Drainage and utilization of Coal Mine Methane (CMM) at the Jastrzębska Coal Company

Kazimierz Gatnar, MSc., Eng.
Team for Power Management and Methane Utilization
Jastrzębska Coal Company plc.

- **5 coal mines**: „Budryk”, „Jas-Mos”, „Krupiński”, „Pniówek” and „Borynia-Zofiówka” (the two-plant mine),
- Total mining area ca. **170 sq. km**
- Total coal output **13 m. ton of coal per year** (including ca. 10 m. ton of coking coal),
- **Since 6th July 2011** the Company’s shares are quoted at the Warsaw Stock Exchange.
Mining areas JSW S.A.

Budryk Hard Coal Mine
Mining areas Ornontowice I, II
35.97 km²

The Czech Republic
♦ About 39% of CMM released during mining operations is captured to methane drainage pipelines and about 61% of methane is disposed from underground excavations via the ventilation system.

♦ Air and methane mixtures with concentration ranging from 45% to 70% CH₄, is delivered via a pipeline network to the following clients:

**JSW S.A.**
- Drying plant of flotation concentrate at the ‘Krupiński’ coal mine
- Gas engine at the ‘Borynia-Zofiówka’ coal mine, the ‘Borynia’ colliery

**Power Engineering Company of Jastrzębie, plc.**
- Heat and power stations ‘Moszczenica’ and ‘Zofiówka’
- Gas engines at the heat stations ‘Suszec’, ‘Pniówek’ and ‘Moszczenica’
- Gas boilers

**Heat Generation Company ‘Żory’ Co. Ltd. (the ‘Budryk’ coal mine)**
- Gas engines
- Gas boilers
Power Engineering Company of Jastrzębie, plc., (SEJ S.A.)

- is incorporated into the Capital Group JSW and 100% of shares is owned by the JSW plc. It was established on 11th October 1995 as a merge of the heat and power stations ‘Moszczenica’ and ‘Zofiówka’.

- uses methane as fuel and has completed a number of associated investments, including installation of gas engines fuelled with methane from the methane drainage systems at ‘Pniówek’ and ‘Krupiński’ coal mines.

- currently operates 6 engines (including two within the system of central air conditioning at the ‘Pniówek’ coal mine) that are fuelled with methane from the methane drainage system.
Fuel for gas engines

Typical composition of methane-containing mixtures (fuel for gas engines) is the following:

\[ \text{CH}_4 - 60\% \quad \text{N}_2 - 33\% \quad \text{O}_2 - 5\% \quad \text{CO}_2 - 2\% \]
Methane disposed from underground excavations via the ventilation system is still unusable for industrial or business purposes due to worldwide inavailability of a technically mature and cost-effective technology for its utilization. The following factors are the major hindrances:

- high flow rates of ventilation air via exhaust shafts, amounting to 20,000 – 40,000 m³/min
- methane concentration much below 0.6% of CH₄
Ventilation Air

In case of coal mines of JSW plc. the weighted average concentration of methane disposed via ventilation shafts amounts to 0.27% of CH₄, with the following distribution:

- Upper limit: 0.09%
- Mean values: 0.12% – 0.20%
- Upper limits: 0.28% -0.40%
Methods of methane drainage

Methane capturing and drainage from roadway excavations
methane draining boreholes with the length of 40-70m

roadway niche
(extension of the roadway width)
methane disposal pipeline

~50 m.  ~50 m.
We mine all the best

Methane capturing and drainage from longwalls

The ‘U’ system of longwall ventilation

methane disposal pipeline

methane draining boreholes with the length up to 100 m

15 - 20 m.

goafs
We mine all the best methane disposal pipeline methane draining boreholes with the length up to 100 m
goafs

The ‘Y’ system of longwall ventilation

methane disposal pipeline methane draining boreholes with the length up to 100 m

‘Y’ system of longwall ventilation with two ventilation drifts
Available resources and methane utilization

About 338 m. m\(^3\) of methane was released during all mining operations in 2010, 132 m. m\(^3\) of that was captured by the methane drainage system.

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane volume [m. m(^3) CH(_4)]</td>
<td>127.5</td>
<td>126.1</td>
<td>123.8</td>
<td>135.9</td>
<td>133.1</td>
<td>132.0</td>
</tr>
</tbody>
</table>
Investments

For further industrial and business utilization of methane a number of relevant investments have been completed, including:

- **methane intakes** (construction and upgrade of methane drainage stations)
- **transfer of gas** (construction and upgrade of gas transfer networks)
- **construction of cogeneration systems** (generation of electric power, heat and ‘cold’ for own needs of coal mines)
Investments from 1997 till 2009

Cogeneration systems
1997 – ‘Krupiński’ coal mine, the gas engine with power of 3.0 MW_{el}
2005 – ‘Krupiński’ coal mine, the gas engine with power of 3.9 MW_{el}
2006 – ‘Pniówek’ coal mine, the gas engine with power of 3.9 MW_{el}
2008 – ‘Borynia’ coal mine, the gas engine with power of 1.8 MW_{el}

