TYPES OF METHANE RECOVERY

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Virgin Coal Bed Methane (VCBM)

- Coal Bed Methane (CBM) and Virgin Coal Bed Methane (VCBM) are terms conventionally used for methane drained and captured directly from the coal seams.
- CBM is generally reserved (in addition to its use as a generic term for all coal seam gas) to describe the gas produced from surface boreholes ahead of mining for coal mine safety and coal production reasons.
- VCBM is produced by a similar process but completely independently of mining activity.
- Methane concentrations in VCBM are generally very high, around 99%, and can be used as a replacement for natural gas supplies.

- There exists an estimated potential of 400 BCM of CBM in three provinces viz. Jharkhand, West Bengal and Chhatisgarh. Commercial scale exploitation of CBM has already begun in Raniganj Coalfield in India.

BCM: Billion cubic metres

Coal Mine Methane (CMM)

- Methane is released as a result of mining activity when a coal seam is mined out and if not controlled to prevent the accumulation of flammable mixtures of methane in air (5-15%) it presents a serious hazard.
- Gas drainage techniques are used to enable planned coal production rates to be achieved safely by reducing gas emissions into longwall mining districts to a flow that can be satisfactory diluted by the available fresh air.
- In some instances gas drainage is also needed to reduce the risk of sudden, uncontrolled emissions of gas into working districts. In well managed mines, in favourable geological and mining conditions, the methane concentrations in drained CMM can reach 70% or more. CMM of such quality may be utilised. However, poorly drained mines will only achieve methane concentrations that are much lower, and may be too low for conventional utilization purposes.
- Three coalfields in the Damodar River Basin (Raniganj, Jharia and Bokaro) were studied for feasibility of recovery and utilization of CMM. Kalidaspur and Ghusick collieries in the Raniganj Coalfield, Murulidih, Amlabad, Sudamdih and Parbatpur mines in the Jharia Coalfield and Jarangdih and Sawang collieries in the East Bokaro Coalfield appear to be favourable sites for CMM recovery.

Ventilation Air Methane (VAM)

- Methane released from coal seams into the ventilation air of the active coal mine is called Ventilation Air Methane (VAM).
- Methane diluted by ventilating air in underground coal mines is vented to the atmosphere and may be captured for its gainful utilization. Concentration of methane in the ventilation air is generally limited by law, for safety reasons, at 0.5 to 2% in different parts of a mine with variations depending on the country.
- Concentrations can be controlled by the volume of ventilation air circulated (dilution) or through special drainage (CMM).
- The concentration of methane in VAM is typically 0.8% or less and is too low for conventional utilisation purposes. However, technologies are being developed to remove the methane, and where additional gas is available to generate electricity using the thermal energy recovered.
- It has been reported that utilization of VAM at Moonidih Mine of BCCL can lead to a net emission reduction of 0.62 million tonnes of CO2 equivalent per year.

Abandoned Mine Methane (AMM)

- When an active coal mine is closed and abandoned, methane continues to be emitted from all the coal seams disturbed by mining, decaying gradually over time unless arrested by flooding due to groundwater recovery.
- Depending on the methane concentrations, local regulations and the geology it may be possible, or required for public safety reasons to continue draining or venting this Abandoned Mine Methane (AMM).
- AMM extraction and utilisation schemes aim to recover the gas left behind in unmined coal above and below goaf(worked-out) areas formed by longwall mining methods. The gas can either be transported by pipeline to a nearby user consumer for combustion in boilers or used on-site to generate electricity for local use or sale to the grid.
- AMM reservoirs consist of groups of coal seams that have been de-stressed, and therefore of enhanced permeability, but only partially degassed by longwall working.
- Favourable project sites are those where a market for the gas exists, the AMM reservoir is of substantial size and not affected by flooding and the gas can be extracted at reasonably high purity.
- A number of schemes are in place in countries such as the UK and Germany. There has been no effort to quantify the potential of AMM resource in India so far. It is imperative, therefore to initiate a study for evaluation of AMM resource potential in India.

Methane Emission and Recovery from Abandoned Underground Coal Mines

- Following mining activities, coal mines are typically sealed and abandoned either temporarily or permanently.
- To prevent methane buildup and gas migration to the surface through overburden fractures, some underground abandoned mines may continue to be vented to the atmosphere through wells, portals, and shafts.
- As work stops within the mines, the methane liberation decreases but it does not stop completely.
- The following factors influence abandoned mine emissions:

❖ **time since abandonment;**
❖ **gas content and adsorption characteristics of coal;**
❖ **methane flow capacity of the mine;**
❖ **mine flooding;**
❖ **presence of vent holes; and**
❖ **mine seals**.

- The rate and amount of methane buildup is usually proportional to how much coal is left in these areas, the coal's gas contents and reservoir properties, the amount of mine void that is not flooded, and the existence of other gas sources within the gas emission zone of the abandoned area.

- Gas accumulation and pressure buildup within abandoned mines can be potentially dangerous for active mines, if they are nearby, by overloading the ventilation system as a result of gas inflows into working areas during periods of decreasing atmospheric pressure.
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- Abandoned mines can also present a danger to active mines operating at a greater depth if the abandoned mine happens to be within the fracture zone, so that any methane accumulation can migrate downwards into the active mine to create a sudden methane emission into the ventilation system. Therefore, abandoned mines sometimes are left venting to prevent gas accumulation.

- Instead of releasing methane emissions from abandoned mines to the atmosphere, recovery and utilization should be considered. This will both reduce the possibility of methane emissions into underlying or nearby operating mines and limit the greenhouse effect.

- However, if the abandoned mine is close to the operating mines, drilling production boreholes and setting operating pressures should be done with full knowledge of the location and condition of the seals and the mine voids.

