Technic and Results of the Measurement of Gas Content and Permeability of Coal Seams in Underground Mines

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Introduction

• Coal and methane outburst can lead to a sharp increase in the concentration of methane in the mine atmosphere and to the formation of conditions for explosions of methane and coal dust.
• Modern geophysical methods could be used for forecasting of hazardous areas applying directly in the coal mines.
• These studies may include:
  – collecting coal samples in the mines and determination of gas content of coal seams
  – defining of the filtration properties of coal seams by conducting injection tests in the mines
  – seismoacoustic survey of coal seams from mine workings
Determination of Residual Gas Content of Coal Seams
Desorption Tests

Open-type Core Samplers

Dependence of a coal sample drilling time ($T_d$) on a coefficient of coal strength ($f$), for the coal sample obtained in mining conditions from LFG grade coal using core samplers of types I-III.

$y = 4.4876x + 16.993$  
$R^2 = 0.98264$

$y = 4.2756x + 9.5504$  
$R^2 = 0.96701$

$y = 1.8021x + 9.3869$  
$R^2 = 0.7659$
## Results of the Tests

Estimate of coal seams degasification efficiency on the basis of direct method

<table>
<thead>
<tr>
<th>Mine</th>
<th>Coefficient of degasification efficiency</th>
<th>In-situ gas content (m$^3$/t dry ash free mass)</th>
<th>Residual gas content (m$^3$/t dry ash free mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.9-0.85</td>
<td>9-14</td>
<td>1.2-2.1</td>
</tr>
<tr>
<td>B</td>
<td>0.01-0.1</td>
<td>9-11</td>
<td>8.7-8.9</td>
</tr>
<tr>
<td>C</td>
<td>0.9-0.6</td>
<td>17-20</td>
<td>2.0-7.6</td>
</tr>
<tr>
<td>D</td>
<td>0.9-8.4</td>
<td>18-20</td>
<td>1.0-3.2</td>
</tr>
</tbody>
</table>

### Effectiveness of coal seams degasification

\[
K_d = \frac{\chi_n - \chi'_n}{\chi_n}
\]

- \(\chi_n\) – in-situ gas content of a coal seam, (m$^3$/t)
- \(\chi'_n\) – gas content after coal seam degasification (m$^3$/t)

Desorption of methane from coal samples of LFG grade, selected in mine entries of Kuzbass mines
Coal Seams Permeability
Methodology and Equipment

- A chamber was designed and manufactured in a form of reinforced rubberized hydraulic hose with a sealed threaded connection on the other side.

- A pre-programmed electronic self-contained manometer is placed in the chamber and is connected to a borehole water supply system for recording pressure changes caused by hydrodynamic impacts.

Three-dimensional view of coal seam permeability: 1 - coal seam; 2 - casing string; 3 - borehole uncased part.
Results

Before Stimulation
\[ k_x = 19.17 \text{ mD} \]
\[ k_y = 11.48 \text{ mD} \]
\[ k_z = 23.51 \text{ mD} \]

After Stimulation
\[ k_x = 73.91 \text{ mD} \]
\[ k_y = 30.20 \text{ mD} \]
\[ k_z = 4.16 \text{ mD} \]

Monitoring injection fall-off test in a borehole drilled from a mine entry
Detection of the Abnormal Tectonic Zones
Seismological Survey in Mines Entries

Source of the Signal

Set of the Seismological Stations

Direct and Transmitted Waves

Reflected and Refracted Waves

Geophones
Results

A, B, G - the probable site of substitution of rocks of a direct roof by sandstone; C1, C2, C3 - zone of low speeds, characterized by increased moisture content; D, E, F, G - influence of the entries
Conclusions

• Direct measurements of the gas content and permeability of coal seams along with their seismological survey in underground mines are feasible

• The results of the geophysical measurements could be used for the following:
  – Prediction of the coal and methane outburst
  – Improving degasification systems
  – Increasing efficiency of the ventilations systems
  – Monitoring process of the hydrofracturing of the coal seams