Measurement approaches for methane emissions in coal mines

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2013 Status of coal mines in the U.S.

- Coal is produced in 25 states
- 70% of production comes from 5 states; Pennsylvania, West Virginia, Kentucky, Wyoming, Illinois

<table>
<thead>
<tr>
<th>Type of mine</th>
<th>Number of mines</th>
<th>Production (x10^6 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground - active</td>
<td>395</td>
<td>309.5</td>
</tr>
<tr>
<td>Surface - active</td>
<td>637</td>
<td>581.3</td>
</tr>
<tr>
<td>Abandoned</td>
<td>7500 (492*)</td>
<td>-</td>
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Total methane emissions from coal mines

- 9% of total methane emissions of the U.S. is from coal mining
- Ventilation, underground degasification, abandoned mine emissions, and surface mine emissions account for ~85% of all emissions and ~130 Bcf of methane
Emissions from surface boreholes

- Used to control strata gas and vented to atmosphere in most cases
- Monitored at the wellhead using methane detectors and flow meters
- Usually daily or once in few days.
- Some mines installed continuous measurement systems monitoring multiple parameters - preferred method
Emissions from surface boreholes

- Emissions - production - show variability. May have methane concentrations > 30%
Ventilation system emissions

- Strata gas that is not captured by boreholes, and face emissions during mining as well as emissions from pillars enters the ventilation system.

- Ventilation system of the mine may have methane concentration <1%
Ventilation system emissions

- Monitoring is performed either by the mine or by MSHA.
- MSHA visits each mine on quarterly basis - at least - and collects flow rate and concentration data at evaluation points and at the shafts.
- MSHA provides results to the mine
Ventilation system emissions

- The disadvantage is reporting basis of pressure and temperature are different
- Missing measurements from entries
- Quarterly monitoring may miss major gas emission events and atmospheric events that result in volume changes of the gob gas
- Emissions should be monitored at the surface and continuously

![District Total Methane Liberation (TL)]
Emissions from surface mines

- Methane emitted from excavated coal, from overburden and/or underburden exposed by surface mining.
- Direct monitoring is difficult – open path FTIR and Gaussian based plume dispersion modeling.
- Most estimations are based on gas content of coals and use of an emission factor.
- Reliable gas content data and calibrated emission factors based on geology may improve estimates.
Emissions from abandoned mines

Shafts and drifts can be plugged with concrete.

Sections of the mine are isolated using mine seals.

- A decline curve methodology exists - EPA
Emissions from abandoned mines

- Most abandoned mines are not monitored. The ones with methane capture projects are monitored through extraction system.
- For emission monitoring – status of the mine, whether it has connected to surface via fractures, time from abandonment should be known.
- An abandonment methodology based on the type of the mine should be in place.
- Frequent, or continuous, monitoring of sealed shafts or drifts for pressure build-up and methane concentration should be conducted at the surface.
- Instrumenting the mine at the time of closure for water level measurements is needed.
Summary

• Currently, there is no well-established monitoring program in place for emissions from mines

• Continuous monitoring at the surface is always the best method for data intensity and representativeness

• Monitoring programs need to be designed based on the nature of the mines and the source of the emissions and affecting factors

• Emission factors, if have to be used, should be calibrated and be site specific