Methane Mondays

Second meeting, Friday, 8 October 2021, 15:00-17:00 Geneva time.

Summary of the meeting

- The second session of the Methane Mondays series was titled: “The impact of methane emitted from coal seams on the state of the atmosphere and the real possibilities of its capture and utilization.”
- In the opening remarks the Moderator highlighted that the mandate of the UNECE Group of Experts on Coal Mine Methane was expanded to include issues related to Just Transition.
- The event started with a presentation on sources of methane emission in underground coal mines, which contained the following information:
  - CH$_4$ accumulated in coalbeds originates through the carbonification of vegetable substances.
  - There are two main stages of the process:
    - diagenesis, i.e., physical, chemical, and biological processes that transform the vegetable substances into peat and then lignite,
    - metamorphism, i.e. further carbonification of lignite into hard coal and anthracite.
  - The diverse composition and structure of rocks have an impact on the variability of methane occurrence in hard coal deposits.
  - Methane occurs in the rock-mass in an adsorbed state and as a free gas in pores, cracks and cavities.
  - Gas sorption depends mainly on the nature and type of coal, temperature, and pressure.
  - The methane migration feasibility in the deposits depends on their saturation with methane and permeability. It varies in different coal basins as it depends on geological and mining conditions.
  - The knowledge of the sorption process makes it possible to determine the amount of gas and its state (adsorbed or as a free gas) in the deposit.
  - Desorption is a reverse process. Its knowledge allows to determine the amount of gas that desorb from coal over time.
  - The process of methane filtration from the coalbed to the excavation takes place as a result of rock depressurizing during the mining operation. This lowers the pressure of free gas, which contributes to its desorption.
  - Methane can be emitted in two ways:
    - Desorption and gradual filtration outflow of CH$_4$ under the pressure gradient caused by mining,
    - Methane outflow from fractures and cracks in the seam as a result of mining operations.
  - In coal deposits characterized by a very low methane content the only thing that can be done is to dilute methane with air flow using ventilation system. That is a way how methane is removed from excavation to ventilation shafts and then to atmosphere (VAM).
  - If the methane content is high, ventilation system is supported by a drainage system which captures methane to decrease its emissions to the excavations.
  - Various examples from Polish mines were provided to illustrate the above (please see the presentation at the webpage dedicated to the second Methane Mondays meeting).
  - In Poland methane emissions efficiency amounts to 37%. The remaining 67% is released to the atmosphere through ventilation systems.
  - All countries under Annex I of the Kyoto Protocol have to report their emissions...
- Underground coalmines are responsible for approx. 8% of total methane emissions from those states (Those numbers do not include China and India).
  - Underground mining contributes to methane emissions. If we continue with mining coal, methane will keep being released. There is no way around that.
- Then the audience listened to a presentation on the environmental impact of CMM, which contained the following information:
  - Methane, measured instantaneously after the release, is 120 times more powerful as a pollutant than CO₂.
    - It is a short-lived climate pollutant and its potency decreases over time. After 20 years it is 86 times more potent than CO₂, and over 100 years the factor varies between 28 and 36.
  - There is no doubt that human activity has been making a huge contribution to methane concentrations in the atmosphere.
    - Methane has always been emitted to the atmosphere. However, since the industrial revolution resulting in an increased use of fossil fuels and more intensive agricultural production, the emissions grew, disturbing the previously existing equilibrium.
    - Coal mining regions are big emitters of methane.
  - To achieve carbon neutrality by 2050 it is necessary to reduce emissions from the energy sector.
    - IEA calls for cutting methane emissions down by 75% over the next decade.
      - It suggests various solutions to meet that goal, including closure of certain mines, particular those that have extremely high methane emissions as compared to others (that refers generally to metallurgical coal mines).
  - Is data on CMM emissions credible?
    - According to the current estimates, CMM accounts for around 30% of methane emissions from the energy sector, for around 10% of anthropogenic methane emissions, and for around 6% of all global methane emissions.
      - Oil and gas sector as well as agriculture are much bigger emitters than the coal industry.
      - There are questions about methodology used for many of the available calculations.
      - The estimates often do not account for AMM emissions.
        - As more and more of coal mines are being closed, the share of AMM emissions will grow.
      - Therefore, including AMM emissions, CMM is estimated to account for around 50% of methane emissions from the energy sector, for around 25% of anthropogenic methane emissions, and for around 12% of all global methane emissions.
- After that, a presentation focused on real possibilities of capturing and utilization of methane from coal mines was delivered. It contained the following information:
  - Methane is dangerous not only for the environment but, being highly flammable, also for the personnel working underground.
    - Coal mines are obliged to assure safety of their workers, what in gassy mines equals a necessity to drain methane.
      - Draining methane decreases its emissions to the ventilation system (to the excavations, i.e. increases safety of the workers).
      - Draining methane generates significant costs.
- Methane can be used for a production of energy, which might balance the cost of activities aimed at its capture, or even bring additional profit.
  - Emissions can be expected from the layers that are over and below the mined longwall.
    - Typically, the amount of release depends on the original gas content in the seam (methane content).
    - The degree of release from individual coal seams depends also on the volume of production in the longwall working.
  - Calculation of the emissions can be done using various methods (please see the presentation at the webpage dedicated to the second Methane Mondays meeting).
    - It is necessary to know the expected emissions to properly design a drainage system.
  - There is a number of available drainage technologies.
    - Pre-mine drainage allows for capturing methane before the start of mining activities, but it requires high permeability of the rock mass.
    - Mine methane drainage captures methane during mining activities.
      - The general principle of methane capturing consists of draining it from the rock mass and isolated goafs through specially designed boreholes.
        - The boreholes can be drilled from behind the longwall face, from before the longwall face, or from another heading (an additional heading can even be built above the mined coal seam and the boreholes could be drilled from it).
      - Then the gas is discharged via a separate pipeline network on the surface, using the low pressure generated in a methane drainage station.
    - Different ventilation systems require different designs of the drainage system (please see the presentation at the webpage dedicated to the second Methane Mondays meeting).
  - Methane is being released to the atmosphere not only with VAM. Certain percentage of methane captured by the drainage system is also not used and therefore released.
  - State of methane emissions in Poland:
    - In 2020, 819.62 million m³ of methane was released from the rock mass affected by mining.
    - On the average it equals 1530.9 m³/min.
    - In 2015–2020, this amount per tonne of coal extracted (relative methane capacity) fluctuated between 12.9 and 15 m³.
    - If counting only the emissions from VAM, 63% of methane emissions from coal mines is released to the atmosphere.
    - If the amount of undeveloped methane (i.e. captured but not utilized) was included in the calculations, the percentage of methane released into the atmosphere would amount to 77%.
  - Uses of methane:
    - Captured methane may be a full-fledged fuel used in various technological solutions. It could be used for:
      - heat production (heating and technological needs),
      - electricity production,
      - combined systems (generation of electricity, heat, cold).
    - An example of methane use by JSW was given (please see the presentation at the webpage dedicated to the second Methane Mondays meeting).
VAM technologies are not yet at the level of efficiency that is required.
  - They work at the level of 3,000m²/h, while many mines have an air flux at the level of 50,000m³/minute.

