Can we rely on quality parameters of coke from laboratory coking installation?

B. MERTAS, A. SOBOLEWSKI, Ł. SMĘDOWSKI
Institute for Chemical Processing of Coal, Zabrze, Poland
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2. Coal quality versus coke quality
3. Pilot/laboratory coking installations
4. Test characteristic and results
5. Target – coal price
6. Conclusions
Introduction

VIU (value-in-use) principle for coking coals

the present net worth of an asset calculated by estimating its net future value including the disposal value, if the asset has been impaired.

http://www.businessdictionary.com/

Value-in-use of an asset is the net present value of cash flows or some other benefits which is generated by an asset in a certain use for a certain owner. It is usually estimated at use and this value is less than the highest and best use and so this value is usually lesser than the market value. The value in use of an asset may be higher than market value, when a person gets special benefits like grandfathered zoning, agglomeration benefits, or extraordinary financing and at that time the value is regarded as an investment value.

http://www.readyratios.com/

TCO (total-cost-of-ownership) principle for coking coals

Estimate of all direct and indirect costs associated with an asset or acquisition over its entire life cycle.

http://www.businessdictionary.com/

The essence of the concept is that the full costs of a decision should be evaluated, rather than focusing on the initial purchase price.

http://www.costquest.com/
# Introduction

Coking coal pricing

**Platts** - [http://www.platts.com/IM.Platts.Content/MethodologyReferences/MethodologySpecs/metcoalmethod.pdf](http://www.platts.com/IM.Platts.Content/MethodologyReferences/MethodologySpecs/metcoalmethod.pdf)

Coal properties – basis for analysis – ISO/ASTM standards

<table>
<thead>
<tr>
<th>HARD COKING COAL</th>
<th>CODE</th>
<th>Mavg</th>
<th>Wavg</th>
<th>Qavg</th>
<th>QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment</td>
<td></td>
<td></td>
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<td>20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddpm maximum fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, 50 mm max</td>
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<td>21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm maximum fluidity, 65% vitrinite</td>
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**Coke properties – CSR - ISO/ASTM standards**

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<td>HCC Peak Downs FOB Australia</td>
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<td>74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddpmp maximum fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, 50 mm max</td>
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<td></td>
</tr>
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<td>Hard Coking Coal Peak Downs CFR China</td>
<td>HCCGC00</td>
<td>HCCGC03</td>
<td>74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddpmp maximum fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, 50 mm max</td>
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</table>
Coal quality versus coke quality

Coal quality

Coke quality

CARBONIZATION

...beyond standards!
# Coke quality prediction source

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial data</strong></td>
<td>• Real values</td>
<td>• No data for single coal</td>
</tr>
<tr>
<td><strong>Math model</strong></td>
<td>• Quick</td>
<td>• Validated on narrow range of coals</td>
</tr>
<tr>
<td></td>
<td>• Result before purchase</td>
<td>• Not acceptable uncertainty out of validate range</td>
</tr>
<tr>
<td><strong>Pilot test</strong></td>
<td>• Validated on real object</td>
<td>• One test – result for lot (representativness)</td>
</tr>
<tr>
<td></td>
<td>• Enable correlate different coals</td>
<td>• Test conditions influence results</td>
</tr>
<tr>
<td></td>
<td>• Correlates with industrial data</td>
<td></td>
</tr>
</tbody>
</table>

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7/wstaw liczbę slajdów ...beyond standards!
Pilot/laboratory coking installations

