OGMP Technical Guidance Document – Glycol Dehydrators

Brief description of the source

Glycol dehydrators in the natural gas industry have the primary purpose of removing water from an incoming wet gas stream using monoethylene glycol (MEG), diethylene glycol (DEG), or, most commonly, triethylene glycol (TEG). 'Lean', or 'dry' glycol (i.e. glycol with little to no dissolved water), is pumped to a gas contactor tower where it mixes with the natural gas stream. The lean glycol absorbs water from the gas stream, drying the gas and producing "rich", or wet, glycol (i.e. glycol with water and some natural gas dissolved within). Some natural gas is mixed with the rich glycol to give the glycol energy exchange pump pneumatic driver mechanical advantage. To regenerate the glycol so it can be reused for additional natural gas drying, it is heated beyond the boiling point of water in a 'reboiler', also known as a 'regenerator'. The water previously dissolved in the rich glycol becomes steam and is vented through the reboiler vent, effectively distilling the glycol, which remains in the reboiler. The steam also contains the dissolved and entrained methane gas and light hydrocarbons which are normally vented to the atmosphere, but can be recovered, or flared. To aid this process, sometimes a stripping gas is intermixed with the rich glycol stream to reduce the partial pressure of water in rich glycol causing more of it to ultimately vaporize. In many cases, natural gas will be used as the stripping gas and thus adds to methane emissions from the glycol reboiler vent. This process is depicted below in Figure 1, with methane emission locations highlighted.

Dehydrators can have a variety of configurations which affects the methane emission levels from their operation.

In some configurations, a 'flash tank', or 'flash separator', is used ahead of the reboiler to remove entrained and most dissolved gas from the rich glycol stream by inducing a pressure drop and thus volatilizing the dissolved gas and little water vapor. This gas can then be recovered for productive use (e.g. compressor suction, low pressure fuel gas, vapor recovery) or flared. If some flash tank gas is vented, this also adds to methane emissions from the glycol reboiler vent. This system with the added flash tank is depicted below in Figure 2.

Two types of circulation pumps are used to circulate glycol in the system: 'gas-assisted glycol pumps', also referred to as 'energy-exchange pumps', and 'electric pumps'[1]. Energy exchange pumps, typically found in more remote locations with no or limited access to electric power, are driven pneumatically using the energy of the natural gas dissolved in the rich glycol stream. Wet inlet gas is used to augment the gas pressure released by the rich glycol mixture. This bypass pneumatic pump gas driver is a primary source of methane emissions. This system configuration utilizing an electric pump is depicted below in Figure 3.

[1] Lessons Learned from Natural Gas STAR Partners, *Replacing Gas-Assisted Glycol Pumps with Electric Pumps*

Figure 1 - Basic glycol dehydrator system process diagram

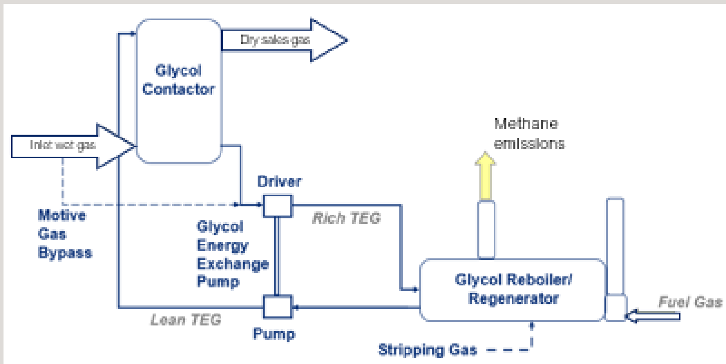
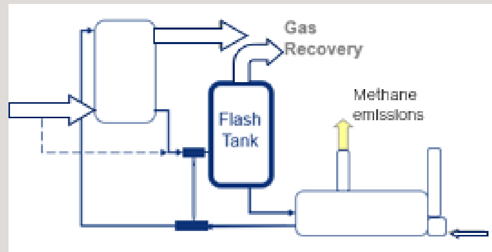
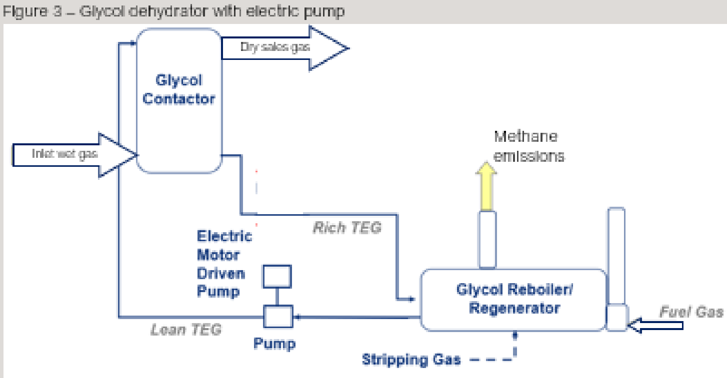


