PURPOSE

The purpose of this presentation is to provide a basic understanding of the quality of coal and related aspects:

1. How coal is defined
2. How coal is distributed in the world
3. How coal is used and our dependence
4. How coal is conventionally analysed
5. Limitations to conventional analyses
6. The nature of coal – types, ranks and grades
7. Reasons for coal quality variations
What is Coal?

Coal is characterised as follows:

- Combustible rock
- `<50% by mass ash content` or `>50% by mass` carbonaceous material derived from ancient plants
- Compaction and alteration of plant material
- Different kind of plant material (`Types`)
- Degree of metamorphism (`Rank`)
- Range of impurities (`Grade`)
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SURVEY OF GLOBAL ENERGY RESOURCES
- COAL -

- North America
- South America
- Europe
- Africa
- Middle East
- Asia
- Oceania

RESERVES 909 Gt
PRODUCTION 4.8 Gt/year
CONSUMPTION 4.8 Gt/year

SOURCE: BP; WCI, Wicks
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The coal trade is divided into **thermal coals** and **metallurgical coals**. Thermal coals are used for **steam raising** and industrial applications such as cement making. Metallurgical coals are used for **iron and steel production**. A third category could be called conversion coals used in oil and gas production but normally not traded. The chart shows the magnitude of the coal trade (After WoodMac, 2009).
South Africa’s Dependence on Coal

South Africa is the
6\textsuperscript{th} largest producer of coal in the world
6\textsuperscript{th} largest exporter of coal
Possesses c 6\% of world coal reserves

Coal in SA accounts for
1\textsuperscript{rd} largest foreign exchange earnings in the country
1\textsuperscript{st} highest mining income earner commodity, beating gold
94\% of SA electricity production
>90\% of carbon reductants in the metallurgical industry
>30\% of petrol and diesel requirements
>200 major chemicals for 1000s of carbon-based products

It is the mainstay of SA’s industrialisation, quality of life, employment and income
SOUTH AFRICA’S COAL CHAIN 2011

Run-of-Mine Production

303.6 Mt

Screening

122.2 Mt

“Washing”

181.4 Mt

Stocks

1.0 Mt

Local Use 24.0 Mt

Exports 64.0 Mt

Discards 51.8 Mt

50.4 Mt

4.0 Mt

40.0 Mt

Synfuels 44.0 Mt

Electricity 120.8 Mt

40.0 Mt

4.0 Mt

80.8 Mt

Source: XMP Consulting
Local Users of Coal

Export

Power Generation

Synfuels

Metallurgical

Small Scale Industry

Coal products from mine

Marketing

- Coking, blend coking, PCI
- Steam / power generation
- Industrial and domestic uses

Eskom – 14 major power stations

IPP – Small independent power stations

Synfuels – Petrol, diesel, Carbotar, petcoke, graphite, fertilisers, explosives, plastics, paints, 200 base chemicals – 1 000’s of down-line carbon products

Chemical Industry – Ammonia, fertilisers, explosives, advanced carbons – carbon fibres, nanotubes

Industries: Kumba/Mittal; SCAW Metals, Samancor; Highveld steel and vanadium; aluminium smelters; silicon carbide; ferrochrome; ferro-manganese, etc.

Coal and C products: Carbon reductants: coke, char, anthracites, bituminous coal, petcoke, graphite; electrode feed; coal for heat production and pre-reduction; carbonising steel; briquettes, etc.

Heat and power generation - pulp and paper, textiles, agriculture, sugar, tobacco, mining, brick and tile, cement, lime, manufacturing factories, hospitals.

Chemical Industry – Ammonia, fertilisers, explosives, carbon products

Domestic households – coal, anthracite, low smoke fuels, etc.
Ranking of South Africa’s role in some world mineral reserves, production and exports (after Pinheiro 2009)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Reserve base</th>
<th>Production</th>
<th>Exports</th>
</tr>
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<tbody>
<tr>
<td>Coal</td>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Chrome (Cr)</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Ferro-chromium (FeCr)</td>
<td>n.a. (1)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ferro-Manganese/Ferro-Silicon (FeMn/Fe-Si-Mn)</td>
<td>n.a.(1)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ferro-Silicon (FeSi)</td>
<td>n.a.</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Iron ore (Fe)</td>
<td>11</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

n.a. denotes not available or confidential
WHY COAL & COKE IN METALLURGY

• Carbon is the no. 1 pyrometallurgical reagent:
  - Reductant (removes oxygen)
  - Fuel (adds energy to the process)
  - Conductor (of electricity) (coke)
  - Structural element (supports blast furnace contents) (coke)
  - Sintering – agglomerating non-usable fine ore

