**NEW MEXICO AIR QUALITY BUREAU**

**NSR & TV: GLYCOL DEHYDRATOR MONITORING PROTOCOL –**

**PERMIT TEMPLATE LANGUAGE**

**Version: May 23, 2011**

Purpose. These guidelines are intended to help permit specialists consistently apply and include monitoring conditions into construction or operating permits in accordance with 20.2.72.210 NMAC or 20.2.70.302 NMAC. When necessary, each permit writer shall review and adjust the requirements below according to the specific facility circumstances.

All glycol dehydrators are combustion devices subject to 20.2.61 NMAC and opacity monitoring, unless they qualify for the exemption under 20.2.61.109 NMAC (see permit template for opacity language).

**If the affected unit is subject to 40 CFR 63 Subpart HH or HHH Major Source requirements or subject to 40 CFR 64, CAM Rule, then Conditions A through D will usually not apply.**

**Hourly VOC emission limits are usually not appropriate.**

## Glycol Dehydrator

1. Extended Gas Analysis and GRI-GLYCalc calculation (Unit(s) X, Y, and Z)

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| **Requirement:** To demonstrate compliance with the allowable VOC emission limits in Table 106.A, the permittee shall conduct an annual extended gas analysis on the dehydrator inlet gas and calculate emissions using GRI-GLYCalc. |
| **Monitoring:** The permittee shall conduct an annual GRI-GlyCalc analysis using the most recent extended gas analysis, and verify the input data. The permittee may use a method of calculating dehydrator emissions other than the most current version of GRI-GlyCalc if approved by the Department. Changes in the calculated emissions due solely to a change in the calculation methodology shall not be deemed an exceedance of an emission limit. |
| **Recordkeeping:** The permittee shall identify in a summary table all parameters that were used as inputs in the GRI-GLYcalc model. The permittee shall keep a record of the results, noting the VOC and HAP emission rates for the dehydrator obtained from estimates using GRI-GLYcalc. |
| **Reporting:** The permittee shall report in accordance with Section B110.  |

1. Extended Gas Analysis and GRI-GLYCalc calculation (Unit(s) X, Y, and Z) [With air cooled condenser – may not be sufficient for liquid cooled.]

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| **Requirement:** To demonstrate compliance with the allowable VOC emission limits in Table 106.A, 1) the dehydrator shall be equipped with a [make, model] condenser and 3) The permittee shall conduct an annual extended gas analysis on the dehydrator inlet gas. |
| **Monitoring:** The permittee shall conduct an annual GRI-GlyCalc analysis using the most recent extended gas analysis, and verify the input data. The permittee may use a method of calculating dehydrator emissions other than the most current version of GRI-GlyCalc if approved by the Department. Changes in the calculated emissions due solely to a change in the calculation methodology shall not be deemed an exceedance of an emission limit. |
| **Recordkeeping:** The permittee shall identify in a summary table all parameters that were used as inputs in the GRI-GLYcalc model. The permittee shall keep a record of the results, noting the emission rates for the dehydrator obtained from estimates using GRI-GLYcalc. |
| **Reporting:** The permittee shall report in accordance with Section B110.  |

1. Glycol pump circulation rate (Unit(s) X, Y, and Z)

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| **Requirement:** To demonstrate compliance with the allowable VOC emission limits in Table 106.A, the glycol pump circulation rate for [the, each] unit shall not exceed XX gallons per hour (XX gallons per minute).  |
| **Monitoring:** The permittee shall monitor the circulation rate [weekly, monthly, quarterly]. [Choose one] Monitoring shall include a calibration [or] visual inspection of pump rate setting [or] other method previously approved by the Department. |
| **Recordkeeping:** The permittee shall maintain records that include a description of the monitoring and are in accordance with Section B109. |
| **Reporting:** The permittee shall report in accordance with Section B110.  |