Jenkner retort

charge mass - ~1kg
Charge diameter – 0,12 m
Charge shape - cylindrical

...beyond standards!
Pilot/laboratory coking installations

Karbotest installation

- Charge mass - ~4 kg
- Charge diameter – 0.15 m
- Charge shape - cylindrical

...beyond standards!
Pilot/laboratory coking installations

DMT 10 kg retort

- Final coke temperature: 1030 - 1040 °C
- Coking time: approx. 4 hours

**Coal charge**
- Charging height: 505 mm
- Internal diameter: 180 mm
- Charge weight: approx. 11 kg

**Probes**
- Temperature gas pressure

**Insulation brick**

- Charge mass - ~11 kg
- Charge diameter – 0,18 m
- Charge shape - cylindrical

...beyond standards!
Pilot/laboratory coking installations

40 kg oven

charge mass - ~40 kg

Charge diameter – 0,30 m
Charge shape - cylindrical

...beyond standards!
Pilot/laboratory coking installations

Movable Wall Oven

charge mass - ~400 kg

Charge diameter – 0,40 – 0,5 m
Charge shape - cubical

...beyond standards!
### Test characteristic and results

#### Coal samples properties

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Z</th>
<th>P</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>10.4</td>
<td>9.2</td>
<td>7.6</td>
</tr>
<tr>
<td>Ash (% db)</td>
<td>8.45</td>
<td>9.02</td>
<td>6.57</td>
</tr>
<tr>
<td>VM (% daf)</td>
<td>22.12</td>
<td>27.76</td>
<td>33.41</td>
</tr>
<tr>
<td>R (%)</td>
<td>1.22</td>
<td>1.09</td>
<td>0.93</td>
</tr>
<tr>
<td>Roga Index</td>
<td>69</td>
<td>77</td>
<td>78</td>
</tr>
<tr>
<td>FSI</td>
<td>7.5</td>
<td>7.5</td>
<td>8</td>
</tr>
<tr>
<td>$F_{max}$ (ddpm)</td>
<td>272</td>
<td>3656</td>
<td>4232</td>
</tr>
<tr>
<td>a (%)</td>
<td>27</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>b (%)</td>
<td>36</td>
<td>166</td>
<td>66</td>
</tr>
</tbody>
</table>
## Test characteristic and results

### Coking tests parameters

<table>
<thead>
<tr>
<th></th>
<th>Karbotest 5 kg</th>
<th>Retort 10 kg</th>
<th>Oven 40 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charge shape</strong></td>
<td>cylindrical</td>
<td>cylindrical</td>
<td>cubic</td>
</tr>
<tr>
<td><strong>Sample mass (wet)</strong></td>
<td>kg</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Moisture content</strong></td>
<td>%</td>
<td>~8</td>
<td>~7</td>
</tr>
<tr>
<td><strong>Charge density (wet)</strong></td>
<td>kg/m³</td>
<td>820</td>
<td>830</td>
</tr>
<tr>
<td><strong>Final coke temp.</strong></td>
<td>°C</td>
<td>950</td>
<td>1030</td>
</tr>
<tr>
<td><strong>Coking time</strong></td>
<td>h</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Test characteristic and results

Coke quality

- 40 kg oven
- 10 kg DMT retort
- 4 kg Karbotest

CRI [%]

Z
B
P

...beyond standards!
Test characteristic and results

Coke quality

- 40 kg oven
- 10 kg DMT retort
- 4 kg Karbotest

CSR [%]

Z

B

P

...beyond standards!
## Target – coal price

### Table E.1 — Reproducibility critical difference

<table>
<thead>
<tr>
<th>CRI</th>
<th>CSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Critical difference</td>
</tr>
<tr>
<td>&gt; 33</td>
<td>5&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>&lt; 33</td>
<td>3,5</td>
</tr>
</tbody>
</table>

<sup>a</sup> Approximate values only.
Test characteristic and results

Coke quality

- 40 kg oven
- 10 kg DMT retort
- 4 kg Karbotest

CRI [%]

Z
B
P

...beyond standards!
Test characteristic and results

Coke quality

[Bar chart showing CSR percentages for different test methods and samples (Z, B, P).]

...beyond standards!
Test characteristic and results

Factors influencing coke quality

- Coal components quality
- Coal charge preparation
- Coke quality
- Coking process parameters
- Coke treatment

...beyond standards!
Conclusions

1. Industrial test is the most reliable but usually impossible to be carried out
2. Mathematical formulas are reliable for narrow range of coal quality variation
3. Pilot/laboratory coking installations are the most useful – acceptable relation between results reliability and cost
4. Differences between results from different installation may vary substantially.
5. Pilot/laboratory coking installations need to have comparable conditions – to compare results.
6. Different coking conditions – need for reliable correlation

Nevertheless it is not possible to value coking coal on the basis of only physico-chemical properties – indispensable to produce coke and analyse it