EXCERPTS FROM EPA DOC, Emissions from the Oil and Gas Industry
LINK TO FULL DOCUMENT
https://www.epa.gov/sites/default/files/2016-08/documents/14_glycol.pdf

RESEARCH SUMMARY

Title	Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators Final Report
Contractor	Radian International LLC GRI Contract Number 5091-251-2171 EPA Contract Number 68-D1-0031
Principal Investigator	Duane B. Myers
Report Period	March 1991 - June 1996 Final Report
Objective	This report describes a study to quantify the annual methane emissions from glycol dehydrators and acid gas recovery units (AGRs), which are significant sources of methane emissions within the gas industry.
Technical Perspective	The increased use of natural gas has been suggested as a strategy for reducing the potential for global warming. During combustion, natural gas generates less carbon dioxide (CO_2) per unit of energy produced than either coal or oil. On the basis of the amount of CO_2 emitted, the potential for global warming could be reduced by substituting natural gas for coal or oil. However, since natural gas is primarily methane, a potent greenhouse gas, losses of natural gas during production, processing, transmission, and distribution could reduce the inherent advantage of its lower CO_2 emissions. To investigate this, Gas Research Institute (GRI) and the U.S. Environmental Protection Agency's Office of Research and Development (EPA/ORD) cofunded a major study to quantify methane emissions from U.S. natural gas operations for the 1992 base year. The results of this study can be used to construct global methane budgets and to determine the relative impact on global warming of natural gas versus coal and oil.
Results	The annual emissions rates for glycol dehydrators for each industry segment are as follows: production, 3.42 ± 192% Bscf; gas processing, 1.05 ± 208% Bscf; transmission, 0.10 ± 392% Bscf, and storage, 0.23 ± 167% Bscf. AGR methane emissions are 0.82 ± 109% Bscf.

Based on data from the entire program, methane emissions from natural gas operations are estimated to be 314 ± 105 Bscf for the 1992 base year. This is about 1.4 ± 0.5% of gross natural gas production. The overall project also showed that the percentage of methane emitted for an incremental increase in natural gas sales would be significantly lower than the baseline case.

The program reached its accuracy goal and provides an accurate estimate of methane emissions that can be used to construct U.S. methane inventories and analyze fuel switching strategies.

Technical Approach

Glycol dehydrators are used to remove water from natural gas streams. A lean (low water content) glycol stream is contacted with the wet natural gas and the glycol absorbs most of the water. The glycol also absorbs small amounts of methane and other natural gas constituents which may then be emitted to the atmosphere when the glycol is regenerated. AGRs work in much the same way as glycol dehydrators. A lean (low acid gas content) amine is contacted with natural gas containing carbon dioxide and/or hydrogen sulfide. The amine preferentially absorbs the carbon dioxide and hydrogen sulfide but also absorbs some methane, which may then be emitted to the atmosphere.

The techniques used to determine methane emissions were developed to be representative of annual emissions from the natural gas industry. However, it is impractical to measure every source continuously for a year. Therefore, emission rates for glycol dehydrators and AGRs were determined by developing annual emission factors for typical units in each industry segment and extrapolating these data based on activity factors to develop a national estimate, where the national emission rate is the product of the emission factor and activity factor.

Emission factors were developed by using process simulation software to model the glycol dehydrator and AGR process operations. Information from site visits and other research programs was used to develop the characteristics of representative units used in the process modeling. An emission factor was developed for glycol dehydrators that reported the amount of methane emitted per unit of natural gas throughput and for AGRs that reported the amount of methane emitted annually for a typical unit.

The development of activity factors for each industry segment are presented in a separate report. In general, the gas throughput for each industry segment was determined from surveys conducted across the entire industry.

Project Implications

For the 1992 base year the annual methane emissions estimate for the U.S. natural gas industry is 314 Bscf ± 105 Bscf (± 33%). This is equivalent to 1.4% ± 0.5% of gross natural gas production. Results from this program were used to compare greenhouse gas emissions from the fuel cycle for natural gas, oil, and coal using the global warming potentials (GWPs) recently published by the Intergovernmental Panel on Climate Change (IPCC). The analysis showed that natural gas contributes less to potential global warming than coal or oil, which supports the fuel switching strategy suggested by IPCC and others.