1. Control Device Inspection (Unit(s) X, Y, and Z)

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| **Requirement:** To demonstrate compliance with the allowable VOC emission limits in Table 106.A, [insert NSR operational requirement, examples follow] 1) [reboiler] the still vent emissions shall be routed at all times to the reboiler firebox, 2) [condenser] the still vent emissions shall be routed at all times to the condenser, 2) [flare] the still vent emissions shall be routed directly to the flare and destroyed, 3) [recycling] the flash tank vent shall be routed at all times to a process point that allows the off-gas to be recycled and recompressed, and not vented to the atmosphere, 4) [inlet scrubber] the still vent and flash tank emissions shall at all times be routed to the compressor inlet scrubber using a closed loop system. The closed loop system shall be designed and operated so that there are no detectable emissions. At no time shall any emissions be emitted directly to the atmosphere, 5) [VRU] the still vent emissions shall be routed to the vapor recovery unit (VRU) and re-injected into the process stream. The VRU shall consist of a closed loop system of seals, ducts, and compressor that will re-inject the gases into the gas gathering pipeline. The VRU shall be operational at all times the facility is in operation. The VRU shall be installed, operated, and maintained according to manufacture’s specifications that are representative of 99% or greater control efficiency.  |
| **Monitoring:** The permittee shall inspect the glycol dehydrator and the control equipment semi-annually [or specify other frequency as necessary] to ensure it is operating as initially designed [or in accordance with the manufacturer’s recommended procedures]. [Insert the following if the dehy reboiler also has emission limits] The permittee shall also inspect that the reboiler is operating as initially designed [or in accordance with the manufacturer’s recommended procedures]. |
| **Recordkeeping:** The permittee shall record the name of the person conducting the inspection and the results of all equipment and control device inspections chronologically, noting any maintenance or repairs needed to bring the dehydrator into compliance. [Insert the following if recommended procedure language is used in box above] The permittee shall maintain a copy of the manufacturer’s maintenance recommendations. |
| **Reporting:** The permittee shall report in accordance with Section B110.  |

[Sources **subject to** 40 CFR 63, Subpart HH that **meet the benzene exemption criteria**:

The condition needs to be adjusted if the facility claims the exemption based on throughput.]

1. 40 CFR 63, Subpart HH (Unit(s) X, Y, and Z) [Exempt from general standards]

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| **Requirement:** The unit(s) is/are subject to 40 CFR 63, Subpart HH and the permittee shall comply with all applicable requirements. |
| **Monitoring:** The permittee shall monitor as required by 40 CFR 63.772(b)(2) to demonstrate facility is exempt from general standards. |
| **Recordkeeping:** The permittee shall generate and maintain the records required by 40 CFR 63.774(d)(1)(ii) to demonstrate compliance with the general standard exemptions found in 40 CFR 63.764(e).  |
| **Reporting:** The permittee shall meet all applicable reporting in 40 CFR 63, Subparts A and HH and in Section B110. |

[Sources **subject to** 40 CFR 63, Subpart HH]

1. 40 CFR 63, Subpart HH (Unit(s) X, Y, and Z)

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| **Requirement:** The unit(s) is/are subject to 40 CFR 63, Subpart HH and the permittee shall comply with all applicable requirements, including the general standards of 40 CFR 63.764. |
| **Monitoring:** The permittee shall comply with the monitoring requirements of 40 CFR 63.773. |
| **Recordkeeping:** The permittee shall comply with the recordkeeping requirements of 40 CFR 63.774. |
| **Reporting:** The permittee shall comply with the applicable reporting requirements of 40 CFR 63.775 and in Section B110. |

[**Case by Case Determination:** Dehydrator has restrictions on its gas-processing rate]

1. Gas Throughput (Unit(s) X, Y, and Z)

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| **Requirement:** To demonstrate compliance with the allowable VOC emission limits in Table 106.A, the unit(s) inlet gas stream shall not exceed XX MMscf/day. The permittee shall [install/maintain] a flow meter that measures the flow rate of gas into or out of the dehydrator. |
| **Monitoring:** The permittee shall monitor the natural gas flow rate daily (in units of MMscf/day). |
| **Recordkeeping:** The permittee shall record the daily total of natural gas throughput each day in units of MMscf/day and in accordance with Section B109. |
| **Reporting:** The permittee shall report in accordance with Section B110. |

**BACKGROUND INFORMATION**

(Not for inclusion in permit)

**Introduction**

Glycol dehydrators are used extensively at oil well sites to remove moisture from casinghead gas before the gas is pressurized and injected into a gathering pipeline. Failure to remove water results in the formation of crystalline hydrates at the high pressures used to transport the gas. Hydrates can block pipelines, jam valves, and can generally wreak havoc on pipeline equipment and instrumentation.

