DTEK ENERGY LLC

THE IMPACT OF MINE METHANE ON COAL PRODUCTION AND SAFETY OF WORKS AT DTEK’S MINES

VADYM MIROSHNYCHENKO, HEAD OF VENTILATION AND DEGASSING UNIT
Coal is one of the Ukraine’s major energy resources. The necessity to satisfy the growing demand for coal, mainly caused by the events in the East of Ukraine, has been the driver to increase the coal production at DTEK ENERGY LLC mines which has led to excessive intensification of all coal production operations and rise of safety risks.

Presence of methane in coal mines poses a serious safety risk, to mitigate which high professionalism and effective preventive measures have to be applied.

Though explosions of methane in coal mines are quite rare, and they are the reason of thousands of injuries and even deaths.

Preventive measures:
- Development and detailed review of mine ventilation plans, constant ventilation monitoring
- Planning, design, and commissioning of methane emission source degassing systems; diverted methane emission monitoring
- Monitoring and measurement of gas concentration in mines; ensuring the appropriate level of automatic gas protection
- Check of underground workings regarding maintenance of required cross-section and ventilation
- Application of intrinsically safe equipment and wires;
- Conduction of timely briefings on safety and confirmation of workers’ qualification;
- Installation of explosion suppression and primary fire-fighting equipment;
For the period of 1990 through 2014, 93 methane-air mixture explosions happened, that is 3.7 explosions annually. In that period, coal production amounted to 80 million tonnes annually, and the number of enterprises (including minor ones) varied from 290 to 377.

In 2003, no explosions happened upon production of about 80 million tonnes of coal.

In 2016 and 2017, the number of explosions persists at the 1990–2014 level given almost 2 times lower coal production and almost 4 times lesser number of mines.

During the period from 2015 till February 2018, 8 methane-air mixture explosions happened, including 3 (37 %) at DTEK Energy LLC enterprises.

**Ratio of frequency of methane-air mixture explosions in the industry:**

- **1990–2014 average – 0.046**
  - (1 explosion per 21 million tonnes of coal produced)
- **in 2015–2018 it has increased from 0.025 to 0.08 – by 3.2 times**
  - (1 explosion per 12.5 million tonnes of coal produced)
<table>
<thead>
<tr>
<th>DTEK Energy LLC mines</th>
<th>Category of gas hazard</th>
<th>Hazard of coal dust explosion</th>
<th>Presence of seams prone to gas-dynamic events</th>
<th>Gas volume</th>
<th>Gas suction</th>
<th>Degassing</th>
<th>AGM system</th>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Abs, m³/min</td>
<td>Rel, m³/tn</td>
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**Notes:**
- $I_2^0$: Hazard of coal dust explosion
- $I_1^0$: Presence of seams prone to gas-dynamic events
- $m_1^2$: Volume of gas
- Vacuum Pump Station goaf gas offtake
- Underground Degassing Station goaf gas offtake
- KAGI: Surface Degassing System
- UTAS: Vacuum Degassing System
- SPI: Static Phase Degassing System
- SPI UTAS: Combination of SPI and UTAS systems

**DTEK Energy LLC Mines Methane Hazard**
METHANE IN DTEK ENERGY LLC MINES

- Ternivska
- Pavlogradska
- Geroiv Kosmosu
- Blagodatna
- Stepova
- Yuvileina
- Samarska
- Dniprovska
- Zakhidno-Donbaska
- Stashkov Mine
- Dobropiska
- Almazna
- Bilytska
- Novodonetsk
- Pioneer
- Bilozerska

- Abs, m³/min
- Rel, m³/tn
- Volume extracted by degassing, m³/min
Major sources of methane emissions in DTEK Energy LLC mines

Increase of depth extraction and loads on longwalls leads to increase of absolute methane emissions in mining sections. The capacities of ventilation systems to dilute methane with fresh air to the safe concentration established by the Safety Rules are limited by the maximum admissible average velocity of air and through the workings depending on their cross-section. Due to this, the gas factor may limit the loads on production faces in mining sections with high gas emission.

One of the most efficient ways to ensure safety of air conditions in high gas emission mining sections and eliminate the gas factor limitation on production faces loads is degassing of methane emission sources.

According to the current Law of Ukraine, degassing of methane emission sources in mining sections of coal mines must be performed if it is impossible to maintain the methane content in the air of mining sections by ventilation in compliance with the value established by the Safety Rules, and if the following condition cannot be met:

\[ I_{sec} \leq 0.007 \ Q_{sec} \ C, \]

where \( I_{sec} \) is average absolute methane emission in a mining section, \( m^3/min \); 
\( Q_{sec} \) is actual or planned flow of air fed to a mining section, \( m^3/min \); 
\( C \) is the maximum admissible concentration of methane in upcast (as per Safety Rules), %.
1. Gas extraction by means of a VMTsG gas suction fan.