The first part of the session ended with a presentation analysing activities aiming at lowering methane emissions undertaken by the industry, which contained the following information:
  - Coal Mine Methane is a broad term which refers to all types of methane related to coal.
  - However, many types of coal mine methane can be distinguished:
    - VAM,
    - Drained CMM,
    - AMM.
    - All those types have different characteristics and pose different challenges
  - There are various mitigation measures available:
    - Pre-mine drainage (efficiency of it depends on geological conditions):
      - It is done from the surface or from within the coal mine by drilling vertical or directional wells into the coal seam or adjacent strata.
      - Drained methane can be flared, sold to gas grid, or used to produce electricity. Unfortunately, it is often simply vented.
      - The process makes mining safer and more efficient due to lower gas factor.
    - VAM:
      - It is done by installing an equipment which captures methane from ventilation air and destroys it.
      - It is done during mining process, using VAM oxidisers, which destroy over 95% of methane that passes through them.
      - Destroyed methane generates heat, which can be used to produce electricity, but the economics are challenging.
      - The process should have no effect on mine safety or operational efficiency.
    - AMM
      - Once mine is abandoned it continue to emit methane for decades. Mines naturally flood in some regions and this will curtail methane emissions:
        - Flooding the closed mine traps methane in the coal seams.
        - It is an excellent option, but not always viable as the process can affect surface water, or cause ground collapse. It can also lead to flooding an adjacent operating mine, causing to major problems.
      - AMM can be captured and destroyed:
        - In order to capture and use AMM, a closed mine has to be sealed and have pumping and power generation equipment installed.
        - Captured methane can be used to generate electricity.
        - While the economics can be good, it will still not be sufficient to cover the costs of the upkeep of the closed mine – i.e. dewatering.
  - There are very many ongoing methane mitigations projects, but it is very difficult to aggregate data about them.
    - Reporting differs among the countries.
  - Effectiveness of methane mitigation efforts:
• It depends on the situation: whether methane mitigation efforts are to be undertaken in an operating mine, in a mine that is closed, or in one that is yet to be opened.
• It also depends on the operational characteristics of the mine, geological parameters, access to customers of electricity, incentives, legislation, etc.
• Many of CMM drainage and utilization projects have excellent economics, as they improve mine's operations and lead to revenues from the sale of gas, heat and/or electricity.
• In some cases, the CMM destruction is quite expensive, but still affordable compared to the costs of methane emissions.

