Explosive Gas and Methane: Are They the Same and How do you Know?

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Rules Background

• Section 2.3 of 6 CCR 1007 states that a landfill shall measure for “explosive gas”

• What is an Explosive Gas?
  – Hydrogen
  – Acetylene
  – Methane
The Cause?

- Methane? Natural Gas?
Methane and Types of

• Biogenic Methane- Formed by anaerobic bacterial metabolism of various organic substrates (e.g. landfills, marshes, compost, glacial till, sewer gas).

• Thermogenic Methane – Formed by abiotic thermal cracking of organic matter buried in sedimentary basins (e.g. natural seeps, leaking well casings, leaking pipelines).
Biogenic Methanogenesis

• Oxygen Free

• Two discreet pathways
  • 1) Acetic Acid Fermentation:
    • CH$_3$COOH $\rightarrow$ CH$_4$ + CO$_2$
  • 2) CO$_2$ Reduction:
    • CO$_2$ + 4H$_2$ $\rightarrow$ CH$_4$ + 2H$_2$O

• Different environments and isotopic signatures.
Isotopic Composition Reflects Origin

- Thermogenic Gas ('Natural Gas' & Coal Gas)
- Near-Surface Microbial Gas (Fermentation)
- Sub-Surface Microbial Gas (CO2 Reduction)

Aquifer Water Gas Sample
How is Origin Determined?

Sampling & Analysis!
How Is Origin Determined?

• The stable isotopes of methane can provide information on the mechanism formation. For instance, stable isotopes can provide information on whether the methane is Biogenic or Thermogenic.

• Radiocarbon, $^{14}\text{C}$, is produced in the upper atmosphere by cosmic rays and occurs in all organic materials that existed as plants and animals within the last 40,000 to 50,000 years, allowing the identification of methane formed from glacial deposits.
How is Origin Determined (continued)?

• Test question..........

• What events during the 1950’s and 1960’s injected amounts $^{14}$C into the atmosphere and provided a “tag” for organic materials with an age of 50 years old?
How is Origin Determined (continued)?

- Tritium
- The production of Tritium 3H was also produced during weapons testing.
- The importance of this is that Natural gas would not have been exposed to recent atmospheric events.
Radiocarbon activity of Gases

Real World Example

![Methane Isotopes Graph]

Legend
- O Known LFG Sample
- △ Methane Sample from Perimeter LFG Monitoring Probe
- O₄,Δ₅ County of Happiness Samples

Note: Samples 5 and 6 are from probe GMP(R)-3 and the flare inlet at the County Happiness Landfill, respectively. Samples 1, 2 and 3 are methane samples collected from perimeter LFG monitoring probes at another MSW landfill which was demonstrated to be from another methane source. Sample 4 is a known LFG sample collected from the same site as samples 1, 2 and 3. Sample 7 is a known LFG sample from another MSW facility.
Real World Example (con’t)

13C Isotopes

Legend
- Known LFG Sample
- Methane Sample from Perimeter LFG Monitoring Probe
- County of Happiness Samples

**Note:**
Samples 5 and 6 are from probe GMP(R)-3 and the flare inlet at the County of Happiness, respectively. Samples 1, 2, and 3 are methane samples collected from LFG monitoring probes at another MSW landfill which was demonstrated to be from another methane source. Sample 4 is a known LFG sample collected from the same site as samples 1, 2, and 3. Sample 7 is a known LFG sample from another MSW facility.
Questions?

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