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METHANE EMISSIONS FROM THE
NATURAL GAS INDUSTRY
Volume 15: Gas-Assisted Glycol Pumps

Prepared for

Energy Information Administration (U.S. DOE)

Prepared by

National Risk Management
Research Laboratory
Research Triangle Park, NC 27711

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METHANE EMISSIONS FROM THE NATURAL GAS INDUSTRY, VOLUME 15: GAS-ASSISTED GLYCOL PUMPS

FINAL REPORT

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RESEARCH SUMMARY

Title	Methane Emissions from the Natural Gas Industry, Volume 15: Gas-Assisted Glycol Pumps Final Report
Contractor	Radian International LLC GRI Contract Number 5091-251-2171 EPA Contract Number 68-D1-0031
Principal Investigators	Duane B. Myers Matthew R. Harrison
Report Period	March 1991 - June 1996 Final Report
Objective	This report describes a study to quantify the annual methane emissions from gas-assisted glycol pumps, 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 gas-assisted glycol pumps are production, 11.0 ± 110% Bscf and gas processing, 0.17 ± 228% 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. At locations without electricity, pumps that circulate the glycol may recover energy from the high-pressure gas/glycol mixture to provide motive force for the lean glycol. Additional gas is entrained with the glycol to supply the necessary energy. The entrained gas is then either removed from the glycol in a flash tank or in the reboiler when the glycol is regenerated. Gas removed in the flash tank is typically burned as fuel, but gas removed in the regenerator is often 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 gas-assisted glycol pumps 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 estimates of pump gas usage from manufacturer's data. Information from site visits and other research programs was used to develop the characteristics of representative glycol dehydrators. An emission factor was developed for gas-assisted glycol pumps that reported the amount of methane emitted per unit of natural gas throughput.

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. No active gas-assisted pumps were found during the site visits to transmission and storage stations, so the activity factors for these industry segments are zero.

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
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1.0 SUMMARY

This report is one of several volumes that provide background information supporting the Gas Research Institute and U.S. Environmental Protection Agency Office of Research and Development (GRI-EPA/ORD) methane emissions project. The objective of this comprehensive program is to quantify the methane emissions from the gas industry for the 1992 base year to within ± 0.5% of natural gas production starting at the wellhead and ending immediately downstream of the customer's meter.

This report documents the basis for calculating the emissions from gas-assisted glycol pumps used in the natural gas industry. Gas-assisted glycol pumps are one of the most common types of glycol recirculation pumps. Gas pressure drives the pump. High-pressure glycol and gas are let down across the driver side of the pump, and the energy recovered is used to recirculate the glycol. Most of these pumps emit the spent gas to the atmosphere through the glycol reboiler. Emissions attributable to these pumps are a small but measurable source of methane.

The annual emissions for gas-assisted glycol pumps are production, 10.96 ± 110% Bscf and gas processing, 0.17 ± 228% Bscf.

2.0 INTRODUCTION

This report describes gas-assisted pumps, identifies their characteristics that affect methane emissions, and provides annual U.S. emissions for the 1992 base year. Background information on gas-assisted pumps is given in Section 3, and sources of data are listed in Section 4. Activity factors, which are the volume of gas processed in each industry segment by dehydrators with gas-assisted pumps, are explained in Section 5. Emission factors, which are the methane emissions per volume of gas processed, are explained in Section 6. Annual methane emissions for pumps in each industry segment are given in Section 7.

For background information on general dehydrator characteristics and for details on other methane emissions attributed to dehydrators, refer to Volume 14 on glycol dehydrators.[1]

3.0 GAS-ASSISTED PUMP APPLICATIONS

All industrial pumps have two major components: a driver side and a motive side. The driver provides the energy for pumping, and the motive side delivers the energy to the fluid being moved. In a typical centrifugal pump, the driver is an electric motor and the motive side is an impeller within a pump casing. This report discusses positive-displacement, gas-assisted glycol pumps (also called gas-driven pumps) that discharge natural gas. Other positive-displacement pumps that discharge gas are discussed in a separate report, Volume 13 on chemical injection pumps.[2]

In many glycol dehydrators in the gas industry, small gas-assisted pumps are used to circulate the glycol. These pumps recover energy from the high-pressure rich glycol/gas mixture leaving the absorber and use that energy to pump the low-pressure lean glycol back into the absorber. Figure 3-1 shows an isometric flow diagram of a typical field glycol dehydrator unit with a gas-assisted glycol pump.