The reboiler from a glycol dehydrator in the worst cases can discharge more than a hundred tons per year of VOCs and similar amounts of H2S into the atmosphere. VOC emissions from dehydrators are profuse when the dehydrator processes natural gas containing large amounts of natural gas liquids, especially aromatics.

**Operating Principles of a Glycol Dehydrator**

The figures attached show simple flow schematics of TEG and EG glycol dehydrators. Moisture removal takes place in the absorber tower where lean glycol contacts the moist gas. The glycol's high affinity for moisture allows the gas to transfer most of the water to the glycol. The dry gas exits the absorber and is ready to be injected into a gas gathering system.

The rich glycol from the absorber tower is piped to the regenerator where the moisture is boiled off by heat supplied from an external burner. The water vapor discharges directly into the atmosphere through the still vent. The lean glycol is now ready to be re-circulated into the absorber tower to remove more moisture, thereby starting a new cycle.

**Character of Emissions from a Glycol Dehydrator**

Triethylene glycol, the most commonly used glycol at dehydrator stations, is well known not only for its affinity for water, but also for its affinity for H2S, CO2, and hydrocarbons. During dehydration, these materials dissolve in the glycol only to be discharged into the atmosphere during the glycol reboiling step.

Most estimates of dehydrator emissions rely on the computer code GRI-GLYcalcwritten by Radian Corp. Both GRI-GLYcalc and stack tests show that even a small field dehydrator operating on rich field gas can dump up to 50 tons per year of VOCs into the atmosphere. The GRI-GLYcalc model was written for dehydrators using triethylene glycol (TEG) or ethylene glycol (EG) but not for dehydrators using diethylene glycol (DEG). Fortunately only a small percentage of dehydrators use DEG. The Bureau will assume that VOC emissions from a DEG dehydrator is 50% to 70% of the emissions predicted for a similar TEG dehydrator.

**Estimating VOC Emissions**

Although GRI-GLYcalc sometimes overestimates VOC emissions, the program represents the only practical method to estimate VOC emissions for the great variety of conditions under which a dehydrator operates. According to a short article in the October 1995 issue of the Gas Research Institute's NewsLine, page 5, EPA has approved use of GRI-GLYcalc for emissions inventory purposes. EPA's blessing of GRI-GLYcalc should reassure our agency to some extent of the validity of the program.

The two most important parameters that determine VOC emissions are the gas composition and the glycol re-circulation rate (see attached 2009 Williams Four Corners Study). Other important variables are the pressure and temperature of the absorber tower, and the gas-processing rate. VOCs can be extracted from wet gas only to the extent that the glycol can hold the glycol molecules; this ability depends on the amount of glycol to which the gas is exposed. The amount of glycol seen by the wet natural gas is directly dependent on the flow rate produced by the recirculation pump.

Most estimates of VOC emissions from dehydrators assume a glycol re-circulation rate that in many cases is significantly below the pump's capacity. For example, a company will submit a dehydrator's VOC emissions based on a re-circulation rate of 1.5 gpm when in fact the pump is capable of 3 gpm. Therefore, the dehydrator's potential to emit (P.E.R.) is about twice the value submitted by the company and the permit specialist needs to take the higher flow scenario into account. Glycol pump capacities should be listed in the equipment capacity column of the application but some companies do not submit the capacity of the glycol pump, this number must be obtained by talking to the appropriate contact. If the calculations are based on less than the maximum pump capacity then a condition limiting the rate with monitoring is required.

Other methods of estimating emissions were derived from sampling and analytical research conducted by GRI. This research involved the comparison of the Total Capture Condensation (TCC) method, the Pressurized Rich/Lean Glycol Method (PRL) and the Atmospheric Rich/Lean Glycol Method (ARL). The EPA regards the TCC method as the most accurate method for estimating emissions.