• Approx. 0.5 tonnes of coke per hot metal (blast furnace)
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HEAT OUTPUT = CALORIFIC VALUE [CV MJ/kg]
- CV +

HEAT CONSUMERS

HEAT PRODUCERS

MOISTURE - H₂O

ASH - MINERALS

VOLATILE MATTER - VM

FIXED CARBON - FC

PROXIMATE ANALYSIS = H₂O + Ash + VM + FC (%)

14
## LOCAL COAL PRODUCTS

### Proportions sold by grade (Ash% ad)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>CALORIFIC VALUE (GMJ/kg ad)</th>
<th>Mass%</th>
<th>Proportion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special</td>
<td>&gt; 28</td>
<td>4 364 232</td>
<td>2,5</td>
</tr>
<tr>
<td>Grade A</td>
<td>&lt;28.5 &gt; 27.5</td>
<td>5 749 903</td>
<td>3,3</td>
</tr>
<tr>
<td>Grade B</td>
<td>&lt;27.5 &gt; 26.5</td>
<td>5 725 462</td>
<td>3,3</td>
</tr>
<tr>
<td>Grade C</td>
<td>&lt;26.5 &gt; 25&lt;5</td>
<td>4 248 201</td>
<td>2,4</td>
</tr>
<tr>
<td>Grade D</td>
<td>&lt; 25.5</td>
<td>154 152 684</td>
<td>88,5</td>
</tr>
</tbody>
</table>

<br>\[<5 470 \text{ kcal/kg}]\]
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5. **Limitations to conventional analyses**
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## SPECIFICATIONS OF TWO COALS

NB: THE SAME PROXIMATE ANALYSES BUT DIFFERENT COKING PROPERTIES

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherent Moisture</td>
<td>2,5</td>
<td>2,6</td>
</tr>
<tr>
<td>Volatile Matter %ad</td>
<td>24,0</td>
<td>24,5</td>
</tr>
<tr>
<td>Ash Content %ad</td>
<td>10,0</td>
<td>9,5</td>
</tr>
<tr>
<td>Fixed carbon</td>
<td>63,5</td>
<td>63,4</td>
</tr>
<tr>
<td>Free Swelling Index (FSI)</td>
<td>9</td>
<td>1,5</td>
</tr>
</tbody>
</table>
QUALITY ANOMALIES USING CONVENTIONAL SPECIFICATIONS OF TWO COALS

<table>
<thead>
<tr>
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<th>A</th>
<th>B</th>
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<tbody>
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</tr>
<tr>
<td>Fixed carbon</td>
<td>63,5</td>
<td>63,4</td>
</tr>
<tr>
<td>Free Swelling Index (FSI)</td>
<td>9</td>
<td>1,5</td>
</tr>
<tr>
<td>Maceral comp (vitrinite%)</td>
<td>82,0</td>
<td>25,0</td>
</tr>
<tr>
<td>Rank (RoV random%)</td>
<td>1,2</td>
<td>0,6</td>
</tr>
</tbody>
</table>
DO NOT ASSIST IN PREDICTING:

**COKING**
- SOFTENING
- SWELLING
- FLUIDITY / PLASTICITY
- BINDING
- STRENGTH

**COMBUSTION**
- IGNITION
- FLAME STABILITY
- TEMPERATURE DISTRIBUTION
- BURNOUT
- BLENDING CAPACITY
THIS REQUIRES A DOUBLE APPROACH TO COAL QUALITY ASSESSMENTS

