Colorado Department
of Public Health
and Environment

Greenhouse Gas Emissions
&
Oil & Gas Industry
Ozone SIP Strategies

Chris Laplante

Environmental Engineer

Air Pollution Control Division

July 8, 2008

Overview

- Introduction
- Oil and Gas Industry Emissions Control Strategies Evaluated
- Analysis of Greenhouse Gas Impacts
- Conclusion

Introduction

- Greenhouse gases (GHG) contribute to global warming by trapping heat in the atmosphere through the greenhouse effect.
- Common greenhouse gases include:
  - Carbon dioxide
  - Methane
- Evaluation of GHG emissions is not a regulatory requirement in ozone SIP development – remains an evolving issue.

Introduction

- Fuel combustion sources are common sources of greenhouse gas emissions.
- To compare global warming impacts of different GHGs, global warming potential (GWP) ratios are used.

Introduction

- Individual GHGs are multiplied by their GWP ratio to convert them into carbon dioxide equivalents (CO_2e) for comparison purposes.
- The GWP ratios used to convert GHGs to CO_2e in this analysis are:
  - CO_2 = 1
  - Methane (CH_4) = 21

Proposed Oil & Gas Industry Emissions Control Strategies Evaluated

- VOC emissions control requirements for condensate storage tanks.
- Elimination high bleed pneumatic controllers.

Analysis of Greenhouse Gas Impacts

Condensate Tank Emissions Controls

- Condensate tank emissions controls are commonly either an:
  - Enclosed Flare; or
  - Vapor Recovery Unit (VRU)
- VRUs are likely to reduce GHG emissions due to capture of methane without generating significant CO2e.
- Enclosed flares require greater analysis to determine GHG impacts due to VOC oxidation.

Analysis of Greenhouse Gas Impacts

Condensate Tank Emissions Controls

- Analysis of enclosed flare emissions controls
  - APCD analyzed the "flash gas" composition of 16 condensate samples collected in the DJ Basin to calculate a representative "flash gas".
  - The data set is the same one developed in 2002 to generate the state VOC emissions factor of 13.7 lb/bbl for Weld County.

Analysis of Greenhouse Gas Impacts

Condensate Tank Emissions Controls

- Compared the CO2e generated from venting 1 mole of flash gas vs. flaring 1 mole flash gas.
- Limitations
  - Assumed stoichiometric complete combustion of all hydrocarbon molecules in the “flash gas” which overestimates CO2e.
  - Excludes pilot gas combustion emissions which underestimates CO2e.

Analysis of Greenhouse Gas Impacts

Condensate Tank Emissions Controls

Component	MW (lb/lb-mol)	Average (mol%)	lbs mol gas	lbs Vented CO2e	lbs Flared CO2e
CO2	44	3.89	1.71	1.71	1.71
N2	28	0.22	0.06		
C1	16	31.33	5.01	105.27	13.79
C2	30	25.61	7.68		22.51
C3	44	21.21	9.33		28.00
i-C4	58	4.08	2.36		7.16
n-C4	58	7.39	4.28		12.98
i-C5	72	2.35	1.69		5.16
n-C5	72	1.81	1.30		3.97
C6	86	0.67	0.57		1.76
C7	100	1.45	1.45		4.48
			35.47	106.98	101.52

Analysis of Greenhouse Gas Impacts

Condensate Tank Emissions Controls

- Use of flares to meet condensate tank emissions control requirements will not likely significantly increase CO2e impacts versus venting (i.e. “no control”), due to methane reductions acheived.
- VRUs are a preferred option to recover product and minimize emissions of GHG.

Analysis of Greenhouse Gas Impacts

Pneumatic Device Emissions Controls

- Pneumatic controllers are a source of both VOC and methane emissions.
- The proposed control program would significantly reduce methane emissions by requiring low/no-bleed devices.
- Significant GHG reduction benefits will be achieved through pneumatics controls.

