Janusz Jureczka, Piotr Kasza, Łukasz Kroplewski

CBM Gilowice Project
Workover, Fracturing and Testing
Gilowice CBM Project

• Gilowice CBM Project is realized by consortium Polish Oil and Gas Company and Polish Geological Institute– National Research Institute

• Target of this project is to check Upper Silesian coal seam methane production increase by completion wells using hydraulic fracturing technique

• Under this Project we are going to perform few fracturing treatments in 510 coal seam completed by horizontal well Gilowice-2H and then testing gas production from wells Gilowice-1 and Gilowice-2H
Gilowice CBM Project work plan

- Workover of the wells
- Hydraulic fracturing of the Gilowice-2H well
- Production testing of the wells
- Well abandonment and remediation of the wellsite
- Reporting results
Gilowice-1 and Gilowice-2H wells

• **Well Gilowice -1**
  - final depth 1080 m (TVD 1039,2 m)
  - horizontal shift of the well 232 m
  - thickness coal seam 510 – 5,28 m
  - gas contents of coal seam 510 – 13,7 m3/t
  - methane content – 97,7%
  - permeability of coal seam 510; 0,2 – 0,8 mD

• **Well Gilowice -2H**
  - final depth 2300 m (TVD 850 m)
  - horizontal shift of the well 1616m
  - length of the well in coal seam 510 – 1505 m
Gilowice-2H workover

- Checking of the condition of the well
- Performing geophysical measurements
- Pushing 4 ½ in casing
- Cementing 4 ½ in casing
- Checking cementing quality
## Gilowice-2H stimulation strategy

### Table: Fluid type, Fracture geometry, Proppant concentration, Fluid volume

<table>
<thead>
<tr>
<th>Brittleness</th>
<th>Fluid type</th>
<th>Fracture geometry</th>
<th>Proppant concentration</th>
<th>Fluid volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>Slick water</td>
<td>Complex multiple fractures</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>60</td>
<td>Slick water</td>
<td>SRV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Hybrid</td>
<td></td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Linear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Crosslinked</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Crosslinked</td>
<td>L. h, w</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>10</td>
<td>Crosslinked</td>
<td>Simple, two-wing fracture</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Fracture Geometry Diagram

- Complex Systems
- Complex Planar w/ Fissures
- Complex Planar
- Planar w/ Fissures
- Planar

### Stress Anisotropy

- Low
- High

### Brittleness

- Brittle
- Ductile

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XXVII School of Underground Mining
Session – Coal Mine Methane as a Valuable Energy Source
Kraków, February 28th 2018
Gilowice-2H stimulation strategy

<table>
<thead>
<tr>
<th></th>
<th>GSP</th>
<th>Coal seam 510</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frac gradient [MPa/m]</td>
<td>0,0147</td>
<td>0,0136</td>
<td>0,0158</td>
</tr>
<tr>
<td>Poisson ratio [-]</td>
<td>0,28</td>
<td>0,35</td>
<td>0,28</td>
</tr>
<tr>
<td>Young modulus [MPa]</td>
<td>2,34E+4</td>
<td>8,27E+2</td>
<td>3,64E+4</td>
</tr>
<tr>
<td>Permeability [mD]</td>
<td>0,2</td>
<td>0,7</td>
<td>0,01</td>
</tr>
</tbody>
</table>

![Diagram of coal structure with labels for face cleats, butt cleats, and matrix block.](image)
Gilowice-2H fracturing design

- Consulting data, analysis and draft design
  - 20# and 30# linear gel approx. 1000 m³/stage
  - 40/70 mesh sand approx. 60 tons/stage
  - flow rate – 8 m³/min

- design prepared and approved for execution
  - 30# linear gel approx. 800 m³/stage
  - 40/70 mesh sand approx. 80 tons/stage
  - flow rate – 8 m³/min
Gilowice-2H fracturing design

- plug and perf method
  5 stages using cluster perforation:
  2046,5 – 1973,1 m (6 clusters)
  1958,4 – 1881,6 m (6 clusters)
  1864,0 – 1790,2 m (6 clusters)
  1775,5 – 1698,7 m (6 clusters)
  1684,1 – 1636,0 m (4 clusters)
Gilowice-2H fractures geometry
Gilowice-2H fractures geometry

<table>
<thead>
<tr>
<th>STAGE</th>
<th>UP</th>
<th>DOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVD</td>
<td>meters</td>
<td>meters</td>
</tr>
<tr>
<td>MINI_Frac</td>
<td>7.38</td>
<td>-49.63*</td>
</tr>
<tr>
<td>I</td>
<td>11.75</td>
<td>-34.25</td>
</tr>
<tr>
<td>II</td>
<td>18.50</td>
<td>-46.50</td>
</tr>
<tr>
<td>III</td>
<td>25.50</td>
<td>-23.50</td>
</tr>
<tr>
<td>IV</td>
<td>12.50</td>
<td>-42.00</td>
</tr>
<tr>
<td>V</td>
<td>14.00</td>
<td>-27.00</td>
</tr>
</tbody>
</table>

Maximum depth (up/down) of seismic events

Avg depth of seismic events
Gilowice-2H testing

- restore hydraulic connection between wells
- install pump in the Gilowice-1 well
- well production test up to 90 days
Gilowice-2H testing

- **Gas Flow Rate [m³/day]**
  - 1000 m³/day
  - 7000 m³/day
  - 5200–5400 m³/day

- **Downhole Pressure [bar]**
- **Water Production [m³/day]**

**Dates:**
- 26.06.2017 to 13.11.2017

**Location:** Kraków, February 28th 2018
Gilowice-2H testing

Gilowice-2H before and after fracturing

- after fracturing
- before fracturing

gas flow rate [m³/min]
downhole pressure [bar]

3.68
0.12
Thank you for your attention