Legend:
1 – mixing chamber
2 – coupler
3 – fan
4 – shutter
5 – air duct with choke for air sampling
6 – air duct $d = 600$ mm
7 – shutter (regulation window)
8 – corrugated duct $d = 600$ mm with intake pup-joint

mine air (methane) parameter monitoring sensor
Types of Degassing Employed in DTEK Energy LLC Mines

2. Degassing with Leaving Gas Offtakes in Goaf.
3. Degassing with leaving gas offtakes in goaf and gas extraction.
4. Degassing of Goaf with Wells.

Types of Degassing Employed in DTEK Energy LLC Mines
5. **Complex degassing by all means possible.**
Results achieved:

1. Improved production indicators while ensuring safe labour conditions regarding the gas factor.
2. Development of mines regarding preparation of new mining fields and levels.
4. Reduction of ambient temperature in mines.

Investments into DTEK Energy LLC mines ventilation and degassing amount to about USD 7–8 million annually.
## DEGASSING SYSTEMS

### Degassing of 7 DTEK Energy LLC mines (12 longwalls)

<table>
<thead>
<tr>
<th>Surface – 5 mines, 9 longwalls, 7 vacuum pump stations</th>
<th>Underground – 2 mines, 3 longwalls, 2 vacuum pump stations</th>
</tr>
</thead>
</table>

| Vacuum pumps: VVN2-150m³ (2–4 ea. per VPS) | Vacuum pumps: VVN2-50M, NVVP-50 (3–4 ea. per MVPS) |

| Degassing tubes diameters: magistral – 325 to 500 mm, local – 200 to 325 mm | Drilling equipment for gas boreholes: SBN-02, SBG-1m, NKR-100 |

| Degassing boreholes to gaseous satellite seams Diameter – 76, 93, 112 mm; depth – 25 to 75 m | Gas offtakes left in goaf with the diameter of 100–150 mm |

### Key Points:
- Methane concentration in captured mixture at VPS is 5 % to 50 %
- Pure captured methane volume (at a longwall) is 2 to 30 m³/min
- Mining sections degassing efficiency factor is 25 to 75 %
- Captured methane average annual volume is about 47 million m³/yr
**Major Ways for Improvement of Degassing Efficiency at DTEK Energy LLC Mines**

1. Increasing the length of boreholes and performance of pumps;
2. Increasing the diameters of boreholes and optimisation of their drilling technology.
3. Improving the quality of boreholes sealings;
4. Improving the boreholes protection against deterioration.
5. Gas capturing from the degassing facilities via separate ducts.

**Ways for Improvement of Mining Safety with Complex Degassing Implementation**

1. Roof degassing (the maximum efficiency achieved is 75 % and depends on the diameter of wells drilled and their wellhead protection quality).
2. Goaf degassing with gas offtakes and wells drilled into goaf (efficiency is 50–80 %, depending on the factor of leakage through goaf and flowrate of gas mixture being pumped).
3. Isolated draining-out of methane from the goaf with VMTsG-7M gas pump fans.

Total efficiency of complex degassing implementation can reach **70–80 %**.
Cogeneration, also known as combined generation of thermal power (heat) and electric power, unifies production of electric power and heat in a single process, which allows to significantly reduce carbon emissions to the atmosphere and electric power costs.

Cogeneration allows to achieve the energy economy of 15 to 40 % against use of thermal and electric energy from conventional power plants and boilers. Cogeneration optimises supplies of electric power to consumers of all kinds, while providing the following benefits for enterprises and community in general:

- Efficient energy transformation and utilization;
- Reduction of emissions to the environment, especially those of CO₂, which is the major greenhouse gas; this is a complex solution for achieving goals on global emissions reduction.
- Cost saving, benefits for industrial and commercial consumers from extra competitive advantages, opportunities of affordable heat for household use.
- Prospect of advancing towards a more decentralized form of electric power generation where factories and plants cover the local consumer demand while ensuring high efficiency and avoiding losses for transmission and improving system utilization flexibility.
- Improvement of supply security at a local level and in general; cogeneration is capable of providing an opportunity for consumers to minimize risks of electric and/or thermal power supplier shortage; decrease of fuel demand due to cogeneration utilization reduces dependence on import of resources and allows to tackle the major problem of Europe’s future energy welfare.
- Opportunity of increasing the variety of generation facilities and driving the energy generation competition; cogeneration is one of the major ways to liberalise the energy market; addressing unemployment: many studies have shown that development of cogeneration provides new jobs.
Mine methane is a gas and air mixture forming in course of coal mining that is vented to the atmosphere while being an alternative energy source. Mine methane utilisation at cogeneration facilities produces electric and thermal power.

The Project objective is the use of mine methane as an energy resource, and reduction of pollutants emissions to the atmosphere.

**Electric power generation amounts in 2018–2027, MW·h**

- **Electric power**
- **Electric power security (independent power supply)**
- **Heat**
- **Mine boiler decommissioning (reduction of emissions)**
- **Mine’s own demand cover**
- **Electric power supply to ENERGY MARKET**
- **Hot water supply**
- **Mine’s factory heating during autumn and winter seasons**
- **Water supply to mine heaters, shaft heating**
THANK YOU VERY MUCH FOR YOUR ATTENTION!