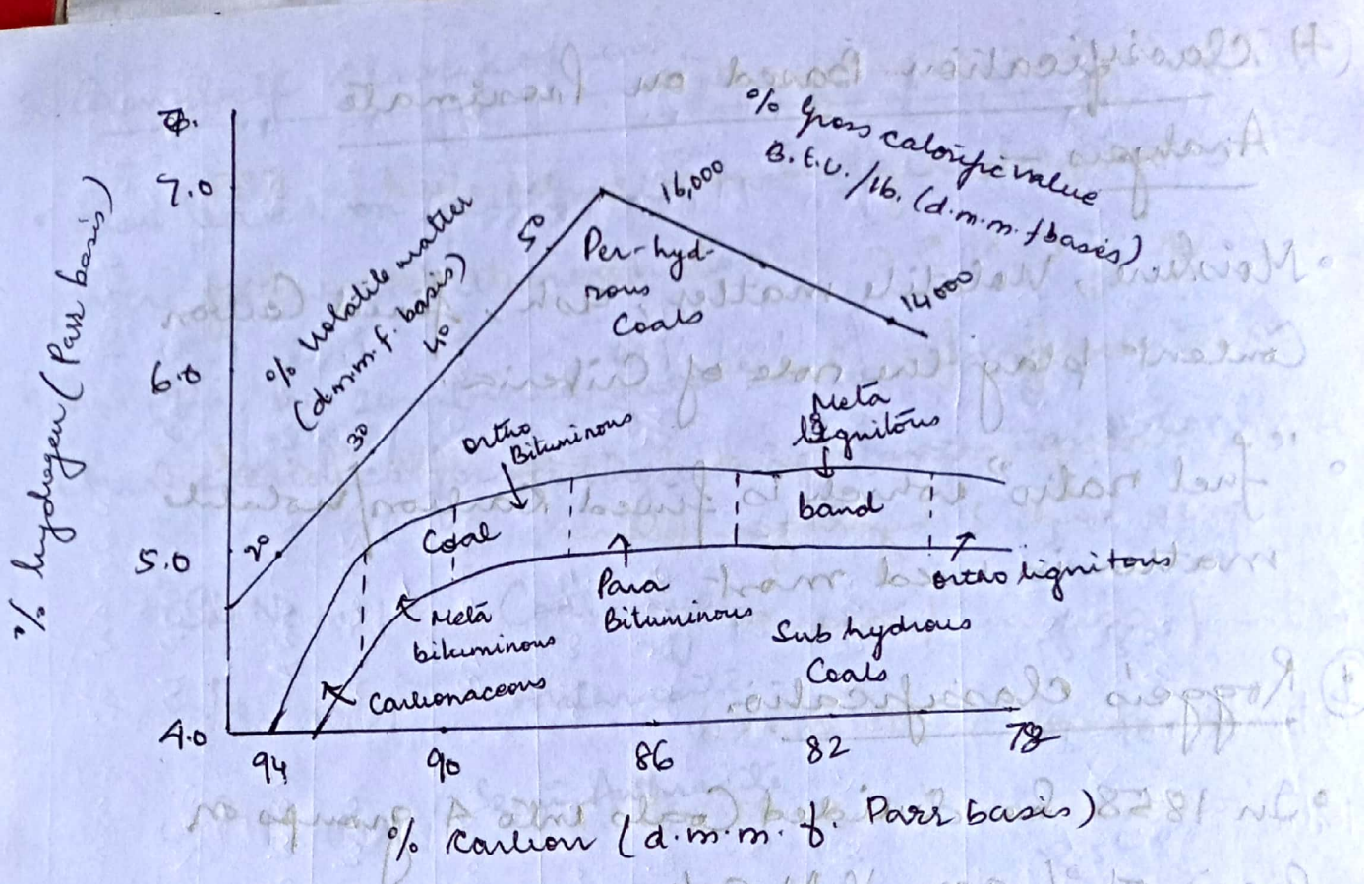
◦ Hydrogen planes

1) Perhydrous ( $> 5.8\% \text{ of H}$ )

2) Subhydrous ( $< 4\% \text{ of H}$ )

### Advantages

- Complex naming
- Inadequate classification for low rank coals
- Applicable only to British Carboniferous coal.



### 3. Grout and Ralston classification

- In 1907 Grout plotted C, H, O content of American Coal on a tri-axial diagram.
- The plot separated Cannel coal (high H) from Ordinary Coal.
- Classification was based on dry- & ash free analysis including fixed C and total C.
- In 1915 Ralston extended the study and found Coal of equal Volatile matter (isovols) and equal Calorific value (isocal) can be represented by straight line in a triangle.