Normal electrical pump configurations would have level controllers in the absorber tower to prevent gas from leaving the absorber bottom with the rich glycol. The gas-assisted pumps used in glycol circulation have a specialized design and construction. The gas-assisted glycol pump configuration, by design, has no level control; natural gas is intentionally entrained with the rich glycol feeding the pump. The natural gas mixed with the rich glycol is a source of pressure energy. The gas is not burned, as in an engine driver, but is discharged from the pump at a lower pressure. The spent gas is not emitted directly from the pump, but is exhausted into the pumped glycol stream that flows to the regenerator.

If the glycol unit has a flash tank, most of the pump exhaust gas can be recovered and used as fuel or stripping gas. If the flash gas is used as stripping gas, or if there is no flash tank, all of the pump exhaust gas will be vented through the regenerator's atmospheric vent stack. Figure 3-2 shows a block flow diagram of the pump configuration. The internal operation of the pumps is complex. For a detailed description, refer to the manufacturer's catalogue.[3]

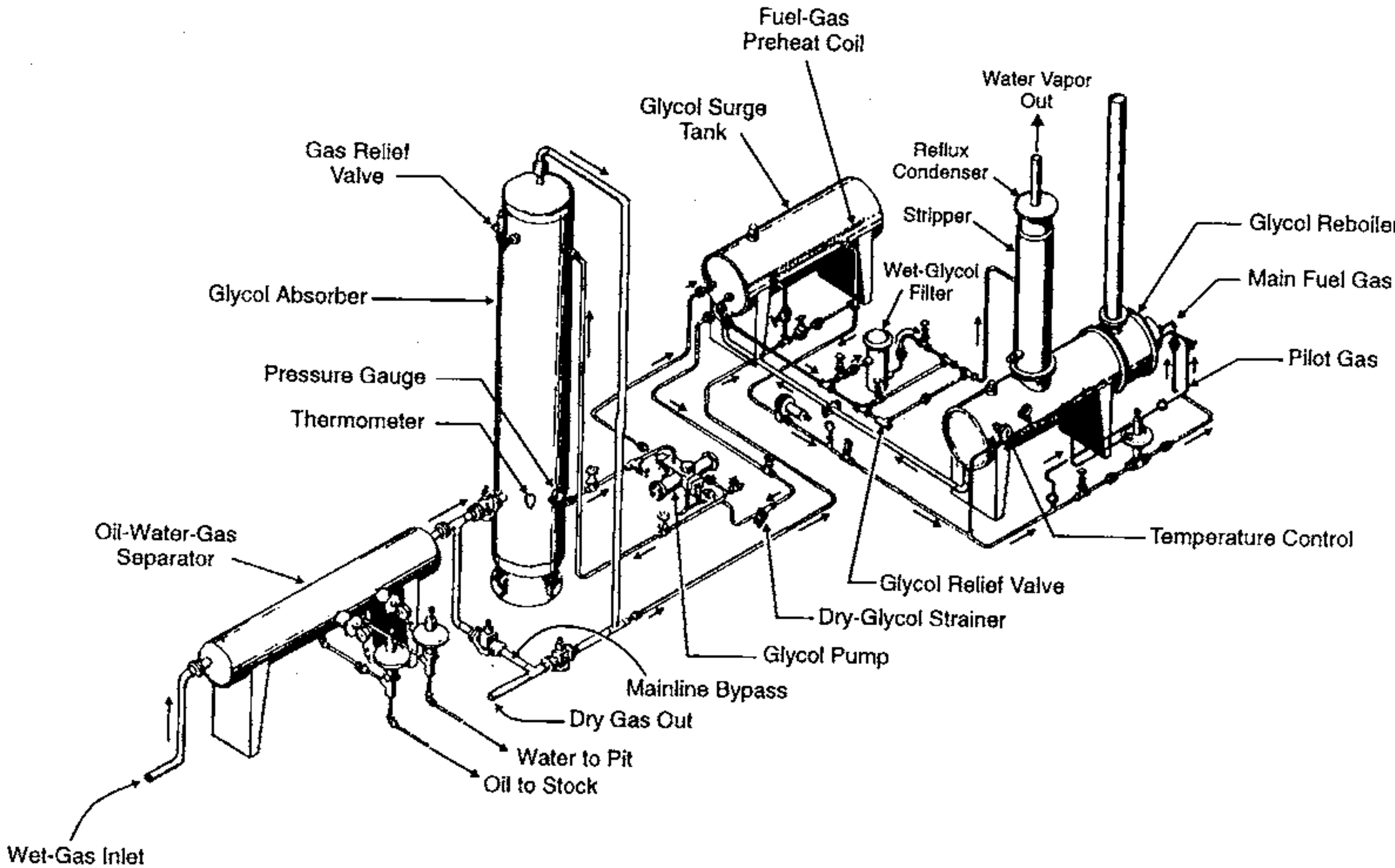

Figure 3-1. Isometric Flow Diagram of a Glycol Dehydrator Unit

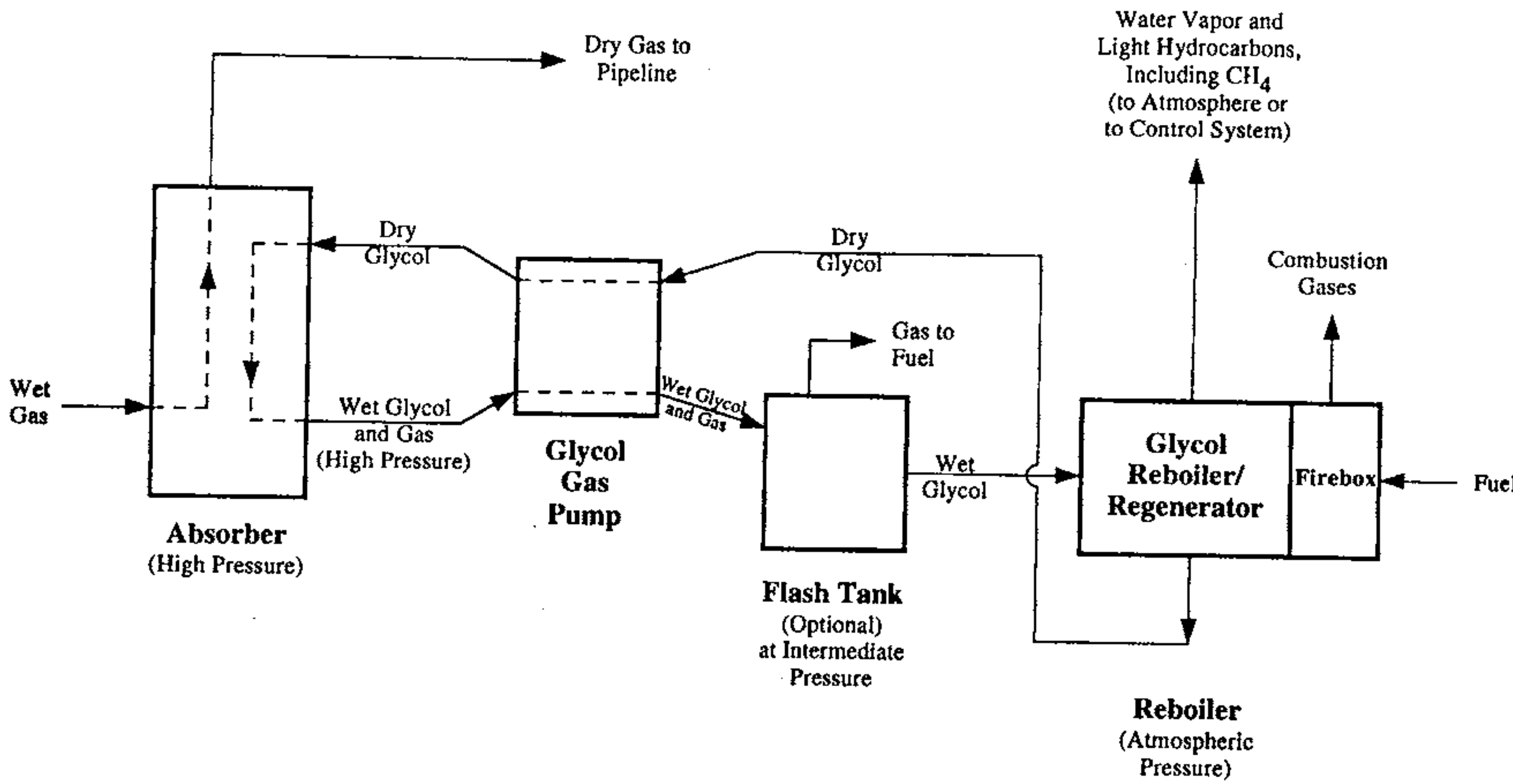

Figure 3-2. Block Process Flow Diagram of Glycol Pumping System

4.0 DATA SOURCES

The manufacturer's data for a pump operating at typical design conditions were used to calculate emissions. No direct measurements of pump gas usage were used in the calculations.