Results of these comparisons show that PRL and ARL methods agreed well with the TCC benchmark results for total VOCs for dehydrators equipped with flash tanks and do not use a stripping gas. However, the comparison results do not agree, as well for dehydrators without flash tanks or use a stripping gas in which case, the TCC method is the only acceptable method.

**VOC Control Methods**

The principal methods used in the oil and gas industry to control the VOCs from the glycol dehydrator are incineration or condensation of the still gases.

Incineration may not be desirable when H2S emissions are copious since large amounts of SO2 would be emitted to the atmosphere. In addition, ordinary incineration is not always successful due to the large moisture content of the still vent gases, which make their ignition very difficult. To ensure proper incineration, supplemental methane must usually be added to the vent gases. Dehydrators at remote sites generally make use of the glycol reboiler furnace to incinerate the still gases.

Condensation is adequate provided the still gases can be cooled well below the condensation point of the most abundant VOC species. Most field condensers use air-cooling, a method that is adequate when ambient temperatures are low or moderate. When ambient temperatures exceed 90oF, condensation of the VOCs may be ineffective and VOCs escape into the atmosphere. However, it the exit temperature from the condenser is equal to or below the design temperature, the condenser is meeting the designed removal efficiency. A second problem with condensation is that the condensed water contains VOCs and may itself become a hazardous waste requiring proper disposal.

One control method which has been approved by our Bureau that does not use incineration or condensation involves collecting the gas from the dehydrator, separating out the water, and reinjecting the VOCs and H2S into the sour pipeline from which they came, thereby causing very few emissions into the atmosphere.

**Stack Tests**

There is at this time a lack of experience with field tests on glycol dehydrators. A major obstacle to accurate stack measurements is the extremely low flow velocity of the stack gas, typically a few inches per second. Total capture methods have been used by emission testers to determine the emissions and this system is favored by Cubix Corporation, which appears to have had success with the method. Other methods include the pressurized rich/lean glycol method (PRL) and the atmospheric rich/lean glycol method whereby the inlet and outlet glycol streams to the dehydrator are sampled for VOC and the loss of VOC is attributed to the absorber tower. These methods also appear to have had some success in the field.

**Compliance Determination**

The most practical way for sources to determine compliance with emission limits from glycol dehydrators is to conduct an annual gas analysis and use the GRI-GLYcalc program to estimate emissions. The company should be asked to monitor the parameters needed to estimate emissions then plug these numbers into the program. In addition, sources demonstrate compliance with dehydrator still vent emissions by monitoring the glycol pump circulation rate.

**Operating Scenarios**

The following possible operating scenarios were identified for a plant that is major under Title V.

 1. Plant is **major/minor** for VOC,

2. a) Plant **has/does not have** an NSR permit, or,

b) If plant has an NSR permit, the permit **has/does not have** VOC limits,

3. Sum of potential emission rates (P.E.R.s) for all dehydrators is **major/minor** for VOC, where:

VOC P.E.R. = the VOC emission rate of the dehydrator under the following conditions:

a) the dehydrator's full rated gas flow capacity,

b) the glycol pump's full rated flow capacity,

c) the expected average annual inlet gas composition,

d) no VOC control equipment, and no operational limits to control VOC (hours, throughput),

e) 8760 hours per year continuous operation.

 4. Plant has **one/multiple** dehydrator(s),

5. One or more dehydrators is **required/not required** by the NSR permit to have VOC controls, (i.e. for one or more dehydrators the potential emission rate (P.E.R.) is **much greater than/equal to** the controlled emission rate.)

6. The permittee has estimated the VOC emissions of one or more dehydrators using the **full/partial** capacity of the dehydrator's glycol pump.

 7. The VOC content of the wet gas is **relatively steady/variable**.

**JUSTIFICATION**

(Not for inclusion in permit)

**Use of Potential Emission Rate instead of Actual Emission Rate**

Potential Emission Rate (P.E.R.) was selected as the major criterion for determining monitoring frequency and for the need to carry out an initial test because P.E.R. reflects the dehydrator's potential to damage the atmosphere more than do actual emissions. Should the VOC controls on the dehydrator be operated improperly or should fail, the actual emission rate could increase by a factor of ten or so and cause more environmental damage than a poorly operated dehydrator without controls. Using P.E.R. would ensure, for example, that a dehydrator with 10 tpy actual VOC emission but 100 tpy P.E.R. would not escape close scrutiny.

