LECTURE – 5

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1.0 METHANE OUTBURSTS

One of the modes of gas emission into mine workings is the release of an abnormally large volume of gas from the strata in a short period of time. Such incidents have resulted in considerable loss of life. In many cases, this sudden emission has been explosive in its violence, fracturing the strata and ejecting large quantities of solid material into the workings. Gas outbursts are different from rock bursts as rock bursts are caused by high strata loadings. However, the chances of gas outburst are more in areas of abnormally high stress such as a pillar edge in overlying or underlying workings.

There are two distinct types of gas outbursts, (a) in-seam bursts and (b) roof and floor outbursts.

1.1 In-seam Outbursts

In-seam outbursts are prevalent in coal and potash mines wherein large amount of gas and solids are ejected in a small period of time. These occur in sections of mineral which have low strength and contain gas at high pressure. There is an increase in the stress on the areas that lie between the free face and the hidden outburst pocket containing compressed coal dust and gas whenever, any heading approaches such pockets/zones. A situation may be reached when the force exerted by gas pressure in the outburst pocket exceeds the resistance of the barrier. In such cases, the coal front bursts outwards explosively. In the coal mines, methane and carbon dioxide are found in in-seam outbursts while in potash mines, nitrogen is generally the major component.

The dangers associated with gas outbursts in mines are:

- The problem in breathing encountered by miners due to both gas and dust.
- The violence of the outburst may damage equipment and cause sparking that can ignite the highly flammable gas/dust/air mixture.
Disruption of the ventilation system of a mine due to sudden expansion of a large volume of gas.

As a precautionary measure against in-seam gas outbursts:

- Drilling exploratory holes
- Pre-drainage of outburst pockets
- Machine mining should be replaced by drilling and blasting methods (volley firing) and the mine should be cleared of personnel before each blast whenever it is suspected that a face or heading is approaching an outburst pocket.

NOTE:

Volley Firing: It is a controlled method of creating a gas-outburst in an area where there is a possibility of outburst, at a known and safe time. This method uses smaller holes and small charges that shake and fracture the coal while leaving it in place. A number of charges are fired simultaneously (a volley), increasing the probability that a dynamic failure will occur in a controlled setting.

1.2 Roof and Floor Outbursts

These outbursts usually occur in longwall mines. Methane gas migrates from higher or lower source beds (source bed refers to a bed in the strata containing methane gas) towards the working horizon behind the working face. However, the passage of gas may be blocked by cap rocks which may result in a reservoir of pressurized gas accumulating beyond the cap rock. If these cap rocks fail in sustaining this pressurized gas, then this failure will produce a large and rapid emission of the gas into the working horizon.

The below figure illustrates how an outburst from the floor develops. In figure, relaxation of the strata allows gas to be evolved from the source bed. This evolved gas then migrates upwards. A strong intervening bed, which contains induced fractures, allows the gas to pass through it.
(a) Safe condition: Isobars distributed; strong bed sufficiently permeable (or fractured) allowing gas to migrate through in a controlled manner.

(b) Potential outburst condition: reduced permeability of the strong bed resulting in an increased pressure gradient across this bed and high.

Fig. 1 Development of a gas outburst conditions under a longwall panel (after McPherson, 1993)

2.0 CONTROL OF METHANE EMISSIONS IN MINES
The control techniques for methane or any other strata gas emission is dependent on the source (especially the gas content of the seam), and the nature of their occurrence. The emission of these gases may be either continuous or intermittent. With change in mine climate, the rate of their emission may also change. Table 1 gives the list of objectives and techniques utilized to control the emission of strata gases.

**Table 1** Techniques to control emission of strata gases with their objectives (Hartman et al., 1982)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Techniques utilized</th>
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<tbody>
<tr>
<td>Prevention</td>
<td>a. Proper procedure in blasting</td>
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<td></td>
<td>b. Maintenance of IC engines</td>
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<td></td>
<td>c. Avoidance of open flame</td>
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<td>Removal</td>
<td>a. Drainage in advance of mining</td>
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<td></td>
<td>b. Drainage by bleeder entries</td>
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<td></td>
<td>c. Local exhaust ventilation</td>
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<td></td>
<td>d. Water infusion in advance of mining</td>
</tr>
<tr>
<td>Absorption</td>
<td>a. Chemical reaction in IC engine conditioner</td>
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<td></td>
<td>b. Solution by air-water spray in blasting</td>
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<tr>
<td>Isolation</td>
<td>a. Sealing of abandoned workings of fire areas</td>
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<tr>
<td></td>
<td>b. Restricted blasting or off-shift blasting</td>
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<tr>
<td>Dilution</td>
<td>a. Local dilution by auxiliary ventilation</td>
</tr>
<tr>
<td></td>
<td>b. Dilution by main ventilation airstream</td>
</tr>
<tr>
<td></td>
<td>c. Local dilution by diffusers and water sprays</td>
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Of all these techniques, dilution by ventilation is universally accepted. There does not exist a single method which is capable of controlling methane to the desired level. The reason may be the dynamic nature of gas emission, the cost of controlling, etc. In general, we need to employ a combination of these techniques for controlling/reducing methane emission.

Let us have a look at the efficiencies of different techniques utilized in controlling methane (Fig. 2).
The results depicted in Fig. 2 are based on the studies of several mines and are likely to change with change in geological, geographical and other environmental conditions.

**3.0 METHANE DRAINAGE**

The organized extraction of methane from carboniferous strata is done in order to:

- Produce a gaseous fuel
- Reduce methane emissions into mine workings or
- A combination of the above two objectives
Methane drainage is practiced when methane emission in a mine exceeds 20 – 25 m³/ton of coal produced.

There are various methods of methane drainage. The various parameters that affect the choice of the method to be used are:

- The natural or induced permeability of the seam and associated strata
- The reason for draining the gas
- The method of mining

The gas capture efficiency of methane drainage system is defined as:

\[
\text{Gas capture efficiency} = \frac{\text{Gas captured by methane drainage}}{\text{Gas captured} + \text{Gas emitted into ventilation system}} \times 100
\]

3.1 Cross-measures Methane Drainage

This method is a very common method of methane extraction in the areas where the drilling of bore hole from the surface is difficult because of more depth. In this method cross measure bore holes are drilled from roadways in working seams at some inclination. The holes may be drilled either upwards or downwards. The upward drilled holes are preferred because methane usually accumulates in bed separation cavities and is driven out as the roof breaks or collapse. Capture efficiencies for this method is usually in the range 20 to 70 %. Boreholes are drilled into the roof and, if necessary, also the floor strata. They are usually drilled in the return airway because the ventilating pressure drives the gas in the gob/goaf towards the return side. This is the dominant method of methane drainage and is particularly applicable to advancing longwall panels.

- Angle of inclination of bore holes in flat seams = 50° - 60°
- Diameter of holes = 65m – 90m
Space between holes = 20m – 30m. Spacing between the bore holes should be such that their zones of influence overlap slightly.

Hole length = 15m – 100m (preferably 30m – 45m).

Suction pressure = 1000Pa-1500 Pa

A mixture of sand and water is injected at high pressure and drained off before starting methane drainage so that it breaks open the pores in the strata.

**Fig. 3** Cross-measures methane drainage in an advancing longwall panel (after, McPherson, 1993)

**REFERENCES**