Kimray, the leading manufacturer of gas-assisted glycol pumps, provided technical data. The most fundamental characteristic of these pumps is the gas usage per unit of glycol pumped, usually expressed as actual cubic feet[a] (acf) per gallon of glycol. Therefore, the usage rate and inherent emissions per pump depend on the size of the unit. Kimray reports that gas usage ranges from 0.081 acf/gallon for high-pressure pumps (>400 psig) to 0.130 acf/gallon for low-pressure pumps (<400 psig).[3] These data underwent QA analysis by other pump vendors and industry reviewers and were revised by Kimray as a result of that analysis. As a result, the manufacturer's data are believed to be accurate and representative.

To estimate the glycol circulation rate for a typical dehydrator, and consequently, the amount of gas used to drive the pump, it was necessary to choose values for wet gas water content and glycol circulated per pound of water. It was assumed that a typical high-pressure dehydrator would remove 53 pounds of water per MMscf of gas and a typical low-pressure dehydrator would remove 127 pounds of water per MMscf of gas. The design glycol-to-gas ratio is calculated using 3 gallons of glycol per pound of water removed.

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[a]Actual cubic feet of gas are used in the calculations because the pump cylinders fill with the same ratio of gas and glycol regardless of the pressure.[3]

5.0 ACTIVITY FACTOR

The activity factor development described here for glycol circulation pumps is also reported in detail in Volume 5 on activity factors.[5] The activity factor for gas-driven glycol circulation pumps is calculated on the same basis as the dehydrator vented emissions in Volume 14 (i.e., Tscf/year gas throughput for each industry segments).[1] The total gas throughputs listed in Table 5-1 were multiplied by the fraction of dehydrators using gas-driven pumps to determine the gas-driven pump activity factor. This value is based on the average from Radian site surveys of the number of pumps per dehydrator. The resulting gas throughputs for glycol dehydrators using gas-assisted pumps are as follows:

- Production: 11.1 Tscf/year ± 62.0%;
- Processing: 0.96 Tscf/year ± 192%;
- Transmission: 0 Tscf/year; and
- Storage: 0 Tscf/year.

These figures are based on total dehydrator gas throughput for each industry segment and the estimates of gas-assisted pump usage based on site visit data. No active gas-assisted pumps were found at transmission or storage facilities during the site visits, so no throughput is reported for those two segments. Although there may be a small number of gas-assisted pumps in transmission or storage service, the resulting methane emissions will be insignificant in comparison to the production and processing emissions.

Table 5-1 lists the characteristics of glycol dehydrators used to develop the activity factors for gas-assisted pumps. Table 5-2 lists some other characteristics of glycol dehydrators that affect emissions from gas-assisted pumps but are not used in the activity factor calculations. These characteristics are accounted for in the emission factor calculations described in Section 5. These characteristics were developed from the site visit data discussed in the Activity Factor Report.[1]

TABLE 5-1. U.S. GAS INDUSTRY CHARACTERISTICS FOR CALCULATION OF ACTIVITY FACTORS FOR GAS-ASSISTED GLYCOL PUMPS

Segment	Industry Segment Gas Throughput	Fraction of Dehydrators with Active Gas Pumps	Throughput for Dehydrators with Gas-Assisted Pumps
Production	12.4 Tscf/yr ± 61.9%	0.891 ± 2.79%	11.1 Tscf/yr ± 62.0%
Gas Processing Plants	8.63 Tscf/yr ± 22.4%	0.111 ± 186%	0.958 Tscf/yr ± 192%
Transmission	1.09 Tscf/yr ± 144%	0	
Storage	2.00 Tscf/yr ± 25%	0	
Total Gas Industry	24.1 Tscf/yr ± 33.5%		12.1 Tscf/yr ± 58.6%