**Frequency of Monitoring Based on Potential Emission Rate Level**

Annual extended gas analysis and GRI-GLYCalc calculations along with quarterly glycol pump circulation rate monitoring were selected for all dehydrators.

Semiannual control device inspection was also selected for dehydrators with controls. The inspection is straightforward and should take no more than a few hours.

**2009 Williams Four Corners Study**

The two critical variables with the greatest impact on predicted emissions are 1) hydrocarbon species analysis and 2) glycol circulation rate. Dehydrator gas volumes do not impact VOC emissions. This was demonstrated through use of simulated GLYCalc runs as shown below.

## REFERENCES

1. Engineering Data Book, Gas Processors Suppliers Association, Tenth Edition, 1994, Chapter 20 (Dehydration).

2. EPA Document #EPA/600/SR-95/046, Project Summary, Glycol Dehydrator BTEX and VOC Emission Testing Results at Two Units in Texas and Louisiana.

3. Glycol Dehydrator Emissions: Sampling and Analytical Methods and Estimation Techniques, Gas Research Institute/Radian Corporation, March 1995, Chapters 6 and 8.

4. Technical Reference Manual for GRI-GLYCalc: A Program for Estimating Emissions from Glycol Dehydration of Natural Gas Version 3.0, Gas Research Institute/Radian Corporation, March 1996, Chapter 2.

## REFERENCES

1. Engineering Data Book, Gas Processors Suppliers Association, Tenth Edition, 1994, Chapter 20 (Dehydration).

2. EPA Document #EPA/600/SR-95/046, Project Summary, Glycol Dehydrator BTEX and VOC Emission Testing Results at Two Units in Texas and Louisiana.

3. Glycol Dehydrator Emissions: Sampling and Analytical Methods and Estimation Techniques, Gas Research Institute/Radian Corporation, March 1995, Chapters 6 and 8.

4. Technical Reference Manual for GRI-GLYCalc: A Program for Estimating Emissions from Glycol Dehydration of Natural Gas Version 3.0, Gas Research Institute/Radian Corporation, March 1996, Chapter 2.

Figures - Typical glycol dehydrator flow configurations for TEG Units.



Air emissions from TEG units are caused by the solubility of natural gas constituents in TEG. Emissions of aromatic hydrocarbons are of primary concern because TEG has a high affinity for these compounds. As a result, a significant fraction (5-35%) of the benzene, toluene, ethylbenzene, and xylenes (collectively known as BTEX) may be removed from the wet natural gas. Because of their high solubility, the BTEX compounds are not flashed from the glycol at typical flash tank conditions. Most of the BTEX is separated from the glycol in the regenerator. Although many of the lighter hydrocarbons may be removed from the glycol in the flash tank, some remain in the glycol and are also driven from the glycol in the regenerator.

Figures - Typical glycol dehydrator flow configurations for EG Units.



Ethylene glycol (EG) units are generally used for a different purpose than TEG units and, therefore, are significantly different in design. Ethylene glycol is used as a hydrate inhibitor in the low-temperature recovery of natural gas liquids. The figure below shows a typical EG unit. As the figure illustrates, glycol is injected into the moist natural gas downstream of any water knockout. The glycol/gas mixture then flows through a series of heat exchangers, where it is cooled to a low temperature (-30 to +20°F). At the low temperature, the gas is separated from the liquid mixture of glycol, water, and condensed hydrocarbons. The liquids are pumped to a low-pressure separator where the light hydrocarbons are flashed and the heavier hydrocarbons are recovered as a liquid product. From the separator, the glycol/water phase is sent to a regenerator to remove the water.

As is the case in a TEG system, the EG absorbs a fraction of the natural gas constituents which are either removed from the glycol in the flash separator or in the regenerator. The regenerator off-gas may be vented to the atmosphere or sent to an emissions control device