Detecting mine voids

- Detection of mine voids to produce gas from abandoned workings has usually relied on existing maps and exploration boreholes.
- However, maps may not be updated and thus may not show the existing boundaries of abandoned workings. In addition, the extent of pillars and old workings can change due to underground stress conditions. Therefore, the maps that show the conditions at abandonment may not give the most accurate information on the latest conditions.
- Therefore, geophysical measurements can be used to augment the borehole data, improve the knowledge of intermediate zones between exploration boreholes, and better identify the voids in abandoned workings. Furthermore, geophysical techniques can be used to optimize the number and locations of the producing boreholes and their proximities to abandoned mine seals and active mines.

- There are several surface geophysical methods that are applicable to detect subsurface voids such as gravimetric, seismic measurements, electromagnetic methods, magnetic, and ground penetrating radar.
- Two techniques in particular have shown the greatest potential for application. The DC resistivity method offers the best potential for the rapid mapping of mine workings at a depth of 40 m or less.
- For workings at depths of 40 m or greater, the seismic reflection method, especially with the use of S-waves, has the greatest potential for success.

- Johnson et al. (2002) have demonstrated the use of various S-wave profiles over abandoned coal mines to detect mine openings that would be suitable targets for the installation of methane extraction wells and to evaluate the conditions of these old workings.
- During the trials to detect voids in these studies, boreholes were also drilled on the basis of old mine maps. However, some of the boreholes did not encounter the mine voids.

- S-wave surveys were performed in lieu of conventional P-wave surveys to detect the mine voids, because S-waves would not transmit through a void.
- It was demonstrated that S-wave seismic surveys can be used successfully to locate mine openings.
- Fig. gives an example of detecting mine voids using reflection amplitude for a mine in Danville, Illinois.

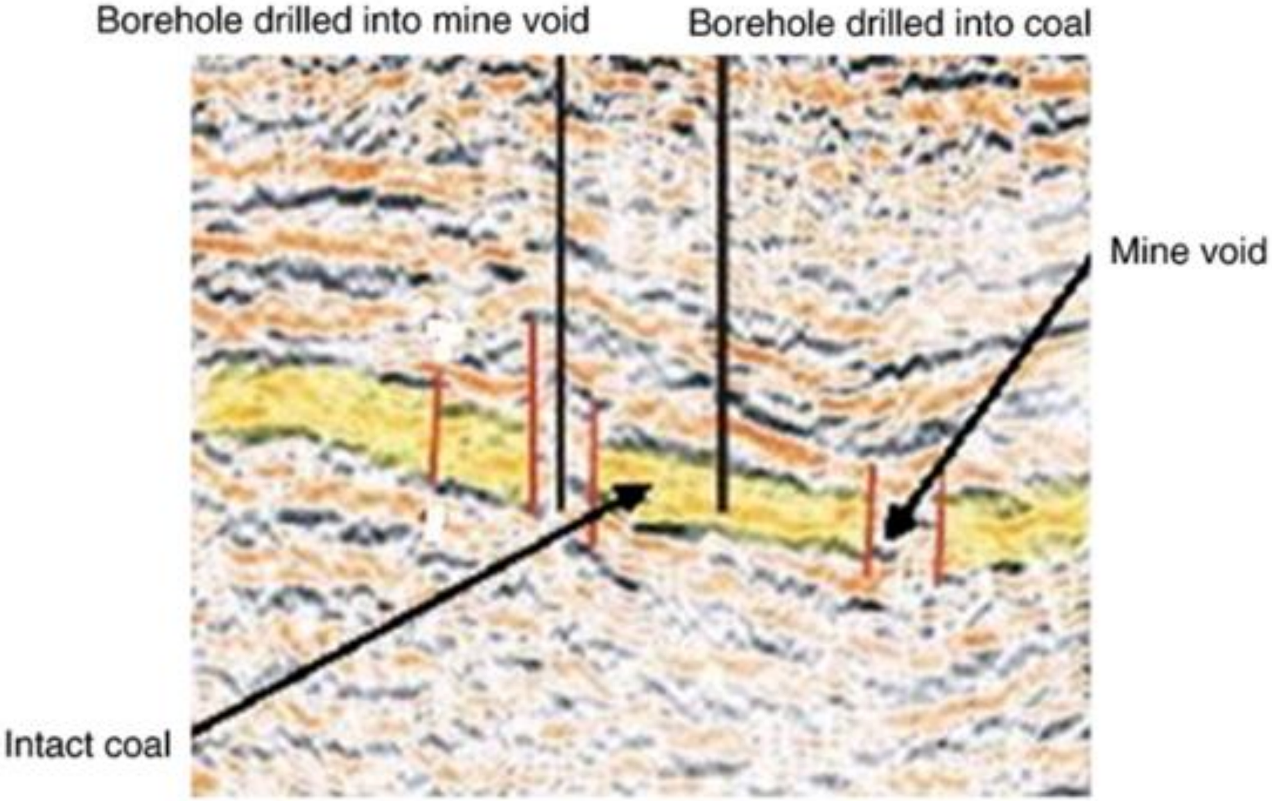

Fig. 23. Intact coal and mine voids detected using S-waves in a mine in Danville, Illinois. Modified from Johnson et al. (2002).

Methane emissions evaluation

- The U.S. Environmental Protection Agency (U.S. EPA, 2004) has developed a methodology to evaluate their methane emissions potential in relation to producing this gas.
- It classified the abandoned mines into three general categories – sealed mines, flooding mines, and venting mines.

- In abandoned mines, methane emissions can be thought of and evaluated only in terms of coal gas content and pressure at abandonment, the void space, gas emissions space left from the mining disturbances, the permeability of the methane source into the mine voids, and the boundary conditions of the mine (i.e. whether it is being vented, tightly sealed, or being flooded as a function of time).