TABLE 5-2. U.S. GAS INDUSTRY CHARACTERISTICS FOR CALCULATION OF EMISSION FACTORS FOR GAS-ASSISTED GLYCOL PUMPS

Segment	Fraction of Dehydrators with Flash Drums	Fraction of Dehydrators with Vapor Recovery that Consumes Methane
Production	0.265 ± 8.35%	0.0118 ± 73.1%
Gas Processing Plants	0.667 ± 10.1%	0.100 ± 90.0%
Transmission	0.669 ± 9.70%	0.148 ± 80.3%
Storage	0.520 ± 33.6%	0.160 ± 80.0%

6.0 EMISSION FACTOR

In general, the emission factor for a Kimray pump was determined to be a function of the pump gas usage and the vent controls on the dehydrator. The use of a flash tank virtually eliminates methane emissions associated with pump gas because the flash gas is typically burned as fuel.

6.1 Emission-Affecting Characteristics

The characteristics that affect methane emissions from the gas-assisted pumps in glycol circulation service are:

- Frequency of operation (pumping rate);
- Size of the unit (volume displacement of the motive chamber);
- Supply gas pressure;
- Inlet methane composition; and
- Use of a flash tank;
  - Percentage of units that have a tank
  - Disposition of the flash gas.

It has been assumed that the operation of the glycol reboiler has no effect on methane emissions to the atmospheric vent arising from the gas-driven pump. If the methane reaches the regenerator/reboiler, all of the methane from the pump exhaust is assumed to vent to the atmosphere.

6.2 Emission Factor Calculations

The following equation was used to determine the emission factor for the average pump in each industry segment:

$$EF_{pump} = PGU \times CR \times WR \times OC \times F_{ND} \times F_{NVC} \quad (1)$$

where:

PGU = pump gas usage (scf CH_4)/(gallon glycol)

CR = circulation ratio (gallons glycol)/(pound water removed from gas)

WR = water removed from gas (pounds H_2O/MMscf gas)

OC = overcirculation ratio

F_{ND} = fraction of dehydrators without flash tanks

F_{NVC} = fraction of the dehydrators without combustion vent controls

CR, WR, F_{ND}, and F_{NVC} were discussed in Sections 4 and 5. The overcirculation factor (OC) was determined from data collected from ten glycol dehydrators.[6] The PGU rate depends on the glycol circulation rate, the absorber operating pressure and temperature, and the pump model. PGU was determined from values reported by the manufacturer. High pressure pumps use on average 0.081 acf gas per gallon of glycol, which corresponds to 4.49 scf/gallon for gas at 800 psig. Low pressure pumps use on average 0.130 acf gas per gallon of glycol, which is equivalent to 2.78 scf/gallon for 300 psig gas. Multiplying by 83 mole% methane in the pump gas results in a methane usage of 3.73 scf/gallon for high pressure and 2.31 scf/gallon for low pressure. The estimated split for high and low pressure in production is 80% high pressure and 20% low pressure.[7] All processing pumps were assumed to be high pressure.

The final emission factor (EF_{pump}) for methane from an average gas-assisted glycol pump was determined for the production and processing industry segments using Equation 1. The transmission and storage segments do not use gas-assisted pumps. The results are as follows:

Production - High Pressure:

PGU = 3.73 scf/gallon ± 30%

CR = 3.0 gallons glycol/lb H_20 ± 33.3%

WR = 53 lb H_2O/MMscf gas ± 20%

OC = 2.1 ± 71.4%

F_{ND} = 0.735 ± 2.99%

F_{NVC} = 0.988 ± 0.87%

EF_{pump} = (3.73) × (3.0) × (53) × (2.1) × (0.735) × (0.988)

= 904.5 scf/MMscf ± 95.0%

Production - Low Pressure:

PGU = 2.31 scf/gallon ± 30%

CR = 3.0 gallons glycol/lb H_20 ± 33.3%

WR = 127 lb H_2O/MMscf gas ± 20%

OC = 2.1 ± 71.4%

F_{ND} = 0.735 ± 2.99%

F_{NVC} = 0.988 ± 0.87%

EF_{pump} = (2.31) × (3.0) × (127) × (2.1) × (0.735) × (0.988)

= 1342.2 scf/MMscf ± 95.0%

Production - Combined:

Fraction High pressure = 0.80 ± 12.5%

Fraction Low Pressure = 0.20 ± 50%

EF (High Pressure) = 904.45 scf/MMscf ± 95.0%

EF (Low pressure) = 1342.18 scf/MMscf ± 95.0%

EF_{pump} = (0.80) (904.45) + (0.20) (1342.18)