#### (4) Classification Based on Proximate Analysis -

- Moisture, Volatile matter, ash, fixed Carbon Content play the role of Criteria.
- "fuel ratio" which is fixed Carbon/volatile matter is used most

#### (1) Rogge's classification

- In 1858 he divided Coals into 4 groups on basis of % age V, M, ash

#### (2) Frazer's classification

In 1877 he used fuel ratio to classify Coal as given: -

| Sl. no | Coal Type       | Fuel ratio |
|--------|-----------------|------------|
| 1      | Anthracite      | 100-12     |
| 2.     | Semi Anthracite | 8-12       |
| 3.     | Semi bituminous | 5-8        |
| 4.     | Bituminous      | 0-5        |

- Coals of lower rank than bituminous were not considered.

- Study was on only Pennsylvania Coals

### 3. Campbell classification

- also based on fuel ratio but all coals below 5 FR were taken as bituminous coal.
- In 1926, he combined fuel ratio to different characteristics for distinguishing lower rank coal.

| Sl. No. | Coal type       | Fuel Ratio |
|---------|-----------------|------------|
| 1       | Anthracite      | 10-50      |
| 2       | Semi Anthracite | 5-10       |
| 3       | Semi bituminous | 2.5-5      |
| 4       | Bituminous      | < 2.5      |

### 4. Parr's classification

- He considered volatile carbon, total carbon, inert volatile matter and gross coal index (C + available H + S).
- The basis was volatile carbon  $\times 100 / \text{Total Carbon}$ .
- He gave a new classification in 1928, where he used following formula.

$$\text{Unit B.T.U} = \frac{(\text{indicated BTU} - 505) \times 100}{100 - (1.084 + 0.555)}$$



$$\text{Unit VM} = \frac{V \text{ as determined} - (0.8A + 0.4S) \times 10}{100 - (1.02A + 0.55S)}$$

| Class           | % Unit VM | Unit BTU      |
|-----------------|-----------|---------------|
| Anthracite      | 0-8       | 15000 - 16500 |
| Semi Anthracite | 8-12      | 15000 - 16500 |
| Bituminous A    | 12-24     | 15000 - 16500 |
| Bituminous B    | 25-50     | 14000 - 15000 |
| Bituminous C    | 36-55     | 12500 - 14000 |
| Bituminous D    | 35-60     | 11000 - 12500 |
| Lignite         | 35-60     | 9000 - 11000  |
| Peat            | 55-80     |               |

So A.S.T.M Classification

- It classifies coal to A broad classes based on fixed Carbon and Calorific value (BTU) on dry mineral matter free basis.
- Application only to vitrinite rich Coal and includes Southern Goodranland Coal.
- Gross Heating value found on a moist ad mineral matter free basis. Moist refers to the percent water contained  $(43 \text{ kJ/kg} \times 43.11 = \dots)$

Coal containing 69 wt% or more fixed carbon on a dry mmf basis are ranked according to their fixed carbon content regardless of their gross heating value.

## 6. Classification By National Coal Board

- Specifically designed for Commercial use.
- Rank based.
- Use 3 digit code to identify main class, class and subclass to which a coal belong.
- Applicable to vitrinite rich coal.
- Volatile matter in dmmf basis and Gray King Coke type value are considered.

## 7) International Classification of Hard Coal

- Mainly for anthracite and bituminous coal but covers fairly all kind.
- Uses 4 digit code that defines 8 parameters namely
  - Vitrinite reflectance
  - Reflectogram characteristics
  - Inertinite Content
  - Exinite / Liptinite Content

- Caking property (PSI)

- 2 for VM

- 2 for Ash

- 2 for S

- 2 for gross calorific value

## ⑧ Classification of Indian Coal

Scientific Coding of Indian Coal.

- 3 basic parameters and 1 supplementary parameter.

- 1st digit (1-9) corresponds to Calorific value (dmmf)

- 2nd (0-9) one volatile matter (dmmf)

- 3rd (0-5) one coke type.

- 4th (1-6) one: Maximum thickness of plastic layers for Caking Coal and M% for non-caking

## ⑨ Grading of Indian Coal

For grading of Non-Coking Coal useful heat value is used which is calculated by

$$HV = 8100 - 138(\text{ash} + \text{moisture}) \text{ Kcal/kg}$$

① If  $M < 2\%$  and  $VM < 19\%$  then deduct 150 Kcal/kg for each 1% reduction in VM.

② M at 40°C and 60% RH.

◦ Grading doesn't include coal from North East India.

◦ Grading of Coking Coal is done as per their ash

Content

### Grading of Non-Coking Coal

| Grade | Useful heat value (kcal/kg) |
|-------|-----------------------------|
| A     | > 6200                      |
| B     | 5601 - 6200                 |
| C     | 4941 - 5600                 |
| D     | 4201 - 4940                 |
| E     | 3361 - 4200                 |
| F     | 2401 - 3360                 |
| G     | 1301 - 2400                 |