Central air conditioning system at the ‘Pniówek’ coal mine
2000 – Gas engines with power 2 x 3.2 MW_{el}, the central air conditioning system with power of 5.0 MW_{cold}
2007 – Free cooling circuit for the system with power of 7.5 MW_{cold}
2008 – Additional cooling module with power of 2.5 MW_{cold}

Methane drainage stations
2005 – ‘Jas-Mos’ coal mine, the new station for the shaft No. VI
2005 – ‘Pniówek’ coal mine, upgrade of the existing station

Other projects
1998 – ‘Borynia’ coal mine, gas-fires boilers with power 2 x 1.2 MW_{el}
2004 – construction of the pipeline between ‘Pniówek’ and ‘Zofiówka’ coal mines
2004 – construction of the pipeline between ‘Zofiówka’ and ‘Moszczenica’ Heat and Power Station
Jastrzębska Coal Company plc.
‘Krupiński’ Hard Coal Mine

We mine all the best
Cogeneration power engineering systems

Such systems are operated at ‘Budryk’, ‘Krupiński’, ‘Pniówek’ and ‘Borynia – Zofiówka’ (‘Borynia’ colliery’). Typical layout of the system:
Technical parameters of the co-generating power engineering systems

<table>
<thead>
<tr>
<th>Coal mine</th>
<th>Operator</th>
<th>Engine type</th>
<th>Engine power</th>
<th>Efficiency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Krupiński’ Coal Mine</td>
<td>SEJ S.A.</td>
<td>TBG 632 V16</td>
<td>3.0</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCG 2032 V16</td>
<td>3.9</td>
<td>4.2</td>
</tr>
<tr>
<td>'Pniówek’ Coal Mine</td>
<td>SEJ S.A.</td>
<td>2xTBG 632 V16</td>
<td>2x3.2</td>
<td>2x4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCG 2031 V16</td>
<td>3.9</td>
<td>4.2</td>
</tr>
<tr>
<td>'Borynia-Zofiówka’ Coal Mine,</td>
<td>JSW S.A.</td>
<td>JMS 612 GS</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>‘Borynia’ colliery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'Budryk’ Coal Mine</td>
<td>ZPC Żory</td>
<td>3xTBG 620 V20K</td>
<td>3 x 1.66</td>
<td>3 x 1.7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>24.0</td>
<td>27.3</td>
</tr>
</tbody>
</table>

‘Moszczenica’ Heat & Power Station (under commissioning)

SEJ S.A.   TCG 2032 V16   3.9          | 4.2            | 86.9           |
The tri-generation power engineering system at the „Pniówek” Coal Mine

Methane from the coal mine
45 m³ per minute

Stack
Heat from flue gas
109°C
125°C

Fan cooling station

Chilled air

6,3 kV

600 m³/h
1.5°C

FREECOOLING
1.5 MW (t_w=0°C)

GAS-FIRED ENGINES

GENERATORS
10,3 MW_G

Heat from cooling of engines
85°C
70°C

Heat from cooling of engines

ABSORPTION COOLERS
5,7 MW_C

COMPRESSOR COOLERS
1,8 MW_C

4,5°C

SURFACE

UNDERGROUND

FLUID FEEDER DRKA-200 SIEMAG

FLUID FEEDER DRKA-200 SIEMAG

Level of 1000m

Level of 830M

300 m³/h
18°C

300 m³/h
18°C

5 MW_{ch}

5 MW_{ch}

AIR CHILLERS

AIR CHILLERS

18°C

3°C

2.5°C

2.5°C

3°C

18°C
Power balance

- **Gas Engines**
  - Methane
  - Electric Power 6.4 MWel (38%)
  - Heat 7.4 MWt (42%)
  - Heat Loss 16%

- **Absorption Coolers**
  - Electric Power 5.6 MWel

- **Compressor Coolers**

- **Auxiliary Needs + Mechanical Loss** 4%

- **Transfer Loss** 16%

- **To Air Coolers**

- **Siemag Feeder**
  - Cold 5.0 MW
1. Jastrzębska Coal Company plc. is the unquestionable leader in industrial utilization of CMM in Poland and accumulated long-term expertise with respect to development and implementation of technical projects in that field.

2. Cogeneration and tri-generation power engineering systems based on gas-fired engines fuelled with methane from methane drainage systems of coal mines represent the most advanced and cost-efficient solution, both for utilization of cheap local fuel and generation of substantial amounts of power from local sources (electric power, heat and cold).

3. Currently JSW plc. operates 10 gas-fired engines with power from $1.66 \text{ MW}_{el}$ to $3.9 \text{ MW}_{el}$ and total installed power is as high as $28 \text{ MW}_{el}$, which presents a substantial rate as compared to the demand for power from the electric power network.
3. Electric power, heat and ‘cold’ generated by the power systems fuelled with methane from methane drainage facilities of coal mines cover the substantial rate of demand for power, which makes it possible to be partly independent from external suppliers and run own power policy within the Capital Group.

4. Low price of energy generated from methane definitely improves cost-effectiveness of purchases and, in consequence, significantly affects efficiency of power consumption by JSW plc.
Gas-fired engine

Absorption cooler

Heat recovery

Engine under installation