= 992.00 scf/MMscf ± 77.29%

Processing:

PGU = 3.73 scf/gallon ± 30%

CR = 3.0 gallons glycol/lb H_20 ± 33.3%

WR = 53 lb H_2O/MMscf gas ± 20%

OC = 1.0 ± 0%

F_{ND} = 0.333 ± 20.1%

F_{NVC} = 0.900 ± 10%

EF_{pump} = (3.73) × (3.0) × (53) × (1.0) × (0.333) × (0.900)

= 177.8 scf/MMscf ± 56.85%

7.0 ANNUAL METHANE EMISSIONS

Annual methane emissions from gas-assisted glycol pumps were calculated to be 11.1 Bscf. This was calculated by multiplying the activity factor (number of pumps) by the emission factor (scf/MMscf) for each industry segment and then summing the values. The results are as follows:

- Production:
  (992.0 scf/MMscf) × 11.05 Tscf= 10.96 Bscf
- Gas Processing:
  (177.745 scf/MMscf) × 0.9579 Tscf = 0.170 Bscf
- Transmission: no emissions
- Storage: no emissions

8.0 REFERENCES

1. Myers, D.B. *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators.* Final Report, GRI-94/0257.31 and EPA-600/R-96-080n. Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

2. Shires, T.M. *Methane Emissions from the Natural Gas Industry, Volume 13: Chemical Injection Pumps.* Final Report, GRI-94/0257.30 and EPA-600/R-96-080m. Gas Research Institute and U.S. Environmental Protection Agency, June 1996.

3. Kimray, Inc. *Glycol Pumps and Accessories*, Tulsa, OK, undated.

4. Sivalls, Inc. *Glycol Dehydration Design Manual.* Odessa, TX, 1982.

5. 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.

6. Rueter, C.O., et al. *Glycol Dehydrator Emissions: Sampling and Analytical Methods and Estimation Techniques.* GRI-94/0324. Gas Research Institute, Chicago, IL. . March 1995.

7. Memorandum from Richard Garrett (Roger-Tech, Inc., Houston, TX) to Rhone Resch (U.S. EPA OAR), March 4, 1996.

8. Texas Mid-Continent Oil and Gas Association Glycol Dehydrator Survey. Personal communication with L. Litzen (Shell Oil Western Exploration and Production) and C.O. Rueter (Radian Corporation). June 17, 1991.

APPENDIX A

Source Sheets

P-7
PRODUCTION SOURCE SHEET

SOURCES:	Dehydrators
COMPONENTS:	Gas Driven Kimray Pumps
OPERATING MODE:	Normal Operation
EMISSION TYPE:	Unsteady, Vented
ANNUAL EMISSIONS:	10.96 Bscf ± 110.0%

BACKGROUND:

Gas driven Kimray glycol circulation pumps use a mixed phase of wet glycol liquid and absorber gas to drive pistons that pump dry (lean) glycol circulation. Unlike chemical injection pumps which vent the driving gas directly to the atmosphere, Kimray pumps pass the driving gas along with the wet glycol to the reboiler. In the reboiler the methane is driven off into the vent line. Depending on dehydrator vent gas dispositions, the methane may be vented to the atmosphere or controlled and burned.

EMISSION FACTOR: (992.0 scf CH_4/MMscf gas processed)

The average glycol pump gas emission factor was determined by an equation describing the gas generation and disposition of gas from the pump. The disposition of gas generated by the pump depends upon the existence of a flash tank and vent controls. Measured and estimated parameters were input into the equation.

In general, the emission factor for a gas-assisted pump was determined by the following equation:

$$EF_{pump} = PGU \times CR \times WR \times OC \times F_{NT} \times F_{NVC}$$

EF DATA SOURCES:

1. Equation 1, i.e. the effects of operating variables on emissions, was defined by the report on *Methane Emissions from the Natural Gas Industry, Volume 15, Gas-Assisted Glycol Pumps* (1).

