Modeling the Concentration Distribution of Benzene from Flowback using AERMOD

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Abstract

Oil and gas well operations are often located near populated areas in communities including schools and parks. This raises concerns about the exposure of people in these areas to compounds emitted from activities associated with oil and gas production. Compounds emitted include a class of compounds known as BTEX (benzene, toluene, ethylbenzene and xylenes) some of which are known carcinogens and can affect the central nervous system. Understanding the increases in the ambient concentration of these species is important for all-risk populations and the general public living in areas close to oil and gas operations. In this study AERMOD was used to model the dispersion of benzene from oil and gas wells in northern Colorado. We focus on comparing concentrations at 500 feet, the current setback distance, with 2000 feet, the proposed setback distance in the State of Colorado. In our simulations (with no terrain), there is a factor of two difference in the concentration of benzene at 500 ft and 2000 ft. The highest concentrations over the course of a year were observed at 500 ft. Simulations were also run with multiple wells, which indicated that the number of wells may be an important factor to consider as the average concentration 500 ft for 4 wells was higher than for 1 well at 2000 ft.

Methods

- Measure and calculate emission rates at local fracking/flowback sites
- Use AERMOD to calculate the concentration field using measured emission rates (0.094 g/s).
- Compare the current 500ft allowed setback distance from residential homes to the newly proposed 2,000 ft distance.

Gathering Emission Rates

A steady-state plume model developed by the EPA to analyze environmental and health impacts from polluting sources.

AERMOD

- Source Info: point, area, volume, stack height, exit velocity, temp., stack diameter, terrain
- Meteorology: surface, profile

Results

- Influence of Source Parameters
  - Parameters for base run:
    - Source: Point
    - Terrain: Flat (no terrain data)
    - Emission Rate: 0.094 g/s
    - Stack Height: 2 meters
    - Temperature: 1273 Kelvin
    - Exit Velocity: 20 m/s
    - Stack Diameter: 2.500 meters

- Base Case: Annual Average Concentration
  - 50% of Original Stack Height
  - 50% of Original Temperature
  - 50% of Original Emission Rate
  - 50% of Original Stack Diameter

- Base Case: Annual Maxima
  - 50% of Original Stack Height
  - 50% of Original Temperature
  - 50% of Original Emission Rate
  - 50% of Original Stack Diameter

Conclusions

- Emission rates can be used to model concentration fields for different scenarios
- There is a factor of two difference in the concentration of benzene at 500 ft and 2,000 ft.
- In this case study the highest concentrations were observed at 500 ft but on average the highest concentrations occur closer to the well.
- Concentrations increase when more wells are present.
- The highest hourly concentration for the year, for one source, is about the same as the local ambient concentration of benzene in Fort Collins (~2.5 ppbv).
- CDPHE will perform a similar analysis to conduct a health risk assessment study.

References


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