In addition, results from this study are being used by the natural gas industry to reduce operating costs while reducing emissions. Some companies are also participating in the Natural Gas-Star program, a voluntary program sponsored by EPA's Office of Air and Radiation in cooperation with the American Gas Association to implement cost-effective emission reductions and to report reductions to the EPA. Since this program was begun after the 1992 baseline year, any reductions in methane emissions from this program are not reflected in this study's total emissions.

Robert A. Lott
Senior Project Manager, Environment and Safety

6.0 ANNUAL METHANE EMISSIONS

Annual methane emissions from glycol dehydrators in each industry segment and from AGRs were calculated by multiplying the activity factor by the emission factor. The results are as follows:

- Production:

  275.6 scf CH_4/MMscf × 12.4x10 ^{6} MMscf = 3.4 Bscf ± 192%

- Gas Processing:

  121.6 scf CH_4/MMscf × 8.63x10 ^{6} MMscf = 1.1 Bscf ± 208%

- Transmission:

  93.72 scf CH_4/MMscf × 1.09x10 ^{6} MMscf = 0.1 Bscf ± 392%

- Storage:

  117.2 scf CH_4/MMscf × 2.00x10 ^{6} MMscf = 0.2 Bscf ± 167%

- AGRs (Production and Gas Processing):

  6083 scfd/unit × 371 units × 365 days = 0.8 Bscf ± 109%

The estimate for annual methane emissions from glycol dehydrators is 4.8 Bscf. The estimate of annual methane emissions from AGRs is 0.8 Bscf.

7.0 REFERENCES

1. Wright Killen & Co. *Natural Gas Dehydration: Status and Trends.* GRI-94/0099, Gas Research Institute, Chicago, IL, January 1994.

2. Myers, D.B. and M.R. Harrison. *Methane Emissions from the Natural Gas Industry, Volume 15: Gas-Assisted Glycol Pumps.* Final Report, GRI-94/0257.33 and EPA-600/R-96-080o. Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

3. Stapper, B.E. *Methane Emissions from the Natural Gas Industry, Volume 5: Activity Factors.* Final Report, GRI-94/0257.22 and EPA-600/R-96-080e. Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

4. Bell, L. "Worldwide Gas Processing." *Oil and Gas Journal.* June 13, 1994, pp. 63-91.

5. American Gas Association. *Gas Facts 1994: A Statistical Record of the Gas Industry.* Arlington, VA, 1994.

6. Texas Mid-Continent Oil and Gas Association (TMOGA) and Gas Processors Association (GPA), Dehydrator Survey, 1991.

7. Tannehill, C.C. and C. Galvin. *Business Characteristics of the Natural Gas Conditioning Industry.* Topical Report, GRI-93/0342, prepared by Purvin & Gertz, Inc., Gas Research Institute, May 1993.

8. Radian Corporation. *Investigation of U.S. Natural Gas Reserve Demographics and Gas Treatment Processes,* Topical Report, Gas Research Institute, January 1991.

9. Radian Corporation. ASPEN/SP® Modeling. Internal project files, 1993.

10. Radian Corporation. *Glycol Dehydrator Emissions: Sampling and Analytical Methods and Estimation Techniques.* GRI-94/0324, Gas Research Institute, Chicago, IL, March 1995.

P-6
PRODUCTION SOURCE SHEET

SOURCES:	Glycol Dehydrators
COMPONENTS:	N/A
OPERATING MODE:	Normal Operation
EMISSION TYPE:	Vented
ANNUAL EMISSIONS:	3.42 Bscf ± 192%

BACKGROUND:

Glycol dehydrators remove water from a gas stream by contacting the gas with glycol and then driving the water from the glycol by heating in the glycol reboiler and into the atmosphere. The glycol also absorbs a small amount of methane, and some methane can be driven off to the atmosphere through the reboiler vent.