Figure 2 – Glycol dehydrator with flash tank



All figures are adapted from EPA, Natural Gas STAR Program, *Natural Gas Dehydration – Producers Technology Transfer Workshop*, 2007

Figure 3 – Glycol dehydrator with electric pump



Description is adapted from CCAC OGMP, *Technical guidance document number 5: Glycol Dehydrators*, 2017 – Provides a more detailed description of the different configuration

System boundaries

Methane that is vented to atmosphere within gas streams from glycol dehydration systems are considered herein. Methane emissions from glycol dehydration that are captured and reintegrated into the process, i.e. not vented, are not to be reported. Methane emissions captured and routed to flare or thermal oxidation should be reported under Flaring (see *Flaring TGD*), fugitive methane emissions within the glycol dehydration system under Fugitive Emissions (see *Fugitive Emissions TDG*), unburned methane from the reboiler's burner under Incomplete Combustion (*see Incomplete Combustion TGD*) and methane emissions from gas pneumatic controllers (level, pressure, temperature, flow) commonly used on glycol dehydrators under Venting – Pneumatics (see *Pneumatics TDG*), unless the latter discharges into the system and is then released with vented reboiler or flash tank gas.

[Placeholder for materiality definition at Asset Level]

For detailed guidelines on materiality, please refer to the [*General guidance TGD*].

Quantification methodology – Level 3

Emission factors

Accepted source-level emission factors or those prescribed by local regulation are considered as providing Level 3 estimates, provided they are specific for the source type and based on throughput of product through the glycol dehydration system. Practitioners are encouraged to use emission factors that best represent conditions and practices at their facilities and adjust the factors, where warranted, to more accurately estimate emissions given differences between the reference system on which the emission factor is based, and their systems. The resources noted below aid in emission factor adjustments to reflect specific circumstances.

The following table presents an example of emission factors which can be used to estimate methane emissions from a basic glycol dehydrator[2]. These emission factors do not consider emissions from use of stripping gas, losses from flash tanks or glycol exchange pumps. They were established from a range of operational conditions (temperature, pressure, with or without flash tank, …)[3].

Industry Segment[4]	Methane Emission factor		
	scm / MMscm throughput	scf / MMscf throughput	CH_4 content basis for industry segment
Production and Gathering	275.6	275.6	78.8 mole %
Processing	121.6	121.6	86.8 mole %
Transmission	93.72	93.72	93.4 mole %
Storage	117.2	117.2	93.4 mole %

It is possible to adapt emission factors to better reflect the Partner's situation. These emission factors can be converted to units more commonly used by the Partner, or as required by reporting. Changes on both the unit of methane emissions and throughput will have an impact on the value of the emission factor when converted.

Methane content of the gas is another aspect for which emission factors can be adjusted to rely on the methane content of the facility instead of the default one provided for the industry segment, using the following formula[5]:

$$E_{CH4} = Throughput * EF * \frac{CH_4\ content\ (facility)}{CH_4\ content\ (default)}$$

Activity data collection should be conducted based on the data required by the selected emission factor. In the example presented above, data on annual volume of gas running through the dehydrator.

[2] American Petroleum Institute, *Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,* 2009, Table 5-2. Additional guidance on using emission factors for other configurations is provided in Sections 5.1.1 and 5.1.2 of this compendium.

[3] EPA, *Methane emissions from the natural gas industry – Volume 14: Glycol Dehydrators,* 1996, p. 13 – Provides a list of characteristics from the reboiler vent that affect methane emissions, considered to develop the emission factors

[4] Industry Segment descriptions are adapted from American Petroleum Institute, *Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,* 2009 – section 2.2.

[5] Adapted from American Petroleum Institute, *Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,* 2009 – p. 5-6

Quantification methodology – Level 4

Direct measurement and Measurement-based Emission factors

Measurements (including continuous and periodic monitoring) or emission factors developed based on representative measured emissions are considered Level 4 emissions quantification. Measurements must be taken that represent the total flow and associated methane content of each gas stream that is vented to atmosphere from the dehydration unit. Piping and Instrumentation Drawings and surveys of the glycol dehydration system with optical gas imaging cameras may be helpful in ensuring all emission points are identified, and thus measured.