• The above-described part was followed by a discussion moderated by the Chair of the Group of Experts on CMM, Mr. Raymond Pilcher. The following statements were made during the debate:
  o Directional drilling is a good and efficient technology allowing to provide security to workers, but at the same time it is not preventing completely emissions to the excavations. It is also expensive.
  o Is there an information on utilisation of the recovered gas for the communities, e.g. benefiting district heating systems (a utilization that is other than for the mine operator itself)?
    ▪ It would be of interest of the project developer, in terms of:
      • how to mobilize resources,
      • how to create an understanding that while the mining continues the recovery and the use of methane can bring immediate benefits,
      • when and how those resources could be use best when the mining continues.
  o In Poland there is an institution called the State Mining Authority which governs all information concerning coalmining. It collects information about emission from each mine and the level of methane utilization. However, it does not gather information on purposes for which captured resource is used. Such information needs to be collected directly from the mines.
  ▪ There is a database developed by GMI and posted online, which covers information on all active CMM projects that the GMI researchers are aware of. However, the information is not complete as not all mines share all the data.
    • The industry often times does not want to release data fearing that it will be used against it.
    • It has to be remembered that the reason why the coal mines exist is that there are consumers for the product that they offer, i.e. coal. In other words, coal mines should not be the only ones to blame, the whole coal-based ecosystem is.
  o Is there any technology that would not only allow to destroy VAM but also capture it and elevate concentration to 27-30%, which would allow for the use in engines?
    ▪ The issue is the volume. At this point there is no possibility to economically capture VAM. While there are some VAM projects in China there is no sufficient information about their economic, and those rely on wholesale capture of the low-grade methane.
    ▪ What is generally recommended at this point is drainage and directing methane that direction.
  o Why in Poland so much coal is produced in highly gassy mines, while other mines are available?
It is because most of Polish coal mines are gassy. There are located in the coal basins that have high methane concentrations. In addition, even those mines which were not very gassy in the past, have now, as the exploration goes deeper, become relatively gassy as well.

In relation to thermal coal mines, would that be possible for Poland to move the production to mines with low methane emissions rather than continue exploitation of the gassy mines?

- It would be very difficult for Poland as most of mines in the country are actually gassy.

If there would be a big amount of money for R&D to tackle methane problem what would be the best way of spending it in Europe so that the benefits of methane reductions are seen in the EU, but at the same time a technology is demonstrated that could have a wider application?

- The question should go to coal mining operators as it is them who are the best suited to answer it.
- Future is in investing in utilization of captured methane.

Those investments are very expensive.

Can VAM be used as a combustion air e.g. in a gas turbine process? In such case it could be used to supplement firing, recovering the energy value of VAM. What if the captured methane is used to help fuel the turbine? What VAM projects would make sense financially, economically, and also be innovative, demonstrating something new?

- At the moment there is no good solution for VAM. However, in the future we will surely come up with a technology that will change it.
- Megtec Durr supplied equipment for Australia, which was working for ten years making electricity of the VAM. They were able to utilize energy from VAM. The minimum of 0.2-0.3% is necessary for installation to be self-sustaining. Everything above is sufficient to produce steam and electricity.

- It appears that under certain economic conditions there is an available technology that can be useful. Therefore, it seems that the problem is rather with regulations and investments.
  - Unless a sellable product, like e.g. electricity, can be produced, the economics of the project depends only on the carbon markets.

A question about a potential for sequestration of CO₂ was asked.

- RECOPOI project was focused on sequestration of CO₂ into coalbeds in Upper Silesian Coal Basin.
  - It was proven that there is a significant increase of CBM recovery while injecting CO₂. However, the process is very complicated. Nowadays the concept is not as popular as it was ten years ago. Partially because there are not many locations in the world where it can be proven that there will not be a leakage of CO₂ afterwards.
  - The process is very dependent on permeability. Unfortunately, once the CO₂ is injected, the matrix of the coal starts to swell becoming in a way less permeable, which is a difficult problem to overcome.

Cost and investments.

- If a coal industry actor is faced with investing in mitigation of methane emissions with a project which may or might not have a high return on investment the question remains where is that money is supposed to come from.
  - Very many commercial banks are not lending to coal industry.
• Multilateral banks made it clear that they cannot invest in anything that may promote continued use of fossil fuels.
• We think about methane in isolation, but it should be placed it in a broader energy system. We will all eventually move to other energy sources. That would allow us to integrate those together and make investments in mitigation of methane emissions. A system-level approach is necessary.
• Alternatively, you treat CMM as a long-term problem and set up projects today that will run using AMM over the next 20 years. But they are much smaller projects and therefore are probably much less interesting to the companies.

- Having more information on emissions and having indication of interest of mitigating them from coal companies which are currently lacking funds to do so, would be very useful. If there is money out there and if there are also technological solutions, what is needed is matchmaking.
- Coal sector needs to think strategically about its place in the energy system. There is no reason why coal industry could not be adapted to the new reality. Coal is today the main product, but when we figure out CO₂ storage that would be an additional stream of revenue for the industry. CMM, CBM are yet another stream. Coal gasification that produces syngas, which can be converted to e.g. hydrogen, or methanol, is also an option. Such solutions coupled with carbon tax credits, or benefits could unlock a lot of financial potential in the industry.