EMISSION FACTOR: (275.57 scf/MMscf gas processed ± 154.48%)

A thermodynamic computer simulation was used to determine the most important emission-affecting variables for dehydrators. The variables are: gas throughput, existence of a flash tank, existence of stripping gas, existence of a gas driven pump, and existence of vent controls routed to a burner. Throughput, since its effect is linear, is handled by establishing an emission rate per unit of gas throughput. Emission rates per unit of throughput are then established for the other important emission affecting characteristics. Gas driven pumps are ignored here and handled in a separate source analysis (see *Methane Emissions from the Natural Gas Industry, Volume 15: Gas-Assisted Glycol Pumps)* (1). The emission factor is then:

$$EF = [(F_{FT} \times EF_{FT}) + (F_{NT} \times EF_{NT}) + (F_{SG} \times EF_{SG})] \times F_{NVC} \times OC$$

$$= [(0.265 \times 3.57) + (0.735 \times 175.10) + (0.00473 \times 670)] \times 0.9882 \times 2.1$$

F_{FT} = Fraction of the population WITH flash tanks
0.265 ± 8.35%

F_{NT} = Fraction of the population WITHOUT flash tanks
0.735 ± 2.99%

F_{SG} = Fraction of the population WITH stripping gas
0.00473 ± 115.78%

F_{NVC} = Fraction of the population WITHOUT combustion vent controls
0.9882 ± 0.87%

EF_{FT} = Total methane emission rate scf per 1 MMscf throughput with a flash tank
= 3.57 +102%/-58%

EF_{NT} = Total methane emission rate scf per 1 MMscf throughput WITHOUT a flash tank
= 175.10 +101%/-50%

EF_{SG} = Incremental methane emission rate per 1 MMscf throughput per dehydrator that has stripping gas
= 670 +40%/-60%

OC = Overcirculation factor for glycol--number of times the industry rule-of-thumb of 3 gallons glycol/lb water
= 2.1 ± 41%

EF DATA SOURCES:

1. *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators* (2) establishes emission affecting characteristics of dehydrators.
2. GRI/EPA site visit data establishes the F_{SG} and F_{NVC} for multiple sites (19 PROD sites).
3. An analysis of a combined database including TMOGA's 1019 dehydrators and GRI/EPA site visits 444 dehydrators established F_{FD} and F_{ND} for production dehydrators.
4. ASPEN computer simulations were used in combination with measured data to determine EF_{FD}, and EF_{ND} from the dehydrator vent.
5. Sampling data from the GRI Glycol Sampling and Analytical Program for one dehydrator was used to determine EF_{SG} (*Glycol Dehydrator Emissions: Sampling and Analytical Methods and Estimation Techniques*) (3). The upper bound was calculated by assuming that all of the measured noncondensable vent gas was due to stripping gas that was 100% methane. The lower bound was calculated as the rule-of-thumb stripping gas rate recommended by a glycol dehydrator manufacturer.
6. Overcirculation factor determined using data from the GRI Glycol Sampling and Analytical Program data for ten dehydrators.

EF PRECISION: 275.57 scf/MMscf gas processed ± 154.48%

Basis:

The accuracy is propagated through the EF calculation from each term's accuracy:

1. ASPEN has been demonstrated to match actual dehydrators within ±20% within the calculated confidence intervals obtained from site data.

2. Individual EF confidence intervals were calculated from the data used in the calculation.

3. Data from site visits has been assigned confidence intervals based upon the spread of the 444 dehydrators from GRI/EPA site data.

ACTIVITY FACTOR: (12.4 Tscf/year gas throughput in the production segment)

The amount of gas processed by glycol dehydrators in the production segment was calculated from the estimated number of glycol dehydrators in production and the average throughput capacity for production dehydrators (Wright Killen & Co., 1994). A capacity utilization factor was estimated based on observations at several sites in the GRI Glycol Dehydrator Sampling and Analytical Program.

AF DATA SOURCES:

The report: *Natural Gas Dehydration: Status and Trends* (4) by Wright Killen for the Gas Research Institute, provides data and describes the methodology used to develop an estimate of the gas dehydrator count for the U.S. The count also estimated the number in several industry segments: production, transmission, and gas processing.