Conclusion

- APCD is considering GHG impacts of control strategies in light of the governor's Climate Action Plan.
- VOC emissions reductions are an important element of meeting health based ozone NAAQS.
- Proposed condensate tank and pneumatic emissions control requirements combined should have a neutral or beneficial impact on GHG reductions.

2002 DJ Basin "Flash Gas" Composition Data Set

Analysis of DJ Basin "Flash Emissions" Composition

June 19, 2008

2002 CDPHE DJ Basin State Emissions Factor Data Set

Modeled "Flash Gas" Composition (Mol%)

Component	MW (lb/lb-mol)	N001	N002	N003	N004	N005	N006	N007	N008	N009	N010	N011	N012	N013	N014	N015	N016	Average
CO2	44	5.48	2.12	2.78	4.25	2.4	3.4	3.53	6.22	6.86	5.62	0.83	3.87	7.64	3.51	1.54	2.13	**3.89**
N2	28	0.04	0	0	0.04	0	0.46	0.15	0.15	0	1.24	0	1.42	0	0	0.03	0.02	**0.22**
C1	16	46.03	22.16	29.71	36.8	15.81	31.1	26.74	40.4	44.89	35.78	20.21	34.16	41.2	29.93	22.38	24	**31.33**
C2	30	25.92	27.06	25.68	24.16	29.44	26	28.98	24.72	23.62	25.07	22.02	27.4	23.56	23.19	25.68	27.24	**25.61**
C3	44	12.68	29.9	22.52	17.94	29.98	20.96	21.27	13.86	13.01	16.69	29.58	17.35	14.54	19.01	29.43	30.62	**21.21**
i-C4	58	2.45	4.23	4.24	3.43	4.81	4.02	4.79	4.55	2.6	4.18	6.33	3	3.19	4.97	4.19	4.23	**4.08**
n-C4	58	3.2	10.41	9.08	6.29	9.77	7.96	7.63	3.73	3.97	4.79	10.88	5.71	4.58	9.87	10.87	9.43	**7.39**
i-C5	72	1.39	1.68	2.45	2.12	3.25	2.41	2.71	2.4	1.74	2.57	3.83	2.23	1.97	3.69	2.21	0.98	**2.35**
n-C5	72	0.79	1.58	2.01	1.91	2.27	1.92	1.95	1.2	1.17	1.42	3.7	1.73	1.22	3	2.2	0.88	**1.81**
C6	86	0.47	0.28	0.51	0.79	0.81	0.58	0.79	0.83	0.58	0.82	1.07	0.86	0.62	1.03	0.47	0.15	**0.67**
C7	100	1.55	0.58	1.02	2.27	1.46	1.19	1.46	1.94	1.56	1.82	1.55	2.27	1.48	1.8	1	0.32	**1.45**

CO2e Comparison of Venting vs. Flaring 1 mol of flash gas

Component	MW (lb/lb-mol)	Average (mol%)	lbs mol gas	lbs Vented CO2e	Complete Combustion Stoichiometric Ratio lb Component Flared:lb CO2e Generated	lbs Flared CO2e	lbs VOC Reduced
CO2	44	3.89	1.71	1.71	1.00	1.71	
N2	28	0.22	0.06				
C1	16	31.33	5.01	105.27	2.75	13.79	
C2	30	25.61	7.68		2.93	22.51	
C3	44	21.21	9.33		3.00	28.00	9.33
i-C4	58	4.08	2.36		3.03	7.16	2.36
n-C4	58	7.39	4.28		3.03	12.98	4.28
i-C5	72	2.35	1.69		3.05	5.16	1.69
n-C5	72	1.81	1.30		3.05	3.97	1.30
C6	86	0.67	0.57		3.07	1.76	0.57
C7	100	1.45	1.45		3.08	4.48	1.45
			35.47	**106.98**		101.52	21.00

Ratios calculated above are based on the stoichometry of complete combustion for each component type.