Minimizing Benzene Emissions from Glycol Dehydrators

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Emissions control criteria [2] recently set forth in provincial non-regulatory programs in British Columbia, Alberta, and Saskatchewan have focused attention on reducing benzene emissions from glycol dehydrators. Guidelines presented here for operation and design of triethylene glycol dehydrators with benzene emissions reduction in mind are intended to help dehydrator owners and operators choose effective and economic ways to comply with these criteria. This article approaches this topic assuming readers are familiar with glycol dehydrator equipment and operation.

Benzene in natural gas production is typically found in rich gas associated with oil production, but can be encountered in any natural gas. Reported concentrations of benzene (or BTEX components) in feed gas to dehydrators range from 0.01 to 0.1 mol % [1,3].

Significant amounts of benzene from feed gas may be absorbed by glycol in the absorber tower because aromatics are highly soluble in triethylene glycol [3] at the relatively high pressure and low temperature tower operating conditions. The absorbed benzene is almost completely liberated from the glycol at the relatively low pressure and high temperature conditions in the regenerator, and exits the regenerator with the still vent vapors.

Operation

The most effective way to reduce benzene emissions from glycol dehydrators without emissions control equipment is to reduce glycol circulation rate. Benzene emissions are directly proportional to glycol circulation rate.

If a dehydrator without emissions control equipment is operating outside of the following guidelines, it may be circulating more glycol than required;

- Glycol circulation rate between 2.5 and 5 US gallons per pound of water removed from the feed gas stream
- Regenerator stripping or sparge gas flow rate of 3.0 to 5.0 standard cubic feet (SCF) per US gallon of glycol circulated (stripping gas in most cases is an insignificant contributor to total benzene emissions)
- Reboiler temperature set at 400 ^{o}F (some operators use slightly higher stripping gas rates to allow for a slightly lower reboiler set temperature)

The above operating guidelines apply to most glycol dehydrators designed to dehydrate 100% water saturated feed gas to meet 65 mg / m^3 (4# / MMSCF) dry gas water content.

If operating conditions in the absorber tower can be controlled, pressure should be set as high as possible, and temperature set as low as practical (without hydrating or causing glycol “hang up” in the absorber), so that the water content of the feed gas is minimized. This will, in turn, minimize benzene emissions by reducing required glycol circulation rate. One might initially think that these operating conditions would maximize benzene emissions, since glycol’s affinity for benzene increases with increasing pressure (except in retrograde) and increases with decreasing temperature, but these effects are minor in comparison to circulation rate when dehydrating water saturated feed gas.

Process Design

Flash Tank

Limited reductions in still vent benzene emissions can be achieved if a flash tank is installed downstream of the lean/rich exchanger so that it operates at 260 – 285 ^{o}F, but problems handling the flash tank vapors may arise due to hydrocarbon or water condensing out of the flash vapors.

A low pressure rich glycol flash tank is required for efficient “add on” still vent condenser operation.

Additional Stages (trays or packing) in Absorber

The number of equilibrium stages installed in the absorber tower has little effect on the quantity of benzene absorbed by glycol [(3)], so adding trays or packing (either random or structured) can reduce benzene emissions by reducing required glycol circulation rate in many cases. However, attention must be given to proper glycol distribution and contact with process gas in the tray or packing design. At low glycol circulation rates, proper glycol distribution and contact with the process gas in the absorber tower may be difficult to achieve.

“Add On” Emissions Control Equipment

Incinerators

Incinerators, when properly operating, will almost completely destroy benzene and all other combustible emissions from the glycol regenerator still vent, and any other source tied into the incinerator feed. Make sure that provision for protecting the incinerator from liquid carryover or partial condensation of its feed vapors is included in the installation plans. In addition, ensure that the incinerator vendor is aware of all potential variations in feed flow, including fluctuations in vapor flow rate from the regenerator still vent.

Still Vent Condensers

The amount of light non-condensable components present in still vent vapors fed to the condenser has a direct impact on the amount of benzene remaining in residual vapors. As a result, use of stripping gas may have to be significantly limited or even eliminated depending on the desired level of benzene recovery from still vent vapors. This means that, for most applications, required glycol circulation rate will increase significantly in order to maintain dry gas specification. Make sure that the absorber trays, and glycol regeneration system can accommodate this required increase in glycol circulation rate.

Also, a low pressure rich glycol flash tank must be installed to reduce the amount of light components entering the regenerator with the rich glycol.

Proprietary Technology

Processes such as Drizo, Coldfinger, Ecoteg, and EDB deserve consideration in applications where the plant site is accessible and electric power available, but are generally not economic in remote well site applications.

REFERENCES

1. Brad Johnson, PanCanadian Petroleum Ltd, Gary Webster, Canadian Association of Petroleum Producers, *Report on Glycol Dehydrator Emissions Study*, Canadian Association of Petroleum Producers, June 1995.

2. *Best Management Practices for the Control of Benzene Emissions from Glycol Dehydrators,* Working Group on Benzene Emissions from Glycol Dehydrators, November 1997.

3. Carl W. Fitz, The University of Oklahoma, R. A. Hubbard, John M. Campbell & Co., "**Quick manual calculation estimates amount of benzene absorbed in glycol dehydrator,**" Oil & Gas Journal. November 23, 1987, p.72

4. Steve Jones & Sarah Lee, British Gas Tunisia Ltd., Megan Evans, & Roger Chen, IPSI LLC, "**Simultaneous Removal of Water and BTEX from Feed Gas for a Cryogenic Plant"**, Proceedings of the Seventy Eighth GPA Annual Convention.

5. Carrie M. Beitler & Curtis O. Rueter, Radian International LLC, C. Richard Sivalls, Sivalls Inc., James M. Evans, Gas Research Institute, **"Design and Operation of Glycol Dehydrators and Condensers"**, Proceedings 1997 Laurance Reid Gas Conditioning Conference, University of Oklahoma, Norman, OK.

6. Michael W. Hlavinka, Vincente N. Hernandez-Valencia, & Jerry A. Bullin, Bryan Research & Engineering, Inc., **"Influence of Process Operations on VOC and BTEX Emissions from Glycol Dehydration Units"**, Proceedings of the Seventy Second GPA Annual Convention.