**EMPirical properties**

Chemical and physical analyses

<table>
<thead>
<tr>
<th>OTHER</th>
<th>ASH</th>
<th>ULTM</th>
<th>PROXIM.</th>
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<tbody>
<tr>
<td>CV</td>
<td>SiO₂</td>
<td>C</td>
<td>H₂O</td>
</tr>
<tr>
<td>AFT</td>
<td>Al₂O₃</td>
<td>H</td>
<td>VM</td>
</tr>
<tr>
<td>Si</td>
<td>Fe₂O₃</td>
<td>O</td>
<td>ASH</td>
</tr>
<tr>
<td>HGI</td>
<td>CaO</td>
<td>N</td>
<td>FC</td>
</tr>
<tr>
<td></td>
<td>MgO</td>
<td>P</td>
<td></td>
</tr>
</tbody>
</table>

**FUNDAMENTAL CONSTITUTION**

Composition, condition and degree of maturity petrographic and microscopic analyses

- Organic macerals
  - Vitrinite
  - Exinite
  - Inertinite
- Inorganic minerals
  - Quartz
  - Clay
  - Pyrite
- Reflectogram
- Refl. of Vitrinite
- Std Deviation
- Key
  - MACERALS – Microscopic residues of decomposed plants materials
  - RANK – Levels of maturity
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Conditions in coal formation

(Cairncross, 2005)
1. TYPE OF COAL

REFERS TO THE ORGANIC COMPOSITION AND NATURE OF COAL

THREE GROUPS OF ORGANIC FRAGMENTS i.e.
MACERAL GROUPS IN COAL

1. Vitrinite Group
2. Inertinite Group (fusinite and semifusinite)
3. Liptinite Group
NEW INTERNATIONAL CLASSIFICATION OF SEAM COAL

BY TYPE - HARD COAL

Macroscopic description of type
NEW INTERNATIONAL CLASSIFICATION OF SEAM COAL
BY TYPE - HARD COAL

ECU-UN TASK FORCE WG OCT 1991/1992

OLD TERMINOLOGY
MACROSCOPICALLY DEFINED TERMINOLOGY

SEAM COAL

HUMIC COAL
Stratified

BRIGHT
VITRINITE >65%

BANCED
INTERMEDIATE-FUSIC

DULL
FUSIC

SAPROPELIC
Non-stratified

MASSEIVE
CONCHOIDAL DULL
(TORBANITE, CANNEL etc.)

INTERMEDIATE-LIPTIC

VISUAL CHARACTERISATION

NEW TERMINOLOGY
MICROSCOPICALLY DEFINED TERMINOLOGY

HAND SPECIMEN

VITRIC

VITRINITE

CLARAIN

INTERMEDIATE-FUSIC

VITRINITE < 65%
INERTINITE 17.5%-55%
LIPTINITE < 17.5%

FUSAIN DURAIN

FUSIC

INERTINITE

>65%

SAPROPEL

INTERMEDIATE-LIPTIC

VITRINITE < 65%
INERTINITE 17.5%-25%
LIPTINITE < 17.5%

SAPROPEL

LNIPTINITE

>65%

COMPOSITION & FORM
FORMATION OF VITRINITIE AND INERTINITE

OXIDATION (Eh) ON PLANT DECOMPOSITION THIS GIVES RISE TO THE BASIC STRUCTURE AND FORM OF THE ULTIMATE ORGANIC COMPONENTS IN COAL - MACERALS

INERTINITE formation
FUSINITE

Semifusinite formation

VITRINITIE formation
ORGANIC MATTER IN COAL
Maceral Groups

**VITRINITE**
- Grey, homogenous;
- Jellified ancient wood
- Wood deposited in-situ in shallow water conditions
- Volatile rich
- Easy to combust, short burn out

**INERTINITE (Fusinite - inert)**
- White, cell walls of ancient wood;
- Cells in-filled with carbonates
- Wood deposited in-situ
- in dry oxidising conditions
- Volatile poor
- Difficult to combust, long burn out

**INERTINITE (Semifusinite - partially reactive)**
- Pale grey, partially jellified cell walls of ancient woody tissue;
- Wood deposited in semi-wet conditions
- Moderate volatiles
- Relatively easy to combust, moderate burnout
FORMATION OF LIPTINITE

Liptinite macerals include spores and pollens with waxy coatings (exines), cuticles of leaves, resins in wood and algae.
THE MICROSCOPIC ORGANIC COMPONENTS OF COAL-GROUP MACERALS AND MACERALS