Level 4 emission factors should be based on measurements conducted on a representative sample. System configurations, environmental and operating conditions (e.g. systems with or without flash tank, systems with or without stripping gas) should be considered in determining 'like' systems that carry a common emission factor. Each system that is not 'like' will require determination of a separate emission factor for that system based on the appropriate measurement studies. For guidelines on the methodology to develop a statistically representative sample, please refer to the [*General guidance TGD*].

Emission factors expressed in terms of emission per unit of vented throughput will allow for easy adjustment of activity data (i.e. flow and composition data).

Accepted equipment and techniques for determining gas flow are to be employed. Following are typical equipment that work well on glycol dehydration systems, but the list is not exhaustive[6][7]:

- Vane anemometer.
- Hotwire anemometer.
- Turbine meter.
- ePV electronic packing vent monitor
- Ultrasonic flow meter

Composition can be modelled, as described under *Engineering calculation*. If practical, direct measurements should be used to determine the composition of the vent stream.

Engineering calculation

Engineering calculations that capture all relevant system vents, use measured or simulated activity data (i.e. flows and compositions) and consider all major physical and chemical processes relevant to the venting of methane from the glycol dehydration system are considered Level 4 emissions quantification. Activity data can be continuous or based on representative sampling. For guidelines on the methodology to develop a statistically representative sample, please refer to the [*General guidance TGD*].

[6] More details on various detection and measurement equipment can be found at CCAC, *Conduction Emissions Surveys, Including Emission Detection and Quantification Equipment – Appendix A of the OGMP Technical Guidance Document,* 2017

[7] More details on various detection and measurement equipment can be found at Marcogaz, *Assessment of methane emissions for gas Transmission and Distribution system operators,* 2019 – Section 7 (p. 34-39)

Where applicable to the operation, emissions simulation software like GlyCalc®[8], Aspen HYSYS[9] or equally robust software are considered to provide Level 4 emissions estimates.

Where the glycol dehydration system configuration does not allow high confidence estimates from these simulation software packages, engineered calculations that include the same level of rigor and are customized to the operation are considered Level 4 emissions quantification. These models should estimate the quantity and composition of the hot vent stream using detailed information including wet gas hydrocarbon composition, wet gas flow rate, wet gas temperature and pressure, existence of a gas-driven glycol energy exchange pump, wet and dry gas water contents, glycol flow rate, use of stripping gas flowrate to the regenerator, and the temperature and pressure of the flash tank, if present.

As with direct measurement, engineering calculations may be performed for a representative sample of like systems and then applied to the larger population. For guidelines on the methodology to develop a statistically representative sample, please refer to the *Uncertainty TGD.*

Example of Engineering Calculations based on TEG sampling

Following are examples of engineering calculations[10] which can be used in in calculating methane emissions for simple glycol dehydration systems that are vented to atmosphere. Please note that they may not provide accurate results for all system configurations but are provided to give practitioners an indication of the level of rigor likely required for a Level 4 emissions estimate. These calculations are for systems which utilize TEG, systems without flash tanks and where no glycol energy exchange pump is used.
For this example, the methane content in the TEG solution, measured as mass per unit volume of TEG solution, is determined by sampling and analysis of the TEG downstream from the reboiler.

$$U_{CH4} = V_{TEG} * k_{CH4} * t$$

Where:

U_{CH4} Methane emissions from the TEG reboiler in the reporting period (tonnes)

V_{TEG} Circulation rate of the TEG solution (m^3 / h)

k_{CH4} Concentration of CH_4 in the rich TEG solution (tonnes CH_4 / m^3 TEG)

t Number of operating hours in the reporting period (hours)

If stripping gas is used, an additional calculation which takes this into account needs to be performed and summed to the one above to determine methane emissions for the entire dehydration system. This formula also applies to systems using MEG.

$$U_{CH4} = V_{NG} * Mol\%_{CH4} * \rho_{CH4} * t * 10^{-5}$$

Where:

U_{CH4} Methane emissions from the TEG reboiler in the reporting period (tonnes)

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[8] http://sales.gastechnology.org/000102.html
[9] Aspen HYSYS | Process Simulation Software | AspenTech
[10] Norsk olje & gas (Norog), Appendix B – Guideline 044 – ver. 16 – Handbook for quantifying direct methane and NMVOC emissions, 2018

V_{NG} Flow rate of natural gas into the reboiler (m^3 / h)

$Mol\%_{CH4}$ Mol% or volume% methane in the stripping gas

ρ_{CH4} Methane density (kg / m^3) at standard condition

t Number of operating hours in the reporting period (hours)