Life Cycle Analysis of Nitrogen Oxide Emissions as a Result of Shale Gas Production in Colorado

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Introduction

In the last ten years, hydraulic fracturing of shale gas has become economically feasible due to new technologies. In Colorado, natural gas is extracted via the hydraulic fracturing of shale deposits in the Denver Julesburg Basin, Piceance Basin, and North San Juan Basin. The production of natural gas emits carbon dioxide, methane, volatile organic carbons, and nitrogen oxides, which all have environmental effects.1,2

Methods

The Natural Gas Life Cycle (and NOx emissions sources) Consists of:
1. Pre Production: drill rigs, hydraulic fracturing, well completions and workovers
2. Production: compressor engines, boilers, heaters, venting, flaring
3. Processing: compressor engines, amine units, glycol dehydrators, boilers
4. Transmission: compressor engines
5. Distribution
6. End Use: residential combustion, electrical generation, commercial/ industrial combustion1,11,12

Results

Colorado Natural Gas Production, Export, and Consumption Trends

NOx Emissions by Stage

Summary of Natural Gas Emissions Sources, Production/Consumption Sources, and Spatial Domain

Pre Production: West J ump
Production: West J ump
Processing: CO
Transmission: CO
Distribution: CO
Residential Combustion: EPA
Electrical Combustion: EPA Clean Air Markets
Commercial/Industrial Combustion: EPA AP-42

RESOLVING THE DATA

The data was normalized to create emissions factors for each stage via the following equations:

Upstream Emissions Factor (lbs/mcf) = Emissions/Production
Midstream Emissions Factor (lbs/mcf) = Emissions/Consumption
Combustion Emissions Factor (lbs/mcf) = Emissions/Consumption

Conclusions

• The total amount of NOx emissions and the life cycle stage percentage of emissions depends on the end use of the natural gas.
• Upstream NOx Emissions account for between 11.67% and 62.18% of the total life cycle emissions.
• Pre Production Emissions for the Piceance Basin are higher than they are in a “typical” year because 2008 was a year of high drilling activity in the Piceance Basin as compared to the DJ and the North San Juan Basin.
• The pre production equipment (drill rigs and production equipment (heaters and compressor engines) should be examined to see how these pieces of equipment could be altered to reduce the total amount of emission.
• Data could have improved if the upstream emissions were not just for three basins, but for statewide natural gas production.

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References

Wells, D.; 2011 Points Based Oil and Gas Inventory. Colorado Department of Public Health and Environment.

Normalization of Data

The data was normalized to create emissions factors for each stage via the following equation:

Emissions Factor (lbs/mcf) = Emissions/Production

2008 marked an elevated year for drilling in the Piceance Basin, which is why drill rigs account for almost 50% of the total upstream emissions.

Life Cycle Analysis for NOx Emissions

Total Emissions: 17 lbs/mcf

Total Emissions: 11 lbs/mcf

Percent of NOx Emissions by Stage

Upstream: 62.18%
Midstream: 32.41%
Combustion: 5.40%