INERTINITE

* Semi-Fusinite

Fusinite

Sclerotinite

*Micrine

*Macrine

Inertodetrinite

RSF - TRANSITIONAL

Collinite

Telinite

Alginite

Sporinite

Cutinite

Resinite

VITRINITE

EXINITE / LIPTINITE

NON-REACTIVE COMPONENTS

REACTIVE COMPONENTS

*Some components semi-reactive within lower ranks of coal.
IMPACT OF BENEFICIATION (WASHING) ON COAL QUALITY

GRADE: CHANGES IN ASH CONTENT

TYPE: CHANGES IN MACERAL COMPOSITION

HMS BENEFICIATION PROCESS

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>ASH %</th>
<th>VOLATILE %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low ash</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>EXPORT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middlings 1</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Grade B/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middlings 2</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Grade DI-III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discard</td>
<td>65</td>
<td>10</td>
</tr>
</tbody>
</table>

Discard
2. GRADE OF COAL

REFERS TO THE INORGANIC COMPOSITION OR MINERALS IN COAL

MINERALS IN COAL ➔ ASH IN ON HEATING
Minerals in Coal

- **MOST COMMON MINERALS**
  - Clay – Kaolinite
  - Quartz
  - Carbonate minerals – calcite, dolomite, siderite
  - Pyrite

- **LESS COMMON MINERALS**
  - Apatite (P-bearing)
  - Zircon (U-bearing)
  - Rutile (Sb-bearing)

And many others

RELATIVE DENSITY OF MINERALS RANGES BETWEEN $2.5 - 5.0$
CLAY MINERALS

NODULE IN VITRINIT

<25% FINE CLAY PARTICLES IN INERT DETRITUS

50% CLAY PARTICLES

80% CLAY PARTICLES

QUARTZ GRAIN AND CLAY
FORMS OF PYRITE AND OTHER FE-S MINERALS

- Ultra-fine granules
- Small granules
- Large nodules
- Composite multi-nodule - framboid
- Woody cellular infillings
- Cleats in fractures

Microns

1-3
10-20
100-150
>500
500-1000
5-30 wide, Long and complex
3. CONDITION OF COAL

- Oxidised and weathered coal
- Penetrated and fissured by groundwater
- Heated by igneous intrusions (volcanic lava) or by spontaneous combustion
- Distorted by rock/ground movements (brittle, multi-cracked)
OXIDISED AND WEATHERED COAL (W) RELATIVE TO FRESH COAL (F)
PRIMARY WEATHERED COAL – IN-SEAM DURING PEAT FORMATION –

Pseudo-vitrinite (note increase in reflectance, stress cracks and breakage)
4. RANK OF COAL

REFERS TO THE
LEVEL OF MATURITY IN COAL

Swamp
Peat
Lignite/Brown coal
Bituminous Coal
Anthracite
SUMMARY – TYPE, RANK AND GRADE OF COAL
- All independent of one another -

Maturity [Ran] incurred by:
- Time
- Temperature
- Pressure
PROGRESSIVE CHEMICAL CHANGES THROUGH INCREASING RANK (MATURITY)

Depth of burial leads to increasing
- temperature
- pressure &
- age
RANK OF COAL

NOW DETERMINED BY COLOUR AND THE REFLECTANCE OF LIGHT ON THE SURFACE OF VITRINITE (RoV%)
### The New International Classification of Seam Coal: Categorisation of Rank

<table>
<thead>
<tr>
<th>Rank Category</th>
<th>Description</th>
<th>New Boundary Definition</th>
<th>Old Boundary Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Vitrinite Reflectance</td>
<td>GCV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Mean Random RoV%)</td>
<td>M J/kg m.at</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft Coals</td>
<td>Lignite</td>
<td>0.4</td>
<td>24</td>
</tr>
<tr>
<td>Low Rank</td>
<td>Very Low Rank Bituminous</td>
<td>0.6</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Low Rank Bituminous</td>
<td>1.0</td>
<td>32</td>
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<tr>
<td>Medium Rank</td>
<td>Medium Rank Bituminous</td>
<td>1.4</td>
<td>22</td>
</tr>
<tr>
<td>Medium</td>
<td>High Rank Bituminous</td>
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<td>14</td>
</tr>
<tr>
<td>Bituminous</td>
<td>Semi-anthracite</td>
<td>3.0</td>
<td>8</td>
</tr>
<tr>
<td>Hard Coals</td>
<td>Anthracite</td>
<td>4.0</td>
<td>2</td>
</tr>
<tr>
<td>High Rank</td>
<td>Meta anthracite</td>
<td>6.0</td>
<td>0</td>
</tr>
<tr>
<td>Anthracite</td>
<td></td>
<td>10.0</td>
<td>0</td>
</tr>
</tbody>
</table>

