Coal washing – control of heavy media density with online LIBS analyzers

Installation site
- Wet coal after dense media separation

Technological task
Optimization of expensive heavy media (magnetite) dosage

Analytical task
Ash and magnetite analysis

Source of economic benefits
- Reduced magnetite consumption
- Improved final product quality

Payback – 3-6 months
Case study 1: Field Test – LIBS analyzer in South Africa

Coaltech is a collaborative research program formed by the major coal companies, Universities, CSIR, NUM and South Africa in order to address the specific needs of the Coal Mining Industry in SA.

Coaltech 2020 accomplished the field test of LIBS analyzer working in Optimum Colliery, South Africa in accordance with the International Standard for on-line analyzers ISO 15239.
Case study 1: Coal – LIBS spectra

Spectral information is used for ash components determination and re-calculated to ash content.
Case study 1: Coal – LIBS and Lab comparison

1. Ash content comparison
   \[ R^2 = 0.9 \]
   Abs. Average Error = +/- 0.81
   RMS = +/- 0.99

2. Al content comparison
   \[ R^2 = 0.9 \]
   Abs. Average Error = +/- 0.12
   RMS = +/- 0.14
Case study 1: Coal – LIBS and Lab comparison

3. Si content comparison
   \[ R^2 = 0.78 \]
   \[ \text{Abs. Average Error} = \pm 0.35\% \]
   \[ \text{RMS} = \pm 0.47\% \]

4. Fe content comparison
   \[ R^2 = 0.9 \]
   \[ \text{Abs. Average Error} = \pm 0.2\% \]
   \[ \text{RMS} = \pm 0.22\% \]

5. Mg content comparison
   \[ R^2 = 0.82 \]
   \[ \text{Abs. Average Error} = \pm 0.01\% \]
   \[ \text{RMS} = \pm 0.01\% \]

6. Ti content comparison
   \[ R^2 = 0.97 \]
   \[ \text{Abs. Average Error} = \pm 0.01\% \]
   \[ \text{RMS} = \pm 0.01\% \]
Case study 1: Coal – LIBS and Lab comparison

Carbon Analysis in Coal

R² = 0.9363
Abs Average error = +/- 0.36%
Case study 1: Coal – Analysis of Magnetite in washed coal

Magnetite detection is extra information, which may be received by LIBS unit. This very expensive material is utilized for coal cleaning and its detection on conveyer belt may be indication that the magnetite recovery process has to be improved.
Case study 2: Lab calibration for different coal types
Case study 2: Lab calibration for different coal types

Net CV as received, cal/g

R² = 0.9796
Case study 2: Lab calibration for different coal types

![Graph showing the relationship between Lab and LIBS measurements with an R² value of 0.9122.](image-url)
Case study 2: Lab calibration for different coal types

![Graph showing total moisture (%), as received with an R² of 0.9667.]

Total moisture (%), as received

$R^2 = 0.9667$
Case study 2: Lab calibration for different coal types

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range of values in samples provided</th>
<th>R^2</th>
<th>Average error</th>
<th>RMSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net CV, kcal/kg</td>
<td>3657 - 4527</td>
<td>0.98</td>
<td>35.39</td>
<td>45.7</td>
</tr>
<tr>
<td>Total moisture, %</td>
<td>27.5 - 37.8</td>
<td>0.97</td>
<td>0.46</td>
<td>0.59</td>
</tr>
<tr>
<td>Ash dry basis, %</td>
<td>2.39 - 7.52</td>
<td>0.91</td>
<td>0.37</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Case study 3: Indian Coals
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Lab calibration for different coal types

<table>
<thead>
<tr>
<th>Coal quality parameter</th>
<th>Range of values in samples provided</th>
<th>R^2</th>
<th>RMSD</th>
<th>Average error</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASH</td>
<td>24 - 45%</td>
<td>0.93</td>
<td>1.12</td>
<td>0.92</td>
</tr>
<tr>
<td>GCV</td>
<td>3675 - 5079 Kcal/kg</td>
<td>0.92</td>
<td>85</td>
<td>67</td>
</tr>
<tr>
<td>IM</td>
<td>1.96 - 8.9%</td>
<td>0.81</td>
<td>0.81</td>
<td>0.76</td>
</tr>
<tr>
<td>VM</td>
<td>21.6 - 27.6%</td>
<td>0.88</td>
<td>0.49</td>
<td>0.40</td>
</tr>
<tr>
<td>FC</td>
<td>29 - 39.6%</td>
<td>0.97</td>
<td>0.45</td>
<td>0.36</td>
</tr>
</tbody>
</table>