2. CR = glycol circulation ratio = 3.0 gal glycol/lb water ± 33.3%.

3. WR = water removed from gas
   = 53 lb/MMscf ± 20% for high pressure
   = 127 lb/MMscf ± 20% for low pressure

4. OC = factor to account for overcirculation of glycol = 2.1 ± 71.4%.

5. F_{NT} = fraction of dehydrators without flash tanks = 0.735 ± 2.99%.

6. F_{NVC} = fraction of the dehydrators without combustion vent controls = 0.9882 ± 0.87%.

7. PGU = pump gas usage (assume 83% methane)
   = 3.73 scf CH_4/gal glycol ± 30% for high pressure

= 2.31 scf CH_4/gal glycol ± 30% for low pressure

CALCULATION METHOD:

It is estimated that 80% of the production dehydrators would be high pressure (R. Garrett memo) (4). The overall production emission factor is then calculated as a weighted average of the high and low pressure emission factors.

EF (high pressure) = (3.73 scf/gal) × (3.0 gal/lb H_2O) × (53 lb H_2O/MMscf)
× (2.1) × (0.735) × (0.9882)
= 904.45 scf/MMscf ± 95.04%

EF (low pressure) = (2.31 scf/gal) × (3.0 gal/lb H_2O) × (127 lb H_2O/MMscf)
× (2.1) × (0.735) × (0.9882)
= 1342.18 scf/MMscf ± 95.04%

EF (Production) = (0.80 ± 12.5%) (904.45 scf/MMscf ± 95.04%) +
(0.20 ± 50%) (1342.18 scf/MMscf ± 95.04%)
992.00 scf CH_4/MMscf ± 77.29%

EF ACCURACY: (± 77.29%)

Basis:

1. Assumption: The manufacturer's data and ranges are relatively accurate (±30%).
2. Dehydrator characteristics based on site visit observations and TMOGA survey.

ACTIVITY FACTOR: (11.05 Tscf/year in the production segment with gas-assisted pumps)

The volume of gas processed through dehydrators using gas-assisted pumps was calculated from the total throughput for production dehydrators and the fraction of dehydrators using gas-assisted pumps determined from site visits. The activity factor is then:

AF = (fraction of dehydrators with gas-assisted pumps) × (throughput for production dehydrators)

= (0.8913 ± 2.79%) × (12.4 Tscf/year ± 48.21%)

= 11.05 Tscf/year ± 61.96%

AF DATA SOURCES:

1. See *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators* (2) for an explanation of production dehydrator throughput. See the *Methane Emissions from the Natural Gas Industry, Volume 5: Activity Factors* (3) for more details.
2. Fraction of dehydrators using gas-assisted pumps came from data from site visits.

AF ACCURACY: (± 61.96%)

Basis:

Calculated from confidence limits of gas throughput and fraction of dehydrators by standard error propagation analysis.

ANNUAL METHANE EMISSIONS: (10.962 Bscf ± 110.03%)

The annual methane emissions were determined by multiplying an emission factor (scf CH_4/MMscf) by the total throughput for production dehydrators using gas-assisted pumps.

(992.00 scf/MMscf) × (11.05 Tscf) = 10.962 Bscf (± 110.03%)

REFERENCES

1. 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.

2. Myers, D.B. *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators.* Final Report, GRI-94/0257.31 and EPA-600/R-96-080n. 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. Memorandum from Richard Garrett (Roger-Tech, Inc., Houston, TX) to Rhone Resch (U.S. EPA OAR), March 4, 1996.

GP-5
PROCESSING SOURCE SHEET

SOURCES:	Glycol Dehydrators
COMPONENTS:	Gas Assisted Kimray Pumps
OPERATING MODE:	Normal Operation
EMISSION TYPE:	Unsteady, Vented
ANNUAL EMISSIONS:	0.170 scf ± 228%

BACKGROUND:

Most glycol circulation pumps in gas plants are electric. However, some gas driven pumps do exist. Gas-assisted Kimray glycol circulation pumps use a mixed phase of wet glycol liquid and absorber gas to drive pistons that pump dry (lean) glycol circulation. Unlike chemical injection pumps which vent the driving gas directly to the atmosphere, Kimray pumps pass the driving gas along with the wet glycol to the reboiler. In the reboiler the methane is driven off into the vent line. Depending on dehydrator vent gas dispositions, the methane may be vented to the atmosphere or controlled and burned.

EMISSION FACTOR: (177.75 scf CH_4/MMscf gas processed)

The average glycol pump gas emission factor was determined by an equation describing the gas generation and disposition of gas from the pump. The disposition of gas generated by the pump depends upon the existence of a flash tank and vent controls. Measured and estimated parameters were input into the equation.