*ECE-UN WG OCT 1993*
EFFECT OF RANK ON TECHNOLOGICAL PROPERTIES
[Applicable to Vitrinite only]
**RoVr% 0.708**

### Reflectance Histogram

<table>
<thead>
<tr>
<th>R-Class %</th>
<th>Relative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td></td>
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<tr>
<td>0.20</td>
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<tr>
<td>0.25</td>
<td></td>
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<tr>
<td>0.30</td>
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<tr>
<td>0.35</td>
<td></td>
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<tr>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>2.0</td>
</tr>
<tr>
<td>0.55</td>
<td>9.0</td>
</tr>
<tr>
<td>0.60</td>
<td>15.0</td>
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<tr>
<td>0.65</td>
<td>24.0</td>
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<tr>
<td>0.70</td>
<td>20.0</td>
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<tr>
<td>0.75</td>
<td>20.0</td>
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<tr>
<td>0.80</td>
<td>5.0</td>
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<tr>
<td>0.85</td>
<td>4.0</td>
</tr>
<tr>
<td>0.90</td>
<td>1.0</td>
</tr>
<tr>
<td>0.95</td>
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<td>1.00</td>
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<td>1.05</td>
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</tr>
<tr>
<td>1.95</td>
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<tr>
<td>2.00</td>
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**Single seam**
RoVr% 1.36

<table>
<thead>
<tr>
<th>R-Class %</th>
<th>Relative Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
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<tr>
<td>0.05</td>
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<tr>
<td>0.15</td>
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**Product 1** - coking

**Product 2** - lean

**Product 3** - Burnt coal
EFFECT OF RANK ON COAL-CHAR-COKE FORMATION

Increasing temperature of devolatilisation/reaction

CHAR – porous thin walled
HIGHLY POROUS CHAR WITH THIN WALLS DERIVED FROM BRIGHT COAL (VITRINITE)
DENSE CHAR DERIVED FROM DULL COAL
(DENSE INERTINITE)
EFFECT OF RANK ON COAL-CHAR-COKE FORMATION

CHAR – porous thin walled

COKE – porous thick walled, mosaic texture
COKE WITH POROUS STRUCTURE
AND MOSAIC TEXTURE DERIVED FROM COKING COAL
FORMS OF COKE – mosaic textures

ISOTROPIC COKE (SMOOTH, UNTEXTURED)

ANISOTROPIC COKE (MINUTE FINE MOSAIC TEXTURE)

ANISOTROPIC COKE (COARSE MOSAIC TEXTURE)

ANISOTROPIC COKE (COARSE NEEDLE – RIBBON MOSAIC TEXTURE)

Source H J Pinheiro
EFFECT OF RANK ON COAL-CHAR-COKE FORMATION

CHAR – porous thin walled

COKE – porous thick walled, mosaic texture

ANTHRACITE – non-porous
# TABLE OF COKE TYPES AND QUALITIES

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Volatile Matter</th>
<th>Indicative VM content (ad), %</th>
<th>Max vitrinite reflectance (Ro), %</th>
<th>CSN (FSI)</th>
<th>General Use</th>
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<tbody>
<tr>
<td>Hard (HCC)</td>
<td>LV</td>
<td>&lt;22</td>
<td>1.3 – 1.7</td>
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<td>Coking</td>
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<td>MV</td>
<td>22 - 28</td>
<td>1.1 – 1.5</td>
<td>7-9</td>
<td>Coking</td>
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<td>HV</td>
<td>&gt;28</td>
<td>0.95 – 1.1</td>
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<td>Coking</td>
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<td>Semi-Hard (SHCC)</td>
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<td>As above, but typically higher ash hard coking coals</td>
<td>6-8</td>
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<td>Coking</td>
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<td>Soft (or weak) (SCC)</td>
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<td>Predominantly HV</td>
<td>&lt; 1.0</td>
<td>4-8</td>
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<tr>
<td>Semi-soft (SSCC)</td>
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<td>Predominantly HV</td>
<td>&lt; 1.0</td>
<td>1-4</td>
<td>Coking/PCI</td>
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<td>LV, semi anthracites and anthracites</td>
<td>&lt;17</td>
<td>&gt; 1.5</td>
<td>0</td>
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<td>PCI</td>
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</table>

LV = low volatile, MV = medium volatile, HV = high volatile
THE EFFECT OF HEATING ON COAL STRUCTURE AND TEXTURE

Increasing temperature of devolatilisation /reaction >2200°C
ANTHRACITES – NORMAL, HEATED AND CALCINED

Anthracite

Anthracite

Anthracite

Anthracite

Devolatilised anthracite

Calcined Anthracite

Calcined Anthracite

Calcined Anthracite

Calcined Anthracite

COKE

Source H J Pinheiro
RANGE OF COAL AND COAL-DERIVED CARBON PRODUCTS USED IN THE METALLURGICAL INDUSTRY

• REDUCTANTS
  • BLAST FURNACE
    » COKE
    » FORM COKE
    » BRIQUETTES
  • SUBMERGED ARC FURNACE
    » COKE
    » CHAR
    » ANTHRACITE
    » CHARCOAL
    » PETROLEUM COKE
    » GRAPHITE
    » FORM COKE
    » BRIQUETTES
• DIRECT REDUCTION
  » PF COAL
  » CHAR GAS CHARCOAL
  » ANTHRACITE
  » COKE
  » PETROLEUM COKE

• CONDUCTANTS
  • ELECTRODE FILLERS
    » CALCINED ANTHRACITE
OBJECTIVES

To provide a basic understanding of coal:

I: The origin and formation of coal

II: The constitution and variations of coal
   - TYPE
   - GRADE
   - CONDITION
   - RANK

III: The impact these issues have on coals and carbons in industry
If I were to be asked if I could only have ONE analysis with which to select and evaluate my coking coals, it would be coal petrography.

Hannes Steyn, Iscor....and many others
PURPOSE

1. How coal is defined
2. How coal is distributed in the world
3. How coal is used and our dependence
4. How coal is conventionally analysed
5. Limitations to conventional analyses
6. The nature of coal – types, ranks and grades
7. Reasons for coal quality variations
S. HEMISPHERE – GONDWANA COAL
- formed in cold to cool temperate conditions in Permian times (280-300 Million years ago)
HOT STEAMY EQUATORIAL SWAMPS IN THE NORTHERN HEMISPHERE DURING COAL FORMING TIMES (Carboniferous)
ECCA - RECONSTRUCTION OF NO 1 AND EARLY NO 2 SEAM CONDITIONS -
Crustal Structure of Southern Africa

Granitic stable Cratons (islands of granite)

With

Inter-cratonic mobile belts (subsided areas where deposition takes place and coalfields form)
Cross-sections through the Coal-bearing Basins and the Kaapvaal Craton in South Africa during Permian 

Coal forming environments occurring in Paralic and Limnic environments
DISTRIBUTION OF THE COAL SEAMS IN THE MAIN KAROO BASIN
Generalised rank (maturity) levels in the Northern Karoo Basin Coalfields

Rank defined according to ASTM classification
Generalised utilisation of coals in the Northern Karoo Basin Coalfields
Section through a developing coal seam shown in relation to floral communities in a Pre-Karoo glaciated valley.
WATERBERG SEQUENCE

COAL SEAMS WITH VITRINITE PROFILE (V)

NB: low vitrinite proportions in lower seams (5%) and high proportions in upper zones (95%)
WATERBERG SEQUENCE – PRODUCTS
Borehole core indicating very narrow bands of bright Vitrinite-rich coal between dull bands of carbonaceous
Bright, vitrinite-rich band – brittle and broken
Abundant pyritic inclusions concentrated in a lense

Bright and dull bands of vitrinite-rich coal and carbonaceous shale
OBJECTIVES

To provide a basic understanding of coal:

I: The origin and formation of coal

II: The constitution and variations of coal
   – TYPE
   – GRADE
   – CONDITION
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III: The impact these issues have on coals and carbons in industry