In general, the emission factor for a gas-assisted pump was determined by the following equation:

$$EF_{pump} = PGU \times CR \times WR \times OC \times F_{NT} \times F_{NVC}$$

$$= (3.73 \text{ scf/gal}) \times (3.0 \text{ gal/lb } H_2O) \times (53 \text{ lb } H_2O\text{/MMscf}) \times (1.0) \times (0.333) \times (0.900)$$

$$= 177.75 \text{ scf } CH_4\text{/MMscf gas} \pm 56.85\%$$

EF DATA SOURCES:

1. Equation 1, i.e. the effects of operating variables on emissions, was defined in *Methane Emissions from the Natural Gas Industry, Volume 15: Gas-Assisted Glycol Pumps* (1).

2. CR = glycol circulation ratio = 3.0 gal glycol/lb water ± 33.3%.

3. WR = water removed from wet gas = 53 lb water/MMscf gas ± 20%. For inlet gas stream of 95°F and 800 psig dried to 7 lb water/MMscf gas.

4. OC = factor to account for overcirculation of glycol = 1.0 ± 0%.

5. F_{NT} = fraction of dehydrators without flash tanks = 0.333 ± 20.12%.

6. F_{NVC} = fraction of the dehydrators without combustion vent controls = 0.900 ± 10%.

7. PGU = pump gas usage = 3.73 scf CH_4/gal glycol ± 30%. Determined by multiplying the volume of gas used by high-pressure pump models by a typical fraction of methane in the natural gas (83 mole%).

PGU = 4.49 scf/gallon × 83%
= 3.73 scf/gallon ± 30%

EF ACCURACY: (± 56.85%)

Basis:

1. Assumption: The manufacturer's data and ranges are relatively accurate (±30%).
2. Dehydrator characteristics based on site visit observations and TMOGA survey.

ACTIVITY FACTOR: (0.9579 Tscf/year in the processing segment with gas-assisted pumps)

The volume of gas processed through dehydrators using gas-assisted pumps was calculated from the total throughput for gas processing dehydrators and the fraction of dehydrators using gas-assisted pumps determined from site visits. The activity factor is then:

AF = (fraction of dehydrators with gas-assisted pumps) × (throughput for gas processing dehydrators)

= (0.111 ± 186%) × (8.63 Tscf/year ± 22.4%)

= 0.9579 Tscf/year ± 191.95%

AF DATA SOURCES:

1. See *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators* (2) for an explanation of processing dehydrator throughput (8.63 Tscf/year). See the *Methane Emissions from the Natural Gas Industry, Volume 5: Activity Factors* (3) for more details.
2. Fraction of dehydrators using gas-assisted pumps came from data from site visits.

AF ACCURACY: **(± 192%)**

Basis:

Calculated from confidence limits of gas throughput and fraction of dehydrators by standard error propagation analysis.

ANNUAL METHANE EMISSIONS: (0.1703 Bscf ± 228%)

The annual methane emissions were determined by multiplying an emission factor (scf CH_4/MMscf) by the total throughput for processing dehydrators using gas-assisted pumps.

(177.75 scf/MMscf) × (0.9579 Tscf) = 0.1703 Bscf (± 228.00%)

REFERENCES

1. 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.

2. Myers, D.B. *Methane Emissions from the Natural Gas Industry, Volume 14: Glycol Dehydrators*. Final Report, GRI-94/0257.31 and EPA-600/R-96-080n. 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.

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16. ABSTRACT The 15-volume report summarizes the results of a comprehensive program to quantify methane (CH4) emissions from the U.S. natural gas industry for the base year. The objective was to determine CH4 emissions from the wellhead and ending downstream at the customer's meter. The accuracy goal was to determine these emissions within +/-0.5% of natural gas production for a 90% confidence interval. For the 1992 base year, total CH4 emissions for the U.S. natural gas industry was 314 +/- 105 Bscf (6.04 +/- 2.01 Tg). This is equivalent to 1.4 +/- 0.5% of gross natural gas production, and reflects neither emissions reductions (per the voluntary Ameri-Gas Association/EPA Star Program) nor incremental increases (due to increased gas usage) since 1992. 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 the IPCC and others. In addition, study results are being used by the natural gas industry to reduce operating costs while reducing emissions.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Emission	Stationary Sources	14G
Greenhouse Effect	Global Warming	04A
Natural Gas		21D
Gas Pipelines